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THE EMERGENT ROLE OF NURSING AND NURSING ROBOTS-COMPREHENSIVE REVIEW

Adel Abdullah Alami, Aeidha Owaid Jubier Alsulami, Marzog Naga Alotaibi, Ashwag Saad Albishi, Latifa Sayer Aldhafeeri, Abdulaziz Ahmed Hassan Alzahrani, Nawal Obaid Ali Alanazi, Hussain Hamad Hakami, Sharifah Hudayban Alharbi, Saleh Motlaq Ibrahim Alotibi, Motaz Hadi Abbas Hakami, Abdullah Naghimash Alharbi, Afnan Othman Omar Hawsawi, Ali Mohmmed Abdo Homedi

Abstract:

This research examines the complex relationship between assistive robotics and nursing, examining how they might transform healthcare delivery while tackling a number of issues. The attitudes and expectations of patients, the elderly, nurses, and caregivers all play a significant role in user approval. Geographical and cultural disparities exacerbate acceptance issues and highlight the necessity for customized design strategies. To ensure safe and efficient human-robot interaction, technological difficulties such as autonomy, motion system design, and interface usability demand creative technical solutions. The deployment and operation of these robots must be governed by strong legal and ethical frameworks, especially with regard to data security and liability concerns. Notwithstanding these obstacles, global research initiatives are propelling advancements in the fields of nursing and assistive robots. Adoption can be facilitated, and obstacles overcome with the help of innovations in stakeholder involvement, interdisciplinary collaboration, and human factors engineering. An understanding of "design for excellence" and using informed design approaches are essential to producing robotic systems that are acceptable, efficient, and usable. Nursing and assistive robots have the power to revolutionize healthcare delivery by tackling these issues, considering the opinions of stakeholders, and improving patient outcomes as well as caregiver assistance and overall quality of care.

Introduction:

The nursing profession is the backbone of the healthcare sector and is essential to the provision of patient care. However, healthcare systems confront enormous challenges due to rising healthcare expenses and an aging population globally. Global population aging has significant financial and social ramifications. Forecasts suggest that the number of elderly people in the European Union alone will rise significantly by 2050, with a particular increase in those who are 65 years of age and older. The old age dependence ratio is changing as a result of this demographic transition and the drop in the population under 55 [1]. The elderly population has a multitude of complex issues in the social, economic, psychological, and medical realms. These issues frequently require specialized care that is beyond the means of family and friends, which might result in institutionalization.

In order to mitigate rising healthcare expenses and address the shortage of nursing and caring staff, technology alternatives have come under investigation. Technologies dubbed "smart home" or "ambient assisted living" have surfaced to help older people live independently. These technologies track regular living activities by placing a range of sensors strategically across living environments. These systems provide important insights into the health and well-being of senior citizens by identifying both acute medical conditions and chronic health changes [2-3]. Although ambient monitoring systems are promising for improving the care of patients and the elderly, robotics-related technologies are the main topic of this debate. These creative fixes are a portion of the technical developments targeted at meeting the changing requirements of the elderly population and promoting independent living [4].

Assistive robotics and nursing constitute a promising new frontier in healthcare, with the potential to reduce the workload of nursing staff and improve patient and senior care quality and quality of life. By handling administrative duties, supporting patient monitoring, and promoting communication between caregivers and patients in both clinical and home environments, nursing robots can supplement healthcare personnel. Conversely, assistive robots enable older and disabled people to live autonomous and fruitful lives by providing them with physical and social support [5]. By expanding their reach and capabilities to remote healthcare delivery, these robotics technologies function within the larger framework of telerobotics and telemedicine. Although medical robotic systems are currently well-established in clinical practice, there are many technological, clinical, budgetary, and ethical obstacles to overcome before nursing and assistive robots may be widely adopted. To guarantee their efficacy and security in medical settings, these robots must overcome a number of challenges, including interior navigation and connection with current hospital systems [6].

Furthermore, the acceptance and impact of nursing and assistive robots will be greatly influenced by user attitudes and perceptions of these devices. Consequently, the effective application of these technologies depends on comprehending and resolving these issues. The purpose of this study is to recognize the difficulties that assistive robotics and nursing encounter while highlighting their promise [7-8]. In summary, a viable approach to resolving the issues brought on by an aging population and the mounting pressure on healthcare systems is the combination of assistive robots and nursing. These technologies present viable ways to reduce the burden of nursing staff, reduce the rate of increase in healthcare costs, and improve the standard of care provided to patients and the elderly. Assistive robots help the elderly and disabled live more independent and satisfying lives by offering social and physical care.

But the widespread use of assistive and nursing robots depends on overcoming a number of clinical, financial, ethical, and technological challenges. It is imperative to tackle obstacles including internal navigation, seamless integration with current healthcare systems, and user acceptance to guarantee the effectiveness and security of these technologies in medical environments. Furthermore, for nursing and assistive robots to be used successfully, it is imperative to comprehend and address user attitudes and views regarding these devices. This study intends to inform the design and development of robotic solutions that are useful and effective in fulfilling the many needs of patients, caregivers, and healthcare professionals by identifying these obstacles and showcasing the potential of these technologies. In summary, even though there are challenges ahead, assistive robots and nursing hold enormous potential for the healthcare industry. These advancements could lead to better patient outcomes, higher standards of care, and increased independence for the elderly and those with disabilities. These technologies have the power to transform healthcare delivery and enhance the lives of millions of people worldwide with continuous research, innovation, and cooperation.

Nursing Robots:

In both hospital settings and establishments devoted to senior care, nursing robots are essential. They provide a way to lighten nurses' workloads so they can concentrate on duties that are essential to their primary duties. The potential of these robotic systems to automate logistical tasks associated with medical equipment and supply management, as well as to expedite procedures like the distribution of meal trays, prescription drugs, and laboratory samples within hospitals, has been investigated. Moreover, they can work in tandem with nurses to improve operational effectiveness, which may lessen the risk of infections or dangerous chemicals coming into contact with human nurses. A new field of expertise may arise if nurses with specific training were able to manage and supervise a robotic fleet in a hospital [9].

Moreover, nurses—who frequently suffer from back pain and other conditions related to their jobs—may realize a considerable reduction in physical strain if specifically engineered robotic systems are used to help with patient transfers, walking, and lifting. These tools, which include wearing exoskeletons, can improve human physical prowess and enable more weightlifting while lowering the risk of musculoskeletal injuries. This method takes advantage of automation while maintaining the important abilities of human caretakers [10]. In addition, nursing robots can facilitate telemedicine by serving as interfaces for distant patient-doctor communication. These robots, outfitted with telepresence systems, are able to virtually visit medical wards and make eye contact with patients. By removing the requirement for manual operation, autonomous navigation features further increase their usefulness. These features are especially helpful for finding specific patients. These robots also have the ability to periodically check on patients' vital signs, which helps with diagnosis and clinical protocol adherence. This feature also applies to home-based care, making specialist medical care possible in rural or remote locations [11].

To summarize, there are several advantages that electromechanical caregivers have over their human counterparts, including as continuous operation and programmed flexibility to the specific demands of each patient. The seamless access to patients' medical histories made possible by integration with hospital technologies, such as cloud-based electronic health record systems, promotes continuity of care.

Nursing-Socially Assistive Robots:

One kind of assistive robotics called socially-assistive robotics helps users mainly through social interaction. These robots, in contrast to computer programs or smartphone applications, make use of the human tendency to imbue physical entities with human-like features and intentions, which makes them especially useful for help. According to the literature, socially-assistive robots could be used for a variety of purposes, such as being a friend, helping people with dementia, encouraging physical activity, and supporting those recovering from strokes [11-13]. Within the field of assistive robotics, companion robots are a unique class of devices that are intended to improve older adults' social life by helping them connect with friends and family. These robots can play music and provide news updates, remind caretakers to take their medications, keep an eye on senior patients via video, and promote physical exercise. The ability of robotic pets to reduce stress and sadness without the practical difficulties of traditional animal care has also drawn attention. The assistance of people with dementia is a vital application for socially-assisted robots. These robots can help with everyday duties, offer emotional support, and stimulate cognitive function, all of which improve the quality of life for both patients and caregivers. Frequent exercise is essential for preserving senior citizens' health and wellbeing and lowering their risk of depression. Elderly people can now be engaged in exercise routines by socially-assistive robots that offer real-time feedback, direction, and performance monitoring. Accurately mimicking the motions of human coaches and adjusting to the physical distinctions between robots and human teachers continue to be difficult tasks [14-17].

Additionally, socially-assisting robots are used in post-stroke rehabilitation, providing therapeutic and diagnostic advantages through carefully crafted exercises meant to enhance mobility and motor function. These robots can help with functional improvement in addition to measuring and evaluating movements [18]. In conclusion, socially-assistive robots have potential applications across a number of fields, including physical exercise assistance, dementia care, post-stroke rehabilitation, and companionship. They are useful tools for improving the well-being and standard of living of a variety of populations because of their capacity to engage people through social contact and offer individualized support.

Nursing-Physically Assistive Robots:

The maintenance of mobility and the capacity to handle objects are two essential elements of independent living that are closely related to the quality of life of both elderly people and sick. Many medical disorders, including strokes, neurological diseases, bone fractures, and muscle deterioration, can cause reduced mobility in older populations. To help with this problem, robotic solutions that support sitting, standing, and walking have been put forth. For example, users of robotic wheelchairs benefit from increased autonomy, improved mobility, and increased safety. Robotic wheelchairs can get over architectural obstacles like curbs that rise and fall by utilizing the right mechanical structures. These wheelchairs have the ability to combine high-level control activities like steering the wheelchair with low-level operations like obstacle avoidance and corridor centering in a hierarchical manner [19-21].

Analogously, well-crafted assistive robotic manipulation devices can benefit people with motor impairments, including tremors, severe spinal injuries, and restricted hand and arm movements. According to surveys, this group of disabled people has unique demands when it comes to assistive technology for a range of activities, such as eating, drinking, taking care of oneself, handling objects, moving around, and gaining access, and basic reaching and carrying out chores. These manipulating devices are wheelchair-mounted or fixed, offering flexible options to meet the various needs of people with motor disabilities [22-24].

Telerobotics and Their Roles:

Teleoperated medical robotic systems have proven useful in the vast field of healthcare, utilizing wired and/or wireless communication networks to perform procedures including surgeries, treatments, and diagnosis over long distances. Advancements in telerobotics and related fields, such as robotics and video streaming, have improved the efficiency of assistive and nursing robots and expanded their range of uses. Robotics technology, which permits mobility and the performance of manipulation activities in remote environments, is essential to advancing telepresence to a more natural and effective level [25]. Telerobotics technologies enable situations like doctor virtual visits in the nursing setting. Users can remotely operate the robot to detect patients in healthcare settings or specify specified destination locations for autonomous navigation by using the onboard adjustable camera. Through the use of bidirectional video conferencing, physicians can communicate with patients via the robot's screen, allowing for remote clinical evaluations and telehealth consultations. As demonstrated by the ENDORSE idea covered in the section on Robots in Healthcare Environments, real-time medical charting can further enhance these assessments using robot-mounted devices outfitted with vital sign gathering capabilities and electronic health record connectivity [26].

With the use of telepresence robots, senior citizens living in their homes can feel more connected to one another as they improve social contact, encourage social engagement, and facilitate virtual visits from family members. By facilitating communication with medical specialists, they also make it easier to monitor health remotely and provide appropriate support. Because of their mobility, telepresence robots provide a more natural degree of interaction than traditional video conversations. As evidenced by the IoT-enabled telerobotics application put out by Zhou et al., telerobotic systems' capabilities are further enhanced when they are integrated with IT technologies, such as the Internet of Things (IoT). Three main areas of application for telepresence robotic systems in elderly care are highlighted in the literature review: telemedicine, remote social interactions, and telehealth monitoring. These applications highlight the diverse potential of telerobotics in improving the quality of life for senior citizens [27-28].

Role of Robots in Disease Outbreaks:

Healthcare personnel are more vulnerable to infection during infectious disease epidemics because of their close contact with patients. By assigning some nursing tasks to robots, this risk can be reduced. This is similar to the use of emergency response robots in polluted areas after events like nuclear plant accidents. Robots act as frontline agents in both situations, lowering the risk to human health. When the COVID-19 pandemic struck in 2020, interest in robotics technologies as useful tools for pandemic response rekindled. The quick deployment of successful solutions during the COVID-19 epidemic caught the robotics world off guard, despite advances in nursing and service robotics. Nonetheless, a more refined function for nursing robots has surfaced, emphasizing the mitigation of individual physical touch and exposure [29].

Nursing robots can be used for a number of tasks, including handling contaminated waste in healthcare facilities, delivering medication and supplies, and disinfecting hospital wards using non-contact ultraviolet (UV) surface disinfection techniques. Furthermore, robots minimize contamination during the removal of personal protective equipment and assist reduce its usage and need for reuse. Robots can help with sample collection during large-scale screening programs, reducing the need for physical interaction and maximizing research coverage. Laboratory testing procedures can be automated with robotic manipulation devices, especially when dealing with high sample sizes. Additionally, for diagnostic and screening purposes, robots can help with temperature assessments in public spaces and at ports of entry [30].

The functions that assistive robotics is expected to play become more important when dealing with the ramifications of social separation and quarantine. When in-person visits are not feasible, socially assistive robots can offer patients and the elderly company and social interaction. When caregivers are scarce, they can also help with health monitoring at home and provide physical support. Exercise regimens and rehabilitation therapies can continue even when a therapist or instructor is not physically present. Mobile robots can monitor the use of protective gear, oversee social distancing protocols in public spaces, and send out notifications and reminders. Robotic vehicles, either on land or in the air, can help with border control and quarantine area enforcement.

Furthermore, without a medical professional's physical presence, teleoperated robotic manipulation devices can support diagnostic and health monitoring. For instance, telesonography robots are capable of performing pulmonary exams and shielding questionable patients from cross-contamination. Telerobotic ultrasonography systems have been proposed recently for the cardiopulmonary assessment of COVID-19 patients, demonstrating how robots might improve the provision of healthcare during pandemics [31-32].

Robots in Healthcare:

Despite the evident therapeutic advantages and economic potential of transportable robotic technologies, their implementation in hospital settings is still rather restricted. This limitation is made worse by the fact that current solutions are frequently tailored for certain uses and are unable to grow to accommodate the vast range of therapeutic services that are in high demand and the logistical duties involved in their widespread adoption. Adoption is further hampered by manufacturers' frequent disregard for the significance of integrating their products with current healthcare systems. Significant problems are also presented by the time-consuming and expensive nature of infrastructure configurations, as well as the susceptibility of robotic fleets to cybersecurity assaults [33].

Owing to these drawbacks, there is a rising global interest in researching these areas of concern. More adaptable and scalable mobile robotic technologies that can successfully address the various demands of healthcare environments are being developed. Prioritizing integration with current healthcare systems will guarantee smooth operation and conformity with established workflows. In addition, cybersecurity protocols are being improved to protect robotic fleets from possible attacks. The potential of mobile robotic technologies to completely transform hospital healthcare delivery can be achieved by tackling these obstacles [34-35].

Challenges of Using Robots:

A major obstacle to the effective use of nursing and assistive robots is user acceptance, which is impacted by the opinions of nurses, caregivers, and patients/elderly people. These judgments are significantly shaped by geographic and cultural differences, as the case of China illustrates. Patients and the elderly are frequently concerned that having robots in their homes will mean receiving less personal attention and support, which will make them feel more alone and isolated. Furthermore, privacy problems are raised by robots' capacity to learn and process personal data, as having robotic devices in the house may give the impression that someone is always watching. It is important to remember, nevertheless, that robotic technology can also improve privacy by enabling people to carry out tasks on their own without requiring human aid. Psychologically speaking, there's a chance that people will grow attached to robots and believe false information about their abilities [36]. Even though they are used to how new technology affect their work, nurses may be concerned about how the advent of robotics could affect their ability to keep their jobs. Adoption of nursing robotic solutions is still hampered by these issues, despite the fact that robotics curriculum is progressively being added to nursing education [37].

Robotics technology presents technological issues that need to be solved in addition to user acceptability. Different from those employed in controlled contexts like industrial facilities, mobile robots functioning in dynamic environments like hospitals or homes require particular sensing, localization, and navigation procedures. In a similar vein, industrially proven safety considerations for manipulation systems must be reexamined before being used to nursing robotics. In tackling these issues, the ENDORSE concept has advanced [38]. Features like sterilizability should be included in nursing robot specifications to keep the robot from spreading infection, especially during infectious illness epidemics. The integration of cloud technologies and communication networks also raises data security concerns, emphasizing the need for strong data security measures to prevent unwanted access to sensitive private data and healthcare databases [39].

The safe and efficient interaction between humans and machines, a topic within the field of human factors engineering, is critical to the development of nursing and senior care robots. Usability and attractiveness to older generations should be given priority when building interfaces for human-robot interaction, especially for elderly-care reasons, given their limited exposure to contemporary ICT applications. Because programmable robots are naturally personalized, users can benefit from interactions that are customized to each user's tastes and abilities. A deep understanding of user characteristics, particularly those related to illnesses, accidents, aging, and birth deformities, is necessary to produce good human factors design. Physical impairments, perceptual impairments, and cognitive limits are the three main categories of disability identified in older people [40].

Users place importance on the look and feel of socially and physically supportive robots. Robotic faces can look anything from humanoid to machine-like, or they might even resemble software agents with human faces. Nonetheless, the literature has long recognized that a robot's outward appearance might engender societal expectations that may be higher than its true capabilities. Wheeled mobile robots are the most common type of motion systems because of their simpler mechanical and control complexity. However, anthropomorphic, or leg-like robots have advantages when employing human-designed tools and operating environments [41]. While nursing and assistive robots need some autonomy to do their tasks, it is imperative that the user maintains high-level control. The increasing ubiquity of autonomous robotic technologies mandates the development of moral and legal frameworks to handle questions of criminal and civil accountability for damages caused by autonomous robots. These are complicated issues that need to be carefully considered, especially in light of the technological character of nursing and care robots [42].

This study has highlighted a number of major obstacles to the adoption and application of nursing and assistive robots, which has resulted in the need for relevant design requirements. End users will be more likely to adopt new robotic solutions if they are more practical and efficient due to informed design. This is where the "design for X" (design for excellence) idea comes in handy, since it enables the efficient summation of important specifications linked to various system aspects, like safety. With an emphasis on requirements pertinent to the usage phase, which are informed by the viewpoints of all stakeholders, including nurses, patients, and management, the assembled design framework covers the full life-cycle of nursing and assistive robots.

Conclusion:

In conclusion, the integration of nursing and assistive robotics represents a promising frontier in healthcare, offering solutions to address various challenges faced by patients, caregivers, and healthcare systems. Despite the documented clinical value and commercial potential of robotic technologies, their widespread adoption faces significant hurdles. Key challenges such as user acceptance, technological limitations, and legal and ethical considerations must be addressed to unlock the full potential of nursing and assistive robotics. User acceptance emerges as a critical factor influencing the success of robotic solutions, with perceptions and expectations of both patients/elderly individuals and nurses/caregivers playing pivotal roles. Geographical and cultural differences further complicate user acceptance, highlighting the need for personalized and culturally sensitive design approaches. Moreover, technological challenges such as interface usability, motion system design, and autonomy necessitate innovative engineering solutions to ensure safe and effective human-robot interaction. Legal and ethical frameworks are also imperative to govern the deployment and operation of nursing and assistive robots, particularly regarding liability issues in cases of robot-related damages. Furthermore, considerations of data security and privacy become paramount with the integration of cloud technologies and communication systems in robotic solutions.

Despite these challenges, ongoing research and development efforts worldwide are driving progress in the field of nursing and assistive robotics. Innovations in human factors engineering, interdisciplinary collaboration, and stakeholder engagement hold the potential to overcome barriers and facilitate the adoption of robotic technologies in healthcare settings. Informed design approaches, guided by the "design for excellence" concept, will play a crucial role in creating robotic solutions that are usable, effective, and acceptable to end-users. By addressing the identified challenges and incorporating stakeholder perspectives throughout the design and implementation process, nursing and assistive robotics can revolutionize healthcare delivery, improving patient outcomes, enhancing caregiver support, and advancing the overall quality of care.

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