

Artificial Intelligence in Nursing Practice: Applications, Opportunities, Challenges, and Future Perspectives

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09 September 2025: Received | 11 October 2025: Revised | 10 November 2025: Accepted | 11 December 2025: Available Online

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Citation: Nusrat Manzoor (2025). Artificial Intelligence in Nursing Practice: Applications, Opportunities, Challenges, and Future Perspectives. *Scientific Reviews An International Journal*. DOI:<https://doi.org/10.51470/SR.2025.03.02.09>

Abstract

Background: Artificial intelligence (AI) is transforming nursing practice and healthcare delivery by enhancing clinical decision-making, patient monitoring, documentation, and healthcare management. AI technologies, including machine learning, robotics, wearable sensors, speech recognition, and telehealth, support nurses in improving patient safety, optimizing workflows, and delivering personalized care. This review examines the evolution, principles, major applications, benefits, and challenges of AI in nursing practice and education.

Methods: A narrative review was conducted using published literature retrieved from electronic databases, including PubMed, Scopus, CINAHL, and Web of Science. Relevant articles on AI applications in nursing, clinical decision support, remote patient monitoring, medication adherence, electronic documentation, and nursing education were critically reviewed and synthesized.

Results: The reviewed evidence indicates that AI has become an important tool in modern nursing by supporting clinical decision-making, risk assessment, patient monitoring, medication management, documentation, and telehealth services. AI-enabled decision support systems assist nurses in early identification of patient deterioration and prediction of adverse clinical outcomes. Wearable sensors and remote monitoring technologies facilitate continuous assessment of physiological parameters, improving patient safety and healthcare accessibility, particularly in rural and underserved settings. AI also contributes to workflow efficiency by reducing administrative burden and enhancing the accuracy of electronic health records.

Conclusion: Artificial intelligence has significant potential to improve nursing practice by enhancing healthcare quality, patient safety, and operational efficiency. However, successful implementation requires appropriate infrastructure, workforce training, ethical governance, data security, and supportive healthcare policies. Rather than replacing nurses, AI should be integrated as a complementary technology that strengthens clinical judgment, supports evidence-based practice, and promotes patient-centered care.

Keywords: Artificial intelligence, nursing, clinical decision support, telehealth, machine learning, patient monitoring, healthcare technology, nursing education.

1. Introduction

Artificial intelligence (AI) has emerged as one of the most transformative technologies in modern healthcare, revolutionizing clinical practice, healthcare management, and nursing services. AI refers to the ability of computer systems or intelligent machines to simulate human cognitive functions such as learning, reasoning, problem-solving, perception, language understanding, and decision-making. It integrates principles from computer science, engineering, mathematics, and data analytics to develop software and automated systems capable of performing tasks that traditionally require human intelligence [3]. The term "artificial intelligence" was first introduced by computer scientist John Mc Carthy in 1956, marking the beginning of AI as a distinct scientific discipline. Today, AI has become an integral part of everyday life through smartphones, wearable health devices, smart assistants, internet-connected technologies, and intelligent healthcare systems that continuously collect and analyze large volumes of health-related data [4]. Based on its capabilities, AI is generally classified into three evolutionary stages.

Artificial Narrow Intelligence (ANI), also known as weak AI, is designed to perform specific tasks within a limited domain and currently represents the most widely used form of AI in healthcare. Examples include clinical decision-support systems, medical image analysis, virtual assistants, and predictive analytics. Artificial General Intelligence (AGI), often referred to as strong AI, represents systems capable of understanding, learning, and performing intellectual tasks at a level comparable to human intelligence across multiple domains. Although AGI remains under development, it has the potential to transform healthcare by enabling autonomous clinical reasoning and complex decision-making. The third stage, Artificial Superintelligence (ASI), describes a hypothetical future in which machines surpass human cognitive abilities in virtually every aspect of intelligence, including creativity, scientific reasoning, and problem-solving. The adoption of AI in healthcare offers numerous advantages for nursing practice and patient care.

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AI enhances clinical decision-making by rapidly analyzing large and complex datasets, enabling early disease detection, accurate diagnosis, and evidence-based treatment planning. It assists healthcare professionals in solving complex clinical problems, performing advanced computational analyses, reducing medical errors, and improving patient safety. AI-powered technologies also automate routine administrative tasks, optimize workflow efficiency, support remote patient monitoring, and facilitate personalized healthcare delivery. As AI continues to evolve, it is expected to complement nursing expertise by improving the quality, accuracy, and efficiency of healthcare services while allowing nurses to devote more time to direct patient care and compassionate clinical practice.

2. Artificial Intelligence in Nursing

Artificial intelligence (AI) is increasingly transforming nursing practice by supporting clinical decision-making, improving patient outcomes, and enhancing the efficiency of healthcare delivery. AI in nursing involves the application of advanced computational technologies, including machine learning, predictive analytics, robotics, natural language processing, and intelligent decision-support systems, to assist nurses in providing safe, timely, and evidence-based care [6]. These technologies enable rapid analysis of large volumes of clinical data, allowing early identification of patient deterioration, prediction of complications, and prompt initiation of appropriate interventions. AI also plays a vital role in high-risk clinical environments by reducing unnecessary exposure of healthcare workers to infectious diseases and other occupational hazards. Rather than replacing nurses, AI serves as a supportive tool that complements professional judgment, improves workflow efficiency, and allows nurses to devote more time to direct patient care. Furthermore, AI facilitates rapid clinical responses during the "golden hour," when timely intervention is critical for improving patient survival and reducing complications. The growing complexity of healthcare systems has increased the need for AI in the nursing profession. AI applications help reduce the workload of nurses by automating routine administrative tasks, streamlining documentation, and optimizing resource utilization. Intelligent systems save time and energy by minimizing repetitive activities, thereby enabling nurses to focus on patient-centered care. AI also supports specialist consultation through telehealth platforms, extending quality healthcare services to rural and underserved populations where specialist care is often limited. Additionally, AI promotes need-based and personalized healthcare by analyzing patient-specific data and recommending individualized interventions. Remote monitoring technologies further reduce unnecessary hospital visits for minor illnesses, improving healthcare accessibility while decreasing the burden on outpatient and inpatient departments [7]. The ethical implementation of AI in nursing is guided by several fundamental principles. These include respecting human autonomy by ensuring that patients retain control over healthcare decisions; promoting patient safety, well-being, and the public interest; maintaining transparency, explainability, and interpretability of AI algorithms; fostering professional responsibility and accountability for AI-assisted decisions; ensuring inclusiveness, fairness, and equitable access to healthcare technologies; and encouraging the development of responsive, ethical, and sustainable AI systems that support high-quality nursing care.

These principles ensure that AI enhances, rather than compromises, the human-centered nature of nursing practice. Several AI-powered clinical tools are now widely used in nursing practice. These include intelligent patient monitoring systems that continuously assess physiological parameters and detect early signs of clinical deterioration; medication adherence technologies that remind patients to take prescribed medications and improve treatment compliance; electronic documentation systems that automate digital nursing records and reduce documentation errors; and robotic or automated systems that perform repetitive, labor-intensive tasks such as inventory management, patient transportation, and routine administrative work [8]. Together, these technologies improve efficiency, reduce nursing workload, enhance patient safety, and contribute to more effective and evidence-based healthcare delivery.

Applications of Artificial Intelligence in Clinical Nursing Practice

3.1 Patient Monitoring

Patient monitoring is one of the most important responsibilities of nurses, and artificial intelligence has significantly improved this aspect of healthcare. AI-powered monitoring systems continuously analyze physiological parameters such as heart rate, respiratory rate, blood pressure, oxygen saturation, and body temperature to detect early signs of patient deterioration. Machine learning algorithms can identify subtle changes in vital signs that may not be immediately apparent to healthcare professionals, enabling timely clinical interventions and reducing the risk of complications [9]. In intensive care units (ICUs), AI-assisted monitoring supports cardiovascular and respiratory assessment, facilitating rapid decision-making and improving patient outcomes.

AI-based sensor technologies also contribute to patient safety by predicting and preventing hospital falls. Falls remain one of the leading causes of hospital-acquired injuries, often resulting in prolonged hospitalization, disability, and increased healthcare costs. Intelligent motion sensors, wearable devices, and computer vision systems continuously monitor patient movement and alert nursing staff when abnormal activity or a high risk of falling is detected. During the COVID-19 pandemic, the CLEWICU clinical decision-support software received emergency authorization from the U.S. Food and Drug Administration (FDA) to predict critical events such as hypotension and respiratory failure, thereby assisting clinicians in the early identification of severely ill patients and improving critical care management [10].

3.2 Improving Medication Adherence

Medication non-adherence remains a major challenge in healthcare, particularly among patients with chronic diseases. Artificial intelligence provides innovative solutions to improve medication compliance through machine learning algorithms, mobile health applications, chatbots, smart packaging, electronic reminder systems, smart pill dispensers, and intelligent medication caps [11]. These technologies remind patients to take medications on time, monitor adherence patterns, and notify healthcare professionals when doses are missed. A landmark advancement in AI-assisted medication monitoring is the approval of Abilify MyCite® (aripiprazole tablets with sensor) by the U.S. Food and Drug Administration (FDA).

This digital medicine incorporates an ingestible sensor within the tablet that activates after ingestion and transmits a signal to a wearable skin patch. The patch communicates with a smartphone application, allowing patients to monitor medication intake while enabling healthcare providers to review adherence data through a secure web-based portal [12]. Such technologies assist nurses in monitoring treatment compliance among both hospitalized and discharged patients, thereby improving therapeutic outcomes.

3.3 Digital Clinical Documentation

Clinical documentation is an essential component of nursing practice but often consumes a considerable proportion of nurses' working time. Artificial intelligence has transformed documentation through voice recognition, natural language processing (NLP), speech-to-text technology, and automated electronic health record (EHR) systems. These tools enable nurses to document patient information more efficiently, reduce manual data entry, minimize documentation errors, and improve the accuracy and completeness of clinical records [13]. By decreasing administrative workload, AI allows nurses to dedicate more time to direct patient care.

3.4 Automation of Routine Nursing Tasks

Artificial intelligence also supports nursing practice by automating repetitive and time-consuming physical tasks. Autonomous service robots are increasingly used in hospitals to transport medications, laboratory specimens, medical supplies, linens, and sterile surgical instruments between departments. Automation reduces unnecessary walking and manual workload, enabling nurses to focus on complex clinical responsibilities and patient-centered care [14]. In many technologically advanced healthcare institutions, robotic systems have become valuable assistants that improve workflow efficiency, reduce fatigue among healthcare professionals, and enhance the overall quality of healthcare delivery.

3.5 Major Applications of AI in Clinical Nursing

Artificial intelligence has a broad range of applications across modern nursing practice. Major clinical applications include clinical decision-support systems, sensor-based patient monitoring, mobile health (mHealth) technologies, robotics, risk prediction and assessment, virtual and voice assistants, text mining of clinical records, and speech recognition technologies [15]. Collectively, these AI-driven technologies enhance diagnostic accuracy, improve patient safety, optimize nursing workflows, facilitate evidence-based practice, and support personalized healthcare delivery, making AI an indispensable component of contemporary nursing and healthcare systems.

3.6 Clinical Decision Support Systems

Artificial intelligence has significantly improved clinical decision support (CDS) by assisting nurses in making timely and evidence-based decisions. AI-powered CDS systems analyze patient information from electronic health records (EHRs) and generate alerts, reminders, clinical guidelines, order sets, and interactive dashboards that facilitate prompt interventions and improve patient safety [16]. When integrated with mobile health (mHealth) applications, these systems provide personalized recommendations, predict clinical outcomes, and support nurses in selecting appropriate interventions with greater accuracy than conventional decision-making methods.

3.7 Sensor-Based Technologies

Sensor-based technologies have revolutionized patient monitoring by enabling continuous assessment of physiological parameters such as heart rate, respiratory rate, blood glucose, oxygen saturation, blood pressure, body temperature, and physical activity [17]. Modern biosensors integrated with smartphones and wearable devices transmit health data in real time, allowing remote monitoring of patients in hospitals and community settings. These technologies are particularly valuable in geriatric care, chronic disease management, and home-based nursing, where continuous surveillance can facilitate early detection of complications and timely clinical intervention [18]. Examples include skin electrodes for heart rate monitoring and piezoelectric sensors for respiratory monitoring.

3.8 Robotics

Robotics has become an important component of AI-assisted nursing by supporting patient care and reducing the workload of healthcare professionals. Telepresence robots equipped with cameras, microphones, speakers, and autonomous navigation systems enable remote patient assessment and communication [19]. AI enhances robotic capabilities through speech recognition, object detection, navigation, and adaptive learning, allowing robots to assist in medication delivery, transportation of medical supplies, and monitoring of patients. During infectious disease outbreaks such as the COVID-19 pandemic, robotic systems minimized healthcare workers' exposure to contagious patients while maintaining continuity of care [20]. The major benefits of robotic technology include reduced nursing workload, improved operational efficiency, and enhanced clinical decision-making.

3.9 Risk Assessment

Artificial intelligence plays a vital role in predicting clinical risks by analyzing large volumes of patient data obtained from electronic health records. AI-based risk assessment systems can identify patients at high risk of conditions such as sepsis, hospital-acquired infections, pressure injuries, and falls, enabling nurses to implement preventive interventions at an early stage. Compared with traditional assessment methods, AI provides faster data analysis, greater predictive accuracy, and automated updating of risk models, thereby improving patient safety and supporting evidence-based nursing care.

3.10 Voice Assistants

AI-powered voice assistants are increasingly being incorporated into nursing practice to improve patient follow-up and home healthcare. Voice-enabled technologies can remind patients to take medications, monitor blood pressure or glucose levels, schedule appointments, and record patient-reported information directly into electronic health records. These systems are particularly beneficial for older adults and individuals with visual impairments or physical disabilities, promoting medication adherence, improving continuity of care, and reducing the workload associated with routine follow-up.

3.11 Speech Recognition Technologies

Speech recognition technology has greatly enhanced nursing documentation by converting spoken language into accurate electronic clinical records. Combined with machine learning and natural language processing, these systems can automatically suggest standardized clinical terminology,

improve documentation quality, reduce typing time, and minimize documentation errors. Consequently, nurses spend less time on administrative tasks and more time delivering direct patient care.

3.12 Text Mining

Text mining is an emerging AI application that extracts meaningful information from large volumes of unstructured clinical data, particularly nursing notes and electronic health records. AI-driven text mining enables the identification of patients with conditions such as a history of falls, substance use disorders, or other high-risk factors, thereby supporting individualized care planning and early risk detection. Machine learning and deep learning algorithms have also been used to predict pain severity, clinical deterioration, and other acute health conditions. Furthermore, AI integrates diverse datasets—including environmental, genomic, clinical, and socio-demographic information—to provide a more comprehensive understanding of patient health and support personalized nursing care.

4. Artificial Intelligence Beyond Hospital Settings

4.1 Telehealth

Telehealth has become an integral component of modern healthcare, particularly following the COVID-19 pandemic. AI-powered telehealth platforms enable nurses to provide remote consultations, health education, follow-up care, and specialist referrals without requiring patients to travel to healthcare facilities. In India, telehealth services have been strengthened through the **eSanjeevani** platform under the National Health Mission, allowing healthcare professionals at Health and Wellness Centres to connect patients with medical specialists. This approach improves healthcare accessibility, particularly in rural and underserved regions, while reducing travel costs and waiting times.

4.2 Remote Patient Monitoring

Remote patient monitoring utilizes wearable sensors and smart medical devices to continuously measure physiological parameters such as heart rate, cardiac rhythm, blood pressure, oxygen saturation, and physical activity. Devices such as the Apple Watch and other wearable technologies can detect cardiac rhythm abnormalities and transmit health information to healthcare providers for timely intervention [21]. These technologies improve chronic disease management, facilitate early detection of complications, and enable continuous nursing supervision outside traditional hospital settings.

5. Challenges of Artificial Intelligence in Nursing

Despite its numerous advantages, the implementation of AI in nursing faces several challenges. These include inadequate training of nursing educators and healthcare professionals, limited technological infrastructure, insufficient integration of AI into nursing education, high implementation and maintenance costs, and the need for large, high-quality clinical databases to develop reliable machine learning algorithms. Additionally, successful adoption requires culturally acceptable AI systems, ethical governance, and organizational support to ensure effective integration into routine clinical practice.

6. Limitations of Artificial Intelligence in Nursing

Artificial intelligence cannot replace the empathy, compassion, ethical reasoning, and interpersonal communication that are fundamental to nursing practice.

AI systems lack human creativity and emotional intelligence and may increase dependence on technology if used without appropriate clinical judgment. Furthermore, AI implementation requires substantial financial investment for infrastructure, maintenance, software development, and cybersecurity, which may limit its adoption in resource-constrained healthcare settings.

7. Conclusion

Artificial intelligence is transforming nursing practice, healthcare delivery, and nursing education by improving clinical decision-making, patient monitoring, documentation, risk prediction, telehealth, and remote patient management. AI enhances healthcare quality, increases efficiency, reduces nurses' administrative workload, and supports timely, evidence-based interventions. However, its successful implementation depends on adequate infrastructure, workforce training, ethical governance, and robust data security. Rather than replacing nurses, AI should be viewed as a complementary technology that strengthens clinical expertise, promotes patient-centered care, and supports the delivery of safe, efficient, and high-quality healthcare.

Declarations

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Author Contributions

Nusrat Manzoor conceived the review topic, performed the literature search, critically analyzed and synthesized the published evidence, prepared the initial manuscript, revised the article for important intellectual content, and approved the final version of the manuscript for publication.

Type of Article

Narrative Review Article.

Funding

The author received no financial support for the research, authorship, or publication of this article.

Conflict of Interest

The author declares that there are no conflicts of interest regarding the publication of this manuscript.

Acknowledgements

The author sincerely acknowledges her parents for their constant encouragement, guidance, and unwavering support throughout the preparation of this manuscript.

Ethical Approval

Not applicable. This review article is based exclusively on published literature and did not involve human participants, animals, patient data, or biological samples.

Consent to Participate

Not applicable.

Consent for Publication

Not applicable.

Competing Interests

The author declares that there are no competing interests.

Data Availability Statement

No new datasets were generated or analyzed during the preparation of this review article. All information included in this manuscript was obtained from previously published literature.

Institutional Review Board (IRB) Statement

Not applicable.

Informed Consent Statement

Not applicable.

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