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Surgical Robotics And Nurse Assisted Robotic Care Integration And Implications In OT Practice

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ABSTRACT

The rapid evolution of surgical robotics and nurse-assisted robotic care is transforming operating theatre (OT) practices by enhancing precision, improving workflow efficiency, and strengthening patient safety. Robotic systems such as the da Vinci platform and multimodal robotic scrub nurses now assist surgeons by facilitating instrument handling, reducing operative time, and minimizing communication errors. As these technologies expand, the role of nurses has become increasingly crucial across all perioperative phases. Pre-operatively, nurses ensure accurate patient positioning, equipment compatibility, and readiness of robotic components. During surgery, they assist with system setup, instrument calibration, tool exchange, and continuous monitoring of patient safety. Post-operatively, nurses play a vital role in assessing recovery, identifying complications, and ensuring effective transitions of care. The integration of robotics in OT practice requires significant workflow adaptation, specialized training, and strong multidisciplinary collaboration. However, challenges persist, including high costs, resistance to change, learning curves, and limitations in current robotic systems. Ethical and legal concerns also arise regarding accountability, workload burden, and the need for regulatory clarity in defining nursing responsibilities. Despite these challenges, robotics offers opportunities for innovation, including advanced automation, AI-driven decision support, and expanded nursing roles in managing robotic systems. Ongoing research, evidence-based practice, and structured education are essential for safe and effective implementation.In conclusion, robotic-assisted surgical care holds promise for improving surgical outcomes and enhancing the nursing contribution in high-tech environments. Clear policies, focused training, and ethical integration are necessary to ensure that technology complements, rather than replaces, the core human elements of nursing care.

KEYWORDS: Surgical robotics; Robotic-assisted surgery; Perioperative nursing; Robotic scrub nurse; Patient safety; Workflow integration.

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INTRODUCTION

The amalgamation of surgical robotics and nurse-facilitated robotic care is revolutionizing practices within the operating room and augmenting the quality of patient care. The performance of nursing staff and the safety of patients during robotic surgeries are comparable to those observed in conventional major surgical procedures, necessitating that patients possess specific knowledge regarding the environment and preparation of the robotic systems (1). Robotic technologies, exemplified by the multimodal robotic scrub nurse, assist surgeons by delivering instruments, thereby reducing operative duration and mitigating the risk of miscommunication (2). The evolution of robotic technologies, particularly those integrated with artificial intelligence, is noteworthy, especially with regard to the emergence of robot-assisted surgical interventions, which bolster safety and diminish infection risks during surgical operations (3). It delineates critical domains such as technical training, professional acknowledgment, patient safety, and the incorporation into operational workflows as vital for the proficient execution of robotic surgery (4). Surgical robots have progressively assumed a significant role within the realm of medical practice, evidenced by a remarkable escalation in robotic surgeries from 1.8% in 2012 to over 15% in 2020 (5). Innovations in robotics, medical informatics, and communication are reforming operating theatres by enhancing precision, accuracy, and patient safety (6). Innovations in robotics, medical informatics, and communication are reforming operating theatres by enhancing precision, accuracy, and patient safety. Ultimately, the advancement of technology in operating theatres is characterized by the introduction of robotic systems that enable healthcare professionals to execute their responsibilities with greater efficacy. The integration of robotic systems within operating theatres not only amplifies surgical precision but also addresses staffing challenges by enhancing workflow efficiency and ensuring patient safety (7).

OVERVIEW OF SURGICAL ROBOTICS:

a) Definition:

Surgical robotics delineates the employment of robotic systems to facilitate surgical interventions, thereby augmenting precision, control, and ergonomics for practitioners in the field (8).

b) History:

Investigations into robotic assistance systems for surgical applications commenced in the 1980s, with the inaugural concept, ROBODOC, unveiled in 1986 for the assistance of hip surgery. The Da Vinci system attained commercialization in 2000 and has since emerged as a preeminent surgical robot (9). The chronicle of surgical robotics commenced in the early 21st century, marked by substantial advancements in the United States, where presently over 1,300 surgical robots are operational. In Brazil, this technological innovation was first introduced in 2008 (10).

ROLE OF NURSES IN ROBOTIC-ASSISTED SURGERY

a) pre operative responsibilities

Pre-operative responsibilities of nurses in robotic-assisted surgery include ensuring patient positioning with millimeter precision, which is crucial for optimal exposure of the surgical field and adequate vascular access. Nurses must also be knowledgeable about the specific surgical procedure to prepare effectively(14). nurses in robotic-assisted surgery include capturing multimodal data for preoperative planning and ensuring that all necessary instruments and equipment are available and compatible with the robotic system(15).

b) Intra-operative roles and collaboration c) Key features and advantages

The salient characteristics of surgical robotics encompass augmented precision, the capacity to execute intricate tasks with heightened dexterity, the integration of multimodal data to facilitate superior decision-making, and the prospective utility of training and simulation methodologies to refine surgical competencies (11).

d) Current Application in Surgery:

Surgical robots are presently employed to automate the transfer of instruments within the operating theater, thereby alleviating the workload of human nursing staff and reducing the likelihood of communication errors during surgical procedures (12). Additionally, surgical robots are utilized to assist surgeons by facilitating the passing of instruments, thus permitting surgical technicians to concentrate on ancillary tasks. They are also implemented in minimally invasive operations, thereby improving safety and operational efficiency within the surgical environment (13).

During the intra-operative phase, nursing professionals are responsible for the operation of the robotic apparatus for the patient under the oversight of the surgeon. They engage in the configuration and preparation of the robotic system, which encompasses the connection of all requisite components and the calibration of the instruments. Their principal emphasis is directed towards the positioning of the patient and ensuring safety throughout the procedure (16). The responsibilities during the intra-operative phase include executing tool transitions on the robotic device, relaying the status of these modifications back to the surgeon, and upholding patient safety by guaranteeing that the robotic system does not impede the patient (17).

c) Post-operative nursing care

Post-operative nursing care is centered on delivering tailored care that addresses the specific needs of the patient, monitoring the recovery process, and managing any complications that may develop following the surgical intervention (18). This includes vigilant observation of the patient for potential complications and facilitating a seamless transition from the surgical setting to the recovery phase while maintaining a continuous emphasis on patient-centered care (19).

INTEGRATION OF ROBOTIC CARE IN OT PRACTICE

The integration of robotic care in operating room (OT) practice necessitates workflow adaptation to accommodate the advanced technology and its operational requirements(20). Training and competency development for nurses is essential to ensure they are equipped to work alongside robotic systems, enhancing their skills in operating and managing these technologies(21). Multidisciplinary teamwork will be crucial in robotic surgery, as collaboration between surgeons, nurses, and robotic systems can improve communication and reduce errors, ultimately leading to better surgical outcomes(22). The operating nurse plays a vital role in this dynamic, requiring clear communication and defined responsibilities within the surgical team to ensure optimal patient care and procedural efficiency(23). Predefined protocols and explicit communication strategies should be established to facilitate smooth transitions and handoffs between team members, especially during vulnerable phases of surgery(24).

IMPLICATIONS FOR NURSING PRACTICE.

The rapid expansion of robotic surgery may impact patient safety and quality of care due to the lack of regulatory clarity regarding the roles and responsibilities of bedside assistants. Ethical considerations arise from the potential liability risks faced by perioperative practitioners without clear governance, which could affect patient outcomes. Legal implications may include inconsistent practices that could expose patients to risks, highlighting the need for defined professional accountability. The evolving nature of surgical roles may lead to increased workload and stress for nursing staff, as they navigate new responsibilities without established guidelines(25).

a) Ethical and legal considerations

Ethical considerations arise regarding the role of technology in patient care, including the need for nurses to maintain

compassionate interactions while utilizing robotic assistance. Legal implications may also be present, as the integration of robots in healthcare settings could affect accountability and liability in patient care(26).

b) Workload, stress, and job satisfaction

The workload and stress levels of bedside assistants can impact their job satisfaction, which in turn may affect their performance and the overall effectiveness of the surgical team(27). Cost and resource constraints may arise due to the expenses associated with implementing the robot system, including the need for bar codes, setup time, and potential integration of advanced technologies.(28).

5. Challenges and Barriers in Implementation.

a) Cost and resource constraint Cost is a significant barrier to the implementation of robotic surgeries, as the technology is associated with high expenses. Resource constraints may limit the availability of -necessary equipment and training for nursing staff. There may be resistance to change among healthcare professionals, which can hinder the adoption of robotic surgery practices. Learning curves associated with new technologies can pose challenges for nursing staff in adapting to robotic surgeries(29).

b) Resistance to change and learning curves

There may be resistance to change from medical professionals who are accustomed to traditional surgical practices, leading to potential learning curves when integrating robotic scrub nurses into the operating room(30). Resistance to change and learnin g curves may hinder the adoption of robotic systems in clinical settings, as physicians and staff may be hesitant to alter established practices and require time to become proficient with new technologies(31).

c) Technical limitations and troubleshooting

Technical limitations of current robotic systems may pose challenges in their effective use during procedures. Troubleshooting issues with robotic systems can lead to delays and complications in surgical settings(32). challenges could arise, impacting the efficiency and effectiveness of the robotic nursing teams during procedures(33).

FUTURE DIRECTIONS IN ROBOTIC-ASSISTED NURSING CARE

Future work in robotic-assisted nursing care includes fusing speech and gesture recognition data in a probabilistic manner. Testing the multimodal robotic scrub nurse system in a live operating room (OR) is also a priority(34)

a) Innovations in robotic surgery

Innovations in robotic surgery could lead to the development of more advanced robotic systems that assist in various surgical procedures, enhancing precision and efficiency. Expanding nursing roles in robotic systems may involve training nurses to operate and manage robotic technologies, thereby increasing their involvement in surgical settings and improving patient care. Research and evidence-based practice will be essential in evaluating the effectiveness and safety of robotic-assisted nursing care, ensuring that new technologies are implemented based on solid data and outcomes(35). Innovations in robotic surgery are expected to lead to the automation of certain surgical tasks, potentially allowing nurses to expand their roles in managing and operating these robotic systems. Future developments in robotic-assisted surgery could create valuable opportunities for nurses to participate in the evolving landscape of surgical care, emphasizing the need for structured knowledge and training in robotic systems(36).

b) Research and evidence-based practice

evidence-based practices to support the integration of robotic systems in nursing care, ensuring that these technologies effectively address the nursing labor shortage(37). Research and evidence-based practice should focus on the ethical implications and perceived usefulness of robotic systems in nursing care, as these aspects showed positive ratings among respondents.
Future directions may include addressing varying opinions on the design and functionality of robotic systems to enhance their integration into nursing practice(38).

c) Expanding nursing roles in robotic systems

There is a focus on expanding nursing roles in the integration and use of assistive robotic systems, which aim to relieve the burden on both formal and informal caregivers(39). expanding nursing roles in robotic systems could enhance team communication and situational awareness, addressing some of the disadvantages identified in current robotic surgery practices.Future directions may involve integrating nurses more effectively into the surgical process, potentially through semi-automated robotic assistance, which could lead to improved collaboration and outcomes(40).

CONCLUSION

Nurses specializing in surgical nursing possess the experience and qualifications necessary for performing highly specialized procedures, particularly in robotic surgeries The transition from laparoscopy to robotic procedures is facilitated by prior experience, allowing nursing staff to develop relevant skills.Opportunities for acquiring knowledge and experience are available through reference centers abroad and local coordinators involved in surgical procedures with robotic systems(41). Surgical robotics has seen significant growth in both academic and clinical settings, evolving into a multi-billion dollar industry with thousands of procedures performed annually(42). Recommendations include ensuring that technological advancements support the core values of the nursing profession and the essential human elements of care.Policies should be developed to facilitate the seamless and ethical integration of technology into nursing practice(43).

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