

The Role of Artificial Intelligence and the Nurse Manager in Operating Room Flow Management: A Descriptive Study

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Abstract

Introduction. Operating room flow management represents a major challenge for contemporary healthcare systems, with implications for operational efficiency, quality of care, patient safety, and organizational well-being. Artificial intelligence (AI) may offer opportunities to optimize surgical planning, reduce waiting times, and improve coordination within operating rooms. In parallel, the Nurse Manager (NM), with advanced competencies in Operating Room Management, may play an important role in facilitating technological and organizational innovation. This descriptive study explored Italian operating room nurses' knowledge and perceptions regarding the use of AI and the contribution of the NM to operating room flow management, with particular attention to perceived opportunities and implementation barriers.

Methods. A structured questionnaire was administered to 94 operating room nurses working in 40 healthcare organizations across 13 Italian regions. The survey investigated professional experience, knowledge and perceptions of AI-based operating room management technologies, perceived barriers to implementation, willingness to undertake specific training, and opinions regarding the role and competencies of the NM. Data were analyzed using descriptive methods.

Results. Among respondents, 73.4% reported being unaware of AI-based software for operating room flow management, while 52.1% considered the integration of such systems important for improving operational efficiency. A total of 83% expressed willingness to participate in specific AI training. The NM was

considered potentially useful for improving operating room management by 80.9% of respondents, while 84.1% indicated that this professional could facilitate the adoption of new technologies. Cultural resistance to change, limited resources, and insufficient training emerged as the main implementation barriers.

Discussion. The findings indicate substantial interest in technological innovation despite limited current familiarity with AI-based systems. Targeted education, organizational investment, and strengthened advanced nursing management competencies may support the sustainable integration of AI into Italian operating room workflows.

Keywords: Artificial Intelligence, Operating Rooms, Perioperative Nursing, Nursing Management, Nurse Managers, Workflow

Introduction

Operating room flow management encompasses the processes governing the surgical patient pathway, from the preoperative phase through discharge (Marzi & Torricelli, 2023; Guerriero & Guido, 2011). Its purpose is to balance operational efficiency and quality of care, with direct implications for patient safety, organizational well-being, and economic sustainability. The operating room complex is, in fact, an essential component of every hospital, significantly affecting costs, workload, and revenue (Pakhare et al., 2022).

Effective organization of staff roles and activities, together with clear and coordinated communication, can help reduce discomfort and work-related stress among healthcare personnel (Gruppo di lavoro ISS Salute mentale ed emergenza COVID-19, 2020). Experience gained during the COVID-19 pandemic also showed that robust infrastructure and well-defined procedures not only ensure staff safety but also help improve the resilience and overall efficiency of healthcare organizations (Fereidouni et al., 2023). Conversely, the lack of effective strategies tends to increase hospital costs, lengthen waiting lists, and compromise equity and access to care (WT Solutions, 2021; Getinge, 2019). In the current context, the adoption of artificial intelligence (AI)-based technologies is transforming scheduling and real-time monitoring, supporting safer and more efficient processes (Cosmai et al., 2024).

Operational and Logistical Management of the

Surgical Pathway

Appropriate management of the surgical pathway requires accurate planning, preparation, and logistical organization, including patient assessment, medical history review, and the coordination of personnel and materials (Marzi & Torricelli, 2023). Delays or errors at this stage may lead to unexpected reallocations, increasing the risk of inefficiencies. Galeazzi-Sant'Ambrogio represents an exemplary case, as the adoption of innovative technological solutions increased the punctuality of operating room admissions from 55% to 92% (WT Solutions, 2024). Furthermore, the absence of standardized protocols and adequate communication among surgical teams may worsen delays and scheduling overlaps, as highlighted in the guidelines of AOU Federico II of Naples (Azienda Ospedaliero Universitaria Federico II, 2022).

During surgical procedures, tools such as ORControl can improve turnover and reduce idle time between one operation and the next (Marzi & Torricelli, 2023; WT Solutions, 2021). At Galeazzi-Sant'Ambrogio, the implementation of these solutions increased operating room utilization from 60% to 90% (WT Solutions, 2024). A growing number of healthcare organizations also use AI and machine-learning algorithms to detect anomalies in real time (Ng et al., 2022), enabling timely corrective action and minimizing decision-making delays (WT Solution, 2021). This technology allows a prompt response to emergencies (Cosmai et al., 2024; Getinge, 2021), owing to its high dynamic adaptability, which makes the operating room system safer and

more responsive.

Postoperative patient management and discharge planning directly affect bed availability and the scheduling of new procedures. AI-based systems designed for continuous monitoring of vital signs allow early detection of complications (Ng et al., 2022). Moreover, effective discharge planning—as emphasized by Guerriero and Guido (2011)—reduces waiting lists and increases patient turnover, thereby optimizing overall resources.

The Role of AI in Surgical Pathway Management

AI plays a leading role throughout the surgical pathway, generating benefits ranging from cost containment to reduced waiting times. According to Sheth et al. (2022), AI-based preoperative planning software can minimize the number of surgical trays required and the associated sterilization costs. Furthermore, machine-learning models such as XGBoost and Random Forest (Bartek et al., 2019; Chu et al. 2022) provide more accurate predictions of procedure duration, supporting more rational operating room management.

AI can also predict the daily surgical demand (Riahi et al., 2023; Hassanzadeh et al., 2022) and coordinate the activities of downstream units such as recovery units and intensive care units (Eshghali et al., 2023). The use of Bluetooth Low Energy (BLE) devices (Bottani et al., 2023) improves patient tracking and the quality of the data collected, enabling even more accurate predictions (Bellini et al., 2024). AI-based monitoring of surgical instruments also helps reduce packaging errors (Zhu et al., 2019). The technologies described in the CADTH Horizon Scan (2024) likewise highlight the potential of AI to optimize patient flow, manage hospital resources, and accurately predict discharges and transfers, thereby improving the overall efficiency of hospital processes (Canadian Agency for Drugs and Technologies in Health, 2024).

From Predictive Analytics to IoT Solutions and Simulation

Predictive surgical scheduling, based on machine-learning algorithms, optimizes operating room allocation and reduces non-productive time (Hassanzadeh et al., 2022). Discrete-event simulation models allow multiple organizational scenarios to be evaluated,

highlighting their impact on operating room outcomes. Integration with the Internet of Things (IoT), particularly the use of real-time BLE devices, provides smoother intrahospital flows and continuous patient monitoring (Bottani et al., 2023).

Systems such as Torin enable continuous oversight of procedures and dynamic adjustments to surgical schedules (Getinge, 2021). At Klinikum Stuttgart, the introduction of Torin resulted in a 3.4% increase in the number of surgical procedures and a 4% increase in annual revenue (Getinge, 2019).

The Nurse Manager in Operating Room Management

Within this complex setting, the NM plays a pivotal role in implementing technological and managerial innovations in the operating room. This professional, equipped with advanced competencies in Operating Room Management, is responsible for:

- Interprofessional coordination: promoting effective communication among the different professional groups and integrating technologies into operational workflows (Gruppo di lavoro ISS Salute mentale ed emergenza COVID-19, 2020).
- Education and supervision: educating staff on the use of new technologies and ensuring their consistent and informed adoption. The second-level master's degree in Operating Room Management at Università Cattolica del Sacro Cuore focuses particularly on these aspects (Università Cattolica del Sacro Cuore, 2024).
- Performance monitoring: analyzing the main efficiency indicators, identifying critical issues, and implementing corrective strategies (Cosmai et al., 2024; Bellini et al., 2024).

Through coordinated action, the NM contributes significantly to the modernization of operating room procedures, promoting the adoption of AI technologies and improvements in the overall quality of care.

Based on the evidence that emerged—which emphasizes the growing relevance of AI, the importance of optimal operating room flow management, and the strategic value of the NM—it became necessary to examine the national

context in greater detail. In particular, it was considered a priority to assess both the actual adoption of AI technologies and the recognition and use of the NM in this field. To address this need, a descriptive study was initiated to provide an essential overview of the Italian situation regarding these aspects.

Methods

Study Design

The study was designed as a descriptive survey to explore the opinions and knowledge of Italian operating room nurses regarding the use of AI in operating room flow management and the role of the NM with advanced competencies.

Sample

The questionnaire was administered to 94 nurses working in 40 healthcare organizations across 13 Italian regions (Table 1). This sample included professionals from public and private organizations, with heterogeneous representation in terms of years of experience and work settings.

Data Collection Instrument

The data collection instrument was a structured questionnaire (Appendix 1), specifically designed to explore operating room nurses' opinions, knowledge, and perceptions regarding the use of artificial intelligence (AI) and the role of the Nurse Manager (NM) holding a second-level master's degree in "Operating Room Management".

The questionnaire was divided into three main sections and comprised 19 questions using a combination of formats: closed-ended questions; multiple-choice questions; Likert-scale questions to measure the degree of agreement or perception on a scale from 1 to 5; and open-ended questions, allowing participants to provide additional details or personal opinions.

Questionnaire Structure

The questionnaire is structured into three main sections.

Table 1. Names, cities, regions, and geographical areas of the healthcare organizations represented by the respondents.

Healthcare Organization	City	Region	Area
Fondazione IRCCS Policlinico San Matteo	Pavia	Lombardia	North
ASST Sette Laghi	Varese	Lombardia	North
Fondazione Poliambulanza	Brescia	Lombardia	North
ULSS 6 Euganea	Padova	Veneto	North
Istituto Europeo di Oncologia	Milano	Lombardia	North
ASST Ospedale Maggiore di Crema	Crema	Lombardia	North
Azienda Ospedaliera di Padova	Padova	Veneto	North
ASL Torino 5	Chieri	Piemonte	North
Azienda Ospedaliero-Universitaria di Ferrara	Ferrara	Emilia-Romagna	Nord
ASL Cuneo 1	Cuneo	Piemonte	Nord
ULSS 7 Pedemontana	Bassano del Grappa	Veneto	Nord
Azienda Ospedaliera di Alessandria	Alessandria	Piemonte	Nord
ASL 4 Chiavarese	Chiavari	Liguria	Nord
Azienda Sanitaria Universitaria Friuli Centrale	Udine	Friuli-Venezia Giulia	Nord
Istituto Giannina Gaslini	Genova	Liguria	Nord
Azienda Ospedaliera Universitaria Città della Salute e della Scienza	Torino	Piemonte	Nord
Policlinico Sant'Orsola-Malpighi	Bologna	Emilia-Romagna	Nord
Azienda USL di Bologna	Bologna	Emilia-Romagna	Nord
ASST Spedali Civili di Brescia	Brescia	Lombardia	Nord
Azienda Ospedaliero-Universitaria Pisana	Pisa	Toscana	Centre
ASL Lanciano Vasto Chieti	Chieti	Abruzzo	Centre
Fondazione Policlinico Universitario Agostino Gemelli	Roma	Lazio	Centre
Ospedale Pediatrico Bambino Gesù	Roma	Lazio	Centre
Clinica Villa Margherita	Roma	Lazio	Centre
IRCCS Istituti Fisioterapici Ospitalieri	Roma	Lazio	Centre
Università Campus Bio-Medico di Roma	Roma	Lazio	Centre
Azienda Ospedaliera Santa Maria di Terni	Terni	Umbria	Centre
Azienda Ospedaliera di Cosenza	Cosenza	Calabria	South
ASL Bari	Bari	Puglia	South
ASL Medio Campidano	Sanluri	Sardegna	South
ARNAS Civico	Palermo	Sicilia	South
IRCCS Fondazione Pascale	Napoli	Campania	South
Azienda Ospedaliera Pugliese Ciaccio	Catanzaro	Calabria	South
ASL Avellino	Avellino	Campania	South
Azienda Ospedaliera Universitaria Federico II	Napoli	Campania	South
AORN Santobono Pausilipon	Napoli	Campania	South
Salus Fisiokinesiterapia Service S.r.l.	Napoli	Campania	South
Azienda Ospedaliera dei Colli	Napoli	Campania	South

The first section, devoted to work experience, collects basic information about participants, including years of service in the operating room, type of employing organization (public or private), and operational setting (operating room department, single-specialty operating room, or multispecialty operating room). It also investigates participants' perceptions of the impact of surgical list management on daily work and the organizational climate using a Likert scale.

The second section examines knowledge and perceptions of AI. In particular, it assesses familiarity with software such as Torin and ORControl, distinguishing among active use, awareness without use, and complete lack of familiarity. It examines the perceived importance of AI for improving operational efficiency, reducing workload, and facilitating communication among team members, as well as willingness to participate in specific training programs. The section also explores the main barriers to AI implementation, such as resistance to change, lack of resources, or technical complexity, and the possible impact of AI on professional responsibilities.

The third section focuses on the NM role, investigating participants' level of awareness of this professional role and its presence in their organizations. It also explores the perceived usefulness of the NM in optimizing operating room flow management and adopting AI technologies. Finally, it collects opinions on the essential competencies of an NM, including data analysis, operational flow management, leadership, and staff education.

Methods of Analysis

The data collected were analyzed using descriptive methods:

- Calculation of frequencies and percentages for each closed-ended question.
- Thematic analysis of open-ended responses to identify common trends and relevant opinions.

This analysis provided an overview of nurses' knowledge and perceptions, highlighting significant trends and barriers to the implementation of AI and the NM role in Italian operating rooms.

Results

The sample (n=94) included professionals from public and private organizations (75% vs 24.5%), with heterogeneous representation in terms of both years of experience (less than 1 year, 16%; 1–5 years, 40.4%; 6–10 years, 20.2%; more than 10 years, 23.4%) and work settings (operating room department, 51.1%; multispecialty operating room, 19.1%; single-specialty operating room, 29.8%).

Relevance of the Issue

On a Likert scale from 1 (not at all) to 5 (very much), 89.4% selected 4 or 5 in response to the question concerning whether operating room flow management is a determining factor in the department's organizational climate (Figure 1). When asked how much it affects their daily work, 75.5% of respondents selected a score of 4 or 5.

Ritieni che la gestione del flusso operatorio influisca sul clima organizzativo?

94 risposte

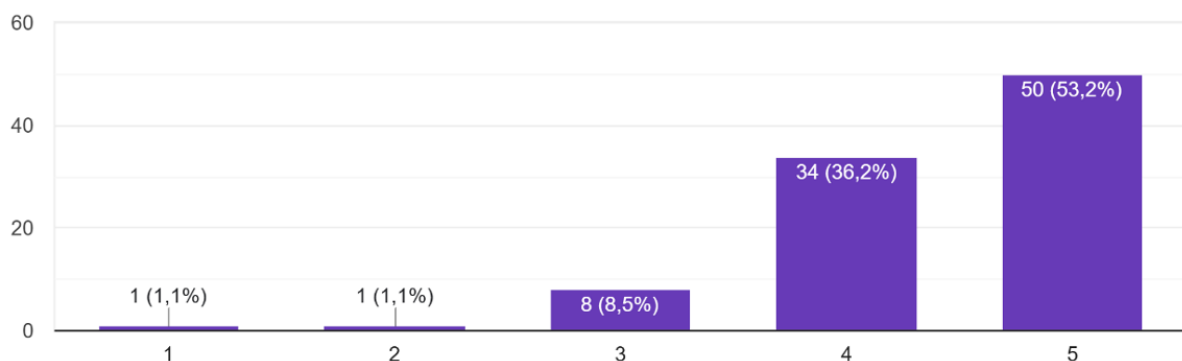


Figure 1. Perceived influence of operating room flow management on the organizational climate. Participants were asked: "Do you think that operating room flow management affects the organizational climate?"

Knowledge of AI, Opinions, and Confidence Levels

Among the Italian operating room nurses surveyed, 73.4% reported that they were unaware of AI software for operating room flow management (Figure 2). However, 52.1% recognized the importance of integrating such systems to improve operational efficiency (Figure 3). High confidence levels, corresponding to responses of 4 or 5 on a 1-to-5 Likert scale, were expressed regarding the ability of AI systems to reduce workload and work-related stress and to improve communication and coordination among members of the surgical team, by 57.5% and 51.1% of respondents, respectively. A score of 1 or 2 for both questions was assigned by fewer than 21% of the surveyed sample. Regarding confidence that AI implementation could improve patient safety, 82.6% assigned a score from 3 to 5 (3: 33.7%; 4: 35.9%; 5: 13%). Finally, the most frequently selected responses to the question “How do you think the introduction of AI could change your role in the operating room?” were increasing process supervision and monitoring (52.1%) and requiring new technological competencies (29.8%).

Role of the Nurse Manager

A total of 56.4% of the sample reported being unfamiliar with the role of an NM holding a second-level master's degree in Operating Room Management. Consistent with this finding, only

Sei a conoscenza di piattaforme o software di gestione del flusso operatorio basati su IA, come Torin?
94 risposte

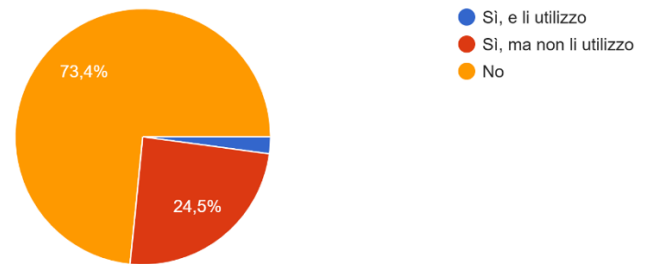


Figure 2. Awareness and use of AI-based operating room flow management platforms or software. Participants were asked: “Are you aware of AI-based operating room flow management platforms or software, such as Torin?”

3.2% of respondents reported the presence of an NM in their organization, whereas 85.1% answered negatively (Figure 4). As shown in Figure 5, 80.9% of respondents assigned a score from 3 to 5 to the question concerning the usefulness of the NM in improving operating room management. Similarly, 84.1% expressed a level of agreement from 3 to 5 that this professional could facilitate the adoption of new technologies in the operating room. Finally, the most frequently selected responses to the question “What specific competencies do you think a nurse with a master's degree in Operating Room Management should possess to support AI implementation?” were data analysis skills and use of advanced software (42.9%), leadership and coordination skills (31.9%), and operational flow management (12.1%).

Pensi che l'introduzione di un software basato su IA per la gestione del flusso operatorio sia importante per il miglioramento dell'efficienza?

94 risposte

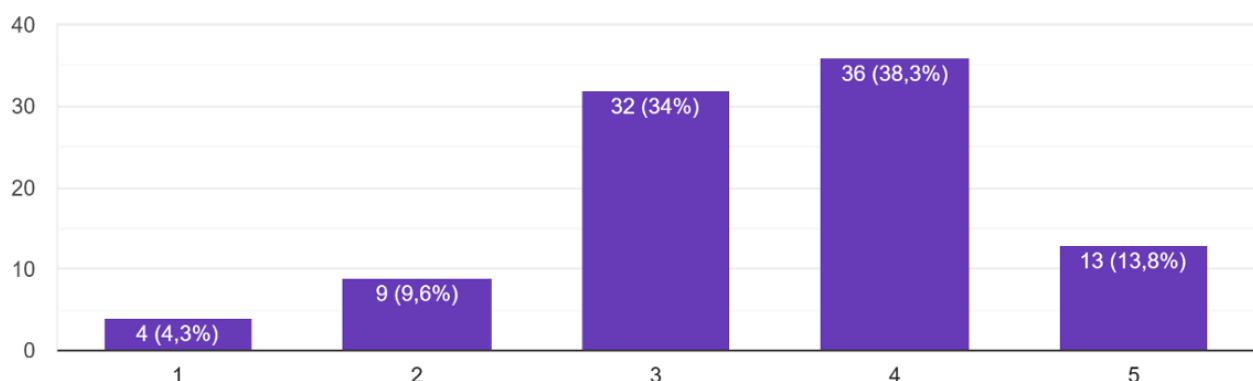


Figure 3. Perceived importance of AI-based software for improving operating room efficiency. Participants were asked: “Do you think that introducing AI-based software for operating room flow management is important for improving efficiency?”

Questa figura professionale esiste nella tua realtà lavorativa?
94 risposte

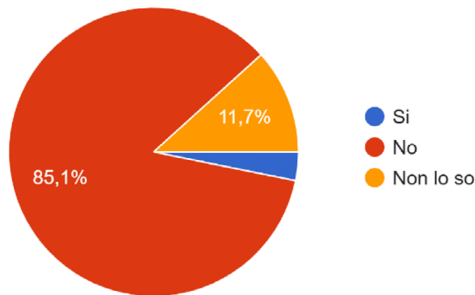


Figure 4. Presence of the Nurse Manager role in respondents' workplaces. Participants were asked: "Is this professional role present in your workplace?"

Identified Challenges

The main barriers identified in implementing AI software in respondents' workplaces were cultural resistance to change (44.7%), lack of resources or funding (23.4%), and insufficient specific training (17%) (Figure 6).

Willingness to Undertake Training

A total of 83% of nurses reported being willing to participate in specific training programs on the use of AI in the operating room (Figure 7).

Quali potenziali sfide o ostacoli vedi nell'implementazione di software basati su IA nella tua realtà lavorativa?
94 risposte



Figure 6. Perceived barriers to the implementation of AI-based software in respondents' workplaces. Participants were asked: "What potential challenges or barriers do you see in implementing AI-based software in your workplace?"

Ritieni che l'implementazione della figura dell'infermiere con master di II livello in "Operating Room Management" potrebbe essere utile per migliorare la gestione della sala operatoria?

94 risposte

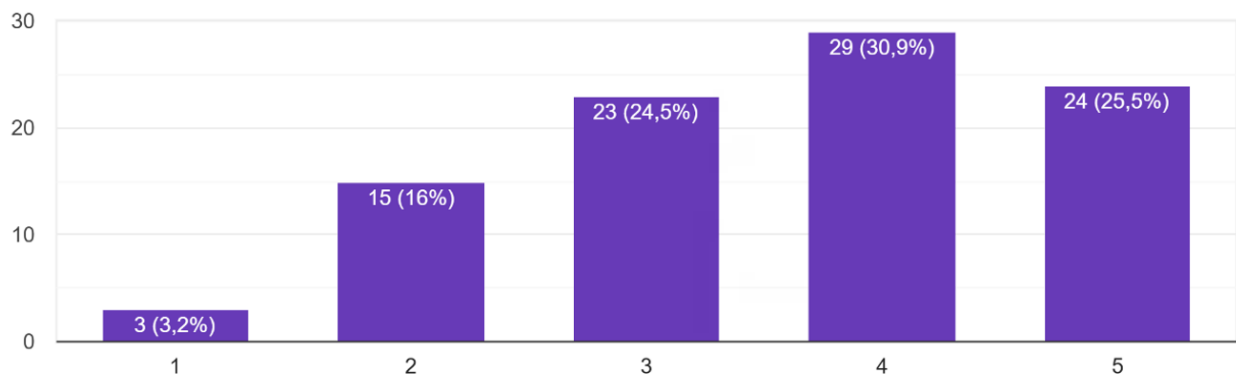


Figure 5. Perceived usefulness of a Nurse Manager with advanced training in Operating Room Management. Participants were asked: "Do you think that introducing the role of a nurse holding a second-level master's degree in 'Operating Room Management' could be useful for improving operating room management?"

Saresti disposto/a a partecipare a un training specifico per l'implementazione e l'utilizzo di un software basato su IA?

94 risposte

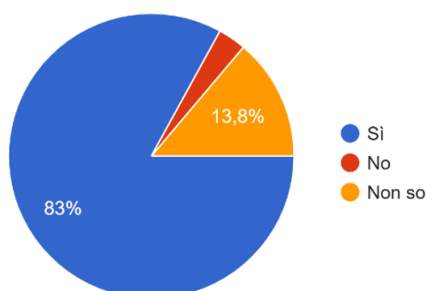


Figure 7. Willingness to participate in specific training on AI-based software. Participants were asked: "Would you be willing to participate in specific training on the implementation and use of AI-based software?"

Ethical Considerations

The study involved adult healthcare professionals who voluntarily completed an anonymous survey. Before participation, respondents received an information statement explaining the study objectives, the voluntary nature of participation, data confidentiality, and data processing procedures. The study did not involve patients, clinical interventions, or the collection of directly identifiable personal or health data. All data were analyzed and reported exclusively in aggregate form. Completion and submission of the questionnaire after reading the participant information statement were considered to constitute informed consent to participate. The study was conducted in accordance with the ethical principles of the Declaration of Helsinki.

Discussion

This multi-organizational descriptive study provides a snapshot of operating room nurses' perceptions of operating room flow management, artificial intelligence (AI), and the potential contribution of the Nurse Manager (NM) with advanced competencies in Operating Room Management. Three findings appear particularly relevant. First, operating room flow was perceived as having a substantial influence on both daily work and the organizational climate. Second, familiarity with AI-based operating room management technologies was limited, despite generally favorable expectations regarding their potential usefulness and a high willingness to undertake specific training. Third, the specialized NM role investigated in this study was rarely reported within respondents' organizations, although participants generally perceived advanced managerial and technological competencies as potentially useful for supporting operating room organization and technological innovation.

The perceived importance of operating room flow is consistent with the broader literature showing that operating room performance depends not only on technical or surgical variables but also on organizational factors, scheduling, communication, resource coordination, and team functioning. Systematic evidence indicates that operating room organization can influence surgical performance

and that organizational interventions may affect efficiency, safety, and quality-related outcomes (Pasquer et al., 2024). Similarly, audits of operating room utilization have identified delayed starts, cancellations, communication problems, and suboptimal resource planning as important sources of inefficiency (Pakhare et al., 2022). The present findings therefore reinforce the concept of operating room flow as a sociotechnical process in which scheduling, human resources, communication, technology, and clinical activities are closely interconnected rather than independent components.

An important finding is the apparent discrepancy between limited familiarity with AI technologies and openness toward their adoption. In this sample, 73.4% of respondents reported that they were unaware of AI-based software for operating room flow management, yet 52.1% rated the importance of introducing such systems for operational efficiency as 4 or 5 on a five-point scale, and 83% expressed willingness to participate in specific training. This pattern may reflect an implementation-readiness gap: nurses may recognize the potential relevance of AI while having limited direct exposure to the technologies currently available. Similar findings have been reported in nursing populations, where interest in AI frequently coexists with limited knowledge, experience, or formal education regarding its clinical application (Abuzaid et al., 2022; Alruwaili et al., 2024; Tuncer & Tuncer, 2024). Consequently, favorable attitudes toward innovation should not be considered equivalent to technological preparedness; rather, they identify an opportunity for structured professional development.

The expectations expressed by participants are also consistent with the growing literature on AI-supported operating room management. Machine-learning models have demonstrated the ability to improve predictions of surgical case duration and operating room utilization compared with conventional estimates, potentially supporting more accurate scheduling and resource allocation (Bartek et al., 2019; Chu et al., 2022; Riahi et al., 2023). Other models have been developed to forecast daily surgical demand or integrate elective and emergency scheduling, further illustrating the potential of predictive analytics in complex operating environments (Eshghali et al., 2024; Hassanzadeh et al., 2022). A systematic review

specifically examining AI in operating room management identified applications involving surgical duration prediction, scheduling, resource allocation, cancellation prediction, and perioperative capacity management (Bellini et al., 2024). Taken together, these studies support the plausibility of the benefits perceived by respondents; however, much of the available evidence concerns predictive performance and optimization models rather than prospective demonstration of improved patient, workforce, or organizational outcomes. AI should therefore be viewed as a decision-support resource rather than as a replacement for professional and managerial judgment.

This distinction is particularly important when interpreting the perceived effects of AI on workload, communication, and patient safety. In the present study, 57.5% of respondents expressed high confidence that AI could reduce workload and work-related stress, and 51.1% expressed high confidence that it could improve communication and coordination. Similarly, 82.6% assigned a score between 3 and 5 regarding AI and patient safety. These results describe expectations rather than measured effects. Reviews of AI applications in nursing have identified potentially beneficial uses in monitoring, prediction, decision support, documentation, and organizational processes, while also emphasizing heterogeneity in technologies and outcome measures and the continuing need for robust clinical evaluation (Cosmai et al., 2024; Ng et al., 2022). Therefore, future implementation studies should assess whether technological adoption actually produces measurable improvements in workload, communication, safety, and workflow rather than assuming that technical performance necessarily translates into better clinical or organizational outcomes.

The findings concerning the NM are particularly relevant from an organizational perspective. Only 3.2% of respondents reported the presence of the specialized professional role described in the questionnaire, while more than half were unfamiliar with it. Nevertheless, respondents attributed considerable potential value to competencies such as data analysis and advanced software use, leadership and coordination, and operational flow management. This profile is consistent with emerging evidence concerning the role of nurse managers in digitally transformed

healthcare environments. A recent systematic review found that AI-supported technologies may contribute to nursing management through resource optimization, decision support, risk assessment, communication, and administrative processes, while emphasizing the importance of training and interdisciplinary collaboration for successful implementation (Gonzalez-Garcia et al., 2024). Nurse managers have also been identified as important actors in creating organizational conditions in which AI can be introduced responsibly and integrated into existing clinical workflows (Peltonen & Topaz, 2022).

At the same time, these results require cautious interpretation. The finding that 80.9% of respondents selected scores from 3 to 5 regarding the usefulness of the NM includes the midpoint of the scale and should therefore be interpreted as a neutral-to-positive distribution, rather than as evidence that approximately 81% unequivocally considered the role essential. The same caution applies to the 84.1% who selected scores from 3 to 5 regarding the NM as a facilitator of technological adoption. Furthermore, the present study investigated a specific professional profile associated with postgraduate education in Operating Room Management. Existing literature supports the broader importance of nursing leadership, digital competencies, and change management, but does not establish that one specific postgraduate qualification is necessary or sufficient to produce these outcomes. The present findings should therefore be interpreted as supporting the potential value of advanced managerial competencies rather than demonstrating the effectiveness of a particular professional credential.

The barriers identified by respondents further emphasize that AI implementation is primarily an organizational change process rather than a purely technological one. Cultural resistance to change was the most frequently reported barrier (44.7%), followed by lack of resources or funding (23.4%) and insufficient specific training (17%). This finding is consistent with implementation research in the operating room. Smith et al. (2022), in developing a change-management model for AI-enabled technologies in surgical environments, highlighted early stakeholder engagement, multidisciplinary team involvement, adaptation to institutional culture, continuous communication, and

anticipation of organizational and regulatory barriers as central elements of implementation. Similarly, the nurse-management literature identifies resistance to technological change, inadequate competencies, and ethical and organizational concerns among the principal challenges to AI adoption (Gonzalez-Garcia et al., 2024). Technology alone is therefore unlikely to improve operating room flow if existing workflows, professional responsibilities, communication pathways, and organizational culture are not addressed simultaneously.

The high willingness to undertake training observed in this study represents an important opportunity. Evidence from educational interventions suggests that structured AI education can increase nurses' knowledge and understanding of AI technologies, although improvement in knowledge does not automatically produce equivalent changes in attitudes or adoption behavior (Karaarslan et al., 2024). Training for operating room professionals should consequently extend beyond basic software instruction and include data literacy, interpretation of algorithmic outputs, recognition of model limitations, workflow redesign, cybersecurity and data protection principles, ethical considerations, and human oversight. International guidance similarly emphasizes transparency, accountability, human autonomy, safety, and appropriate governance when AI is introduced into healthcare systems (World Health Organization, 2021).

From an implementation perspective, these findings support a gradual rather than technology-driven approach to AI adoption. Healthcare organizations could initially identify specific workflow problems, establish baseline performance indicators, and introduce AI-supported solutions through controlled pilot projects. Relevant outcomes could include first-case on-time starts, operating room utilization, turnover time, overtime, cancellations, scheduling accuracy, recovery-unit bottlenecks, staff workload, user acceptance, and patient-safety indicators. The NM or another appropriately trained perioperative leader could contribute by linking clinical staff, hospital management, information technology teams, and technology providers; however, the effectiveness of such a model should itself be prospectively evaluated rather than assumed.

Several limitations should be considered when interpreting the findings. The sample was relatively small and, although respondents represented 40 healthcare organizations across 13 Italian regions, it cannot be considered representative of all Italian operating room nurses. The descriptive and cross-sectional design precludes causal inference and does not permit identification of factors independently associated with attitudes toward AI or the NM role. The study relied on self-reported perceptions rather than objective measures of AI adoption, operating room efficiency, workload, or patient outcomes. In addition, the study-specific questionnaire does not report psychometric validation, which may limit the reliability and construct validity of some measures. The questionnaire also referred collectively to "AI-based" platforms and software, although contemporary operating room technologies may combine workflow control, real-time tracking, predictive analytics, and AI functions; respondents may therefore have interpreted the concept of AI differently. Finally, interpretation of Likert-scale findings should distinguish neutral midpoint responses from clearly positive responses. Future studies should use validated instruments where possible, larger probabilistic or systematically recruited samples, inferential analyses, and prospective implementation designs to determine whether AI-supported operating room management and advanced nursing leadership roles translate into measurable organizational, workforce, and patient outcomes.

Study Limitations

The study has several limitations, including the sample size and the absence of inferential statistical analysis. Furthermore, although the geographical representation was substantial, it may not reflect the entire national context.

Conclusions

This study showed that ineffective operating room flow management is perceived by nurses as a major critical issue, with consequences for the organizational climate and operational efficiency. Although the use of AI remains limited (73.4% of respondents reported being unfamiliar with its application), strong interest

in its adoption emerged, supported by broad willingness to undertake specific training (83%). Although the Nurse Manager role was poorly represented (only 3.2% of respondents reported its presence), it was recognized as essential for facilitating AI integration and promoting organizational change (84.1% believed that this professional could act as a facilitator).

The main barriers identified, such as cultural resistance to change (44.7%) and the lack of financial and educational resources (40.4%), require targeted interventions. The adoption of an integrated approach that enhances the NM role and promotes technological innovation represents a decisive step toward more efficient and sustainable operating room flow management.

Looking ahead, this study provides a basis for further research aimed at exploring organizational dynamics, measuring the impact of AI, and developing strategies to promote its adoption. The synergy between technology and advanced competencies is confirmed as a crucial lever for ensuring sustainability and innovation in Italian healthcare systems.

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References

- Abuzaid, M. M., Elshami, W., & Mc Fadden, S. (2022). Integration of artificial intelligence into nursing practice. *Health and Technology*, 12(6), 1109–1115. doi: 10.1007/s12553-022-00697-0.
- Alruwaili, M. M., Abuadas, F. H., Alsadi, M., Alruwaili, A. N., Ramadan, O. M. E., Shaban, M., Al Thobaity, A., Alkahtani, S. M., & El Arab, R. A. (2024). Exploring nurses' awareness and attitudes toward artificial intelligence: Implications for nursing practice. *DIGITAL HEALTH*, 10, 20552076241271803. doi: 10.1177/20552076241271803.
- Azienda Ospedaliera Universitaria Federico II. (2024). *Percorso del paziente chirurgico programmato: Modalità operative* [Manuale operativo].
- Bartek, M. A., Saxena, R. C., Solomon, S., Fong, C. T., Behara, L. D., Venigandla, R., Velagapudi, K., Lang, J. D., & Nair, B. G. (2019). Improving operating room efficiency: Machine learning approach to predict case-time duration. *Journal of the American College of Surgeons*, 229(4), 346–354.e3. doi: 10.1016/j.jamcollsurg.2019.05.029.
- Bellini, V., Russo, M., Domenichetti, T., Panizzi, M., Allai, S., & Bignami, E. G. (2024). Artificial intelligence in operating room management. *Journal of Medical Systems*, 48, Article 19. doi: 10.1007/s10916-024-02038-2.
- Bottani, E., Bellini, V., Mordonini, M., Pellegrino, M., Lombardo, G., Franchi, B., Craca, M., & Bignami, E. (2023). Internet of Things and new technologies for tracking perioperative patients with an innovative model for operating room scheduling: Protocol for a development and feasibility study. *JMIR Research Protocols*, 12, e45477. doi: 10.2196/45477.
- Canadian Agency for Drugs and Technologies in Health. (2024). Artificial intelligence for patient flow: Emerging health technologies (CADTH Horizon Scan, Report No. EH0125). doi: 10.51731/cjht.2024.877.
- Chu, J., Hsieh, C.-H., Shih, Y.-N., Wu, C.-C., Singaravelan, A., Hung, L.-P., & Hsu, J.-L. (2022). Operating room usage time estimation with machine learning models. *Healthcare*, 10(8), 1518. doi: 10.3390/healthcare10081518.
- Cosmai, S., Gibellato, A., Chiari, C., Valsecchi, A., Zuliani, F. M., Salvini, L., & Mazzoleni, B. (2024). Applicazioni di intelligenza artificiale nell'assistenza infermieristica: Risultati di una umbrella review. *L'Infermiere*, 61(3), e152–e165. doi: 10.57659/SSI.2024.12.
- Eshghali, M., Kannan, D., Salmanzadeh-Meydani, N., & Esmaieeli Sikaroudi, A. M. (2024). Machine learning based integrated scheduling and rescheduling for elective and emergency patients in the operating theatre. *Annals of Operations Research*, 332(1), 989–1012. doi: 10.1007/s10479-023-05168-x.
- Fereidouni, A., Teymoori, E., Maleki, Z., Ghanavati, M., & Vizeshfir, F. (2023). Relationships between job satisfaction of operating room nurses and hospital's compliance with protective guidelines during the COVID-19 pandemic: A cross-sectional study, Iran. *Journal of PeriAnesthesia Nursing*, 38(1), 51–57. doi: 10.1016/j.jopan.2022.03.007.
- Getinge. (n.d.). *Klinikum Stuttgart increased profit by 4% with Torin OR Management solution* [Customer case story].
- Gonzalez-Garcia, A., Pérez-González, S., Benavides, C., Pinto-Carral, A., Quiroga-Sánchez, E., & Marqués-Sánchez, P. (2024). Impact of artificial intelligence-based technology on nurse management: A systematic review. *Journal of Nursing Management*, 2024, 3537964. doi: 10.1155/2024/3537964.
- Gruppo di lavoro ISS Salute mentale ed emergenza COVID-19. (2020). *Indicazioni ad interim per la gestione dello stress lavoro-correlato negli operatori sanitari e socio-sanitari durante lo scenario emergenziale SARS-CoV-2: Versione del 7 maggio 2020* (Rapporto ISS COVID-19 n. 22/2020). Istituto Superiore di Sanità.
- Guerriero, F., & Guido, R. (2011). Operational research in the management of the operating theatre: A survey. *Health Care Management Science*, 14(1), 89–114. doi: 10.1007/s10729-010-9143-6.
- Hassanzadeh, H., Boyle, J., Khanna, S., Biki, B., & Syed, F. (2022). Daily surgery caseload prediction: Towards improving operating theatre efficiency. *BMC Medical Informatics and Decision Making*, 22, 151. doi: 10.1186/s12911-022-01893-8.
- Karaarslan, D., Kahraman, A., & Ergin, E. (2024). How does training given to pediatric nurses about artificial intelligence and robot nurses affect their opinions and attitude levels? A quasi-experimental study. *Journal of Pediatric Nursing*, 77, e211–e217. doi: 10.1016/j.pedn.2024.04.031.
- Marzi, L., & Torricelli, M. C. (2021). Modelli di layout e flussi. In M. Geddes da Filicaia, F. Gemmi, M. Moglia, & M. C. Torricelli (Eds.), *Il blocco operatorio: Guida ragionata alla progettazione* (pp. 157–205). Agenzia Regionale di Sanità della Toscana.
- Ng, Z. Q. P., Ling, L. Y. J., Chew, H. S. J., & Lau, Y. (2022). The role of artificial intelligence in enhancing clinical nursing care: A scoping review. *Journal of Nursing Management*, 30(8), 3654–3674. doi: 10.1111/jonm.13425.
- Pakhare, V., Gopinath, R., Surya Dhanalakshmi, S. K., Nanda, A., Kanojia, N., & Venu, P. (2022). Audit of operation theater time utilization with perspective to optimize turnaround times and theater output.

- Journal of Anaesthesiology Clinical Pharmacology*, 38(3), 399–404. doi: 10.4103/joacp.JOACP_398_20.
- Pasquer, A., Ducarroz, S., Lifante, J. C., Skinner, S., Poncet, G., & Duclos, A. (2024). Operating room organization and surgical performance: A systematic review. *Patient Safety in Surgery*, 18, Article 5. doi: 10.1186/s13037-023-00388-3.
 - Peltonen, L.-M., & Topaz, M. (2022). Artificial intelligence in health care: Implications for nurse managers. *Journal of Nursing Management*, 30(8), 3641–3643. doi: 10.1111/jonm.13858.
 - Ramolla, T., & Jürgensen, J. S. (2023). Optimierte Saalauslastung: Künstliche Intelligenz in der OP-Planung. *OP-Management up2date*, 3(1), 77–88. doi: 10.1055/a-1992-9076.
 - Riahi, V., Hassanzadeh, H., Khanna, S., Boyle, J., Syed, F., Biki, B., Borkwood, E., & Sweeney, L. (2023). Improving preoperative prediction of surgery duration. *BMC Health Services Research*, 23, 1343. doi: 10.1186/s12913-023-10264-6.
 - Sheth, B., Lavin, A. C., Martinez, C., & Sabesan, V. J. (2022). The use of preoperative planning to decrease costs and increase efficiency in the OR. *JSES International*, 6(3), 454–458. doi: 10.1016/j.jseint.2022.02.004.
 - Smith, T. G., Norasi, H., Herbst, K. M., Kendrick, M. L., Curry, T. B., Grantcharov, T. P., Palter, V. N., Hallbeck, M. S., & Cleary, S. P. (2022). Creating a practical transformational change management model for novel artificial intelligence-enabled technology implementation in the operating room. *Mayo Clinic Proceedings: Innovations, Quality & Outcomes*, 6(6), 584–596. doi: 10.1016/j.mayocpiqo.2022.09.004.
 - Tuncer, G. Z., & Tuncer, M. (2024). Investigation of nurses' general attitudes toward artificial intelligence and their perceptions of ChatGPT usage and influencing factors. *DIGITAL HEALTH*, 10, 20552076241277025. doi: 10.1177/20552076241277025.
 - World Health Organization. (2021). *Ethics and governance of artificial intelligence for health: WHO guidance*.
 - Workflow Technology Solutions. (2021, September 24). *ORControl™: Migliorare la soddisfazione lavorativa degli infermieri attraverso l'empowerment strutturale*.
 - Workflow Technology Solutions. (2024, April 18). *ORControl™ e WTS Planning per la gestione operativa della sala operatoria*.
 - Zhu, X., Yuan, L., Li, T., & Cheng, P. (2019). Errors in packaging surgical instruments based on a surgical instrument tracking system: An observational study. *BMC Health Services Research*, 19, 176. doi: 10.1186/s12913-019-4007-3.