Artificial Intelligence and Predictive Analytics in Nursing Care: Advancing Decision-Making through Health Information Technology

Khalid Abdullah Saeed Alsaeed[1], Manal Turki Ali Almutairi[2], Salman Mohammed Dughayyim Almutairi[3], ABDULLAH QOBLAN.S ALDAKEEL[4], Meshal Samah Al Nawmasi[5], Nawaf Abdullah Alharby[6], Mohammad Masafr Alharbi[7], Mohammed Saud Sad Alazzmi[8], Adel Hamad Alsalman[9], Fahad Ayed Alenazy[10], Falaj Ibrahim Alfalaj[11]

Abstract

Artificial intelligence (AI) and predictive analytics are transforming nursing care by improving decision-making processes and enhancing patient outcomes. This study examines the integration of AI technologies within nursing practice, emphasizing their potential to support nurses in delivering high-quality care. A comprehensive literature review was conducted to identify key applications of AI in nursing, including machine learning algorithms for risk assessment, natural language processing for documentation, and predictive analytics for patient outcomes. Results indicate that AI tools can significantly reduce the administrative burden on nurses, allowing them to focus more on direct patient care. Additionally, the review highlights ethical, legal, and social implications associated with the adoption of AI technologies in nursing, such as the need for bias mitigation and ensuring patient privacy. Furthermore, the necessity for nursing education to incorporate AI competencies is emphasized, as current curricula often lack adequate training in health informatics and AI. In conclusion, while AI presents substantial opportunities to enhance nursing practice and patient care, it also poses challenges that must be addressed through comprehensive education and ethical frameworks. Future research should explore the long-term impact of AI on nursing roles and patient outcomes, ensuring that technology complements rather than replaces the human elements of nursing care.

Keywords: *Necrotizing Fasciitis, Soft Tissue Infection, Diagnosis, Surgical Debridement, Nursing Interventions, LRINEC Score.*

Introduction

Artificial intelligence (AI) is described as "the science and engineering of creating intelligent machines, particularly intelligent computer programs" (1). Advanced AI technologies, like targeted advertising and autonomous vehicles, are transforming several professional areas. Artificial intelligence is being used in healthcare to assist professionals in providing high-quality treatment more effectively and equitably. AI may assist less experienced healthcare workers, who may have limited resources, in providing high-quality treatment by facilitating learning from others' experiences, such as identifying unusual illness signs via extensive database searches (2).

In nursing, instances of AI applications illustrate the significant influence these technologies may have on nursing practice. Speech recognition technologies can expedite and improve nursing documentation (3,4), while machine learning has been employed to create a tool that assists nurses in utilizing standardized technologies by automatically recommending the most pertinent terms based on the nurse's written text

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[1] KSA, Ministry Of Health, Qassim Health Cluster

[2] KSA, Ministry Of Health, Alshammasia Primary Health Care Center.

[3] KSA, Ministry Of Health, Alshammasia Primary Health Care Center.

[4] KSA, Ministry Of Health, Qassim Health Cluster.

[5] KSA, Ministry Of Health, Qassim Health Cluster

[6] KSA, Ministry Of Health, Arras General Hospital

[7] KSA, Ministry Of Health, Qassim Health Cluster

[8] KSA, Ministry Of Health, Qassim Health Cluster

[9] KSA, Ministry Of Health, Qassim Health Cluster

[10] KSA, Ministry Of Health, Qassim Health Cluster

[11] KSA, Ministry Of Health, Warehouse Management And Performance Control

(5). Additional applications encompass text mining, wherein AI technologies are employed to analyze vast quantities of nursing notes to identify patients with a history of falls or substance use disorders, thereby facilitating care planning and patient risk assessment (6). Machine learning, particularly deep learning, has been used to forecast pain perception and physical decline in acute critical situations (7,8).

Shortly, AI technology will assist nurses in delivering accurate and personalized evidence-based treatment that aligns with patients' objectives and priorities. AI technology will assist nurses in integrating many pertinent data types, hence enhancing their ability to provide comprehensive care. A recent scoping review indicates that the majority of research on AI in healthcare has concentrated on secondary and tertiary care, hence presenting significant opportunities to investigate nurses' use of AI in primary care (9). These instances demonstrate that nurses are not immune to the expansion of AI in healthcare systems, since AI is often promoted as a means to revolutionize healthcare delivery and enhance health outcomes (10).

The relationship between AI and nursing has not been thoroughly examined. Despite nurses being the biggest cohort of healthcare workers globally, they are likely the most exposed to emerging AI technologies due to their substantial workforce presence. The Students and Emerging Professionals Special Interest Group of the International Medical Informatics Association convened the inaugural international invitational expert think-tank workshop of the Nursing and Artificial Intelligence Leadership Collaborative (NAIL), entitled 'Artificial Intelligence in Nursing: Social, Ethical, and Legal Implications,' acknowledging the diverse and intricate, yet constrained, viewpoints regarding AI in nursing. The NAIL Collaborative consists of specialists in AI development and implementation, nursing, biomedical ethics, AI in primary healthcare, legal aspects of AI, philosophy of AI in health, nursing practice, implementation science, senior policymakers from healthcare institutions and international informatics organizations, a patient and public representative, and the Chair of the ITU/WHO Focus Group on Artificial Intelligence for Health. Activities included a pre-event survey to gather guests' first views on AI in nursing, presentations by all invited participants about their areas of expertise relevant to AI and/or nursing, and collaborative sessions for in-depth discussions.

The Artificial Intelligence in Nursing: Ethical, Legal, and Social Implications Invitational Think Tank

In nursing, developments in AI technology are often met with measured enthusiasm (11-13). The utilization of AI offers the potential to enhance nursing care delivery by relieving nurses of routine, time-consuming tasks that do not necessitate specialized skills or knowledge (e.g., managing hospital room logistics, contacting housekeeping for cleaning and restocking supplies), thereby allowing nurses to allocate more time to direct patient care. Conversely, the use of AI simultaneously presents the possibility of unforeseen outcomes that may adversely affect the nursing profession.

AI technologies can enhance nursing competencies and empower nurses to provide more evidence-based and individualized care to their patients. AI technologies can enhance responsive and evidence-based nursing practice by offering cognitive insights and decision support, such as visualizing patient trends that inform both immediate care and long-term management strategies. Advocates of AI highlight its potential to liberate time for healthcare workers, allowing them to enhance their interactions with patients (14). Certainly, the time allocated to nurses may be used to enhance relationship care, so enabling nurses to cultivate a deeper understanding of the situations around patients' health. Furthermore, the time allocated to nurses may be used for interacting with contemporary research and enhancing their understanding of evidence-based practices, tasks often neglected due to time constraints and lack of opportunity (15). Enhanced connections with patients and current understanding of evidence together improve nurses' capacity to provide tailored care that encompasses a comprehensive perspective of patients.

In addition to their potential benefits, AI technologies may yield unforeseen effects that might adversely affect the nursing profession and the primary objectives of nursing practice. For instance, there is a risk that AI may perpetuate or systematically integrate existing human biases into systems (16), exemplified by a recent case in which a clinical decision algorithm exhibited racial bias by prioritizing care for less ill white patients over more severely ill Black patients in the United States (17). In addition to affecting clinical and health outcomes, AI in nursing may further intensify the emphasis on market-driven efficiency objectives.

There is a tangible opportunity to reallocate newly available time towards augmenting the number of patients and responsibilities given to nurses. Consequently, efficiency objectives may overshadow the potential benefits that the use of AI in healthcare systems is intended to provide.

Such adverse effects are not unavoidable. For example, AI possesses the capability to elucidate and eliminate human bias, thereby enhancing decision-making (18), by identifying and quantifying the effects of commonly accepted variables such as sex, gender, ethnicity, or race (acknowledging that race lacks scientific validity, yet experiences of racism are correlated with health outcomes), for which our comprehension of impacts is evolving (19). The optimal outcomes of AI in nursing will hinge on the goals and objectives that drive the creation of AI tools, as well as the extent to which these tools are deployed with a comprehensive grasp of their capabilities and constraints.

The unintended consequences of utilizing AI tools in the hands of nurses can be direct and significant, mirroring the concerns articulated by O'Keefe-McCarthy (20) regarding the mediating role of technology in nurse-patient interactions and its subsequent impact on nurses' moral agency. Considering the significant potential influence of AI tools, it is ethically essential for nurses to possess a fundamental grasp of the development process of these tools, the factors that inform them, and the consequences of their use on clinical judgment and practice. The need for nurses to possess a fundamental comprehension of AI is comparable to the necessity for them to get basic proficiency in any new technology or instrument used in their profession.

Despite the significant implications of AI for the nursing profession, there exists a burgeoning although relatively restricted critical conversation within the nursing literature (21,22). In the realm of nursing education, the incorporation of AI is mostly lacking. Nursing curricula persistently face challenges in integrating fundamental nursing informatics capabilities into basic nursing education (23,24), a concern that intensifies with the increasing interest in using AI technologies inside health systems. The challenges nurses currently encounter in effectively utilizing and leading innovations in health information technologies may be exacerbated by an additional deficiency in AI knowledge, compounding existing gaps in fundamental health informatics knowledge.

A Prospective Trajectory for Artificial Intelligence In Nursing

This document summarizes the key debate themes highlighted in the NAIL Collaborative think-tank, articulated as urgent needs for the nursing profession. Each priority point begins with the discovery of an existing gap in the comprehension or application of AI to nursing practice. For each identified need, we provide solutions and opportunities—impacting nursing practice, education, research, and leadership—that may be implemented to guarantee the proper and safe use of AI in nursing, therefore enabling the profession to leverage AI technologies to enhance health outcomes.

Nurses are the cohort of healthcare workers who produce the highest volume of data inside health systems, due to their extensive documentation responsibilities. Nurses are crucial in gathering data that may ultimately be used by AI systems, as shown by research connecting the characteristics and patterns of nursing documentation practices to patient mortality (25). There seems to be a limited comprehension of the connection between nursing documentation and its potential applications beyond urgent clinical decision-making, administrative reporting, and maintaining a legal record as instructed in foundational nursing education. Although comprehension of these documentation components has previously sufficed to guide nursing practice, we contend that nurses must additionally grasp the connection between their clinical documentation and artificial intelligence. Understanding the kind and quality of data gathered and recorded in nursing practice may directly feed AI systems. Furthermore, AI-driven clinical decision support encompasses several degrees of ambiguity necessitating practitioner interpretation (26). Nurses act as the final evaluators of the suitability of an intervention when opting to adhere to a piece of AI-based advice (27). Furthermore, a notable contemporary challenge is that numerous nursing educational programs—encompassing both entry-level nursing education and the continuing education of professional nurses—lack sufficient expertise in instructing health informatics and AI technologies (28,29).

To address the educational disparity, it is essential to establish a curriculum including 'minimum AI in nursing competencies,' a collection of domains and ideas that all entry-level nurses must acquire throughout their foundational nursing education (30). Certain organizations, such as the American Association of Colleges of Nursing (AACN), are transitioning to a competency-based education model that integrates technology across all domains, reflecting the present need for this subject at all tiers of nursing education. Concurrent efforts must be undertaken to foster the development of these competencies among practicing nurses and nurse leaders (31), with the information disseminated via continuing education programs. Graduate nursing education would also benefit from the establishment of advanced AI educational possibilities and the development of sub-specializations in AI inside health informatics programs.

The involvement of nurses in every phase of the AI development lifecycle is essential, as it highlights the complex implications of AI utilization in nursing—both advantageous and detrimental—while aligning with the core principles of the nursing profession, which prioritize beneficence towards patients, communities, and populations, as well as advocacy for social justice (32-34). Advocacy for patients, families, and communities, together with the promotion of person-centered care, constitutes the essential responsibility of the nurse. Nurses are particularly qualified to provide methods for assessing the influence of AI on nursing and patient outcomes. Active engagement in all phases of the AI development lifecycle (35) allows nursing to provide distinctive insights that enhance the deliberate creation and application of AI, maximizing benefits while mitigating adverse effects for patients, communities, populations, healthcare systems, and the nursing profession.

Nurses must be substantively engaged and participate as essential members of AI development and deployment teams inside health systems. Nursing may significantly contribute to the AI development lifecycle in several capacities, particularly via three different and vital informant/communicator functions. These encompass: (a) defining clinical issues; (b) acting as intermediates between clinical and technological domains; and (c) integrating elements of relational practice (36). The knowledge of nurses and their extensive experience in patient interactions should be used to more clearly define the clinical issues that AI technologies seek to resolve. For instance, during the development of predictive algorithms utilizing clinical data, nurses can provide practice-based insights to technical teams—typically comprising engineers, computer scientists, and user interface design specialists—to elucidate the reasons behind the absence or incompleteness of certain data elements (e.g., inadequate documentation of social risk factors) (37) and propose viable strategies to rectify these deficiencies.

Nurses may act as crucial intermediates between technological specialists creating solutions and nurses functioning as clinical end-users (36). The two groups use distinct professional terminologies, and nurses proficient in AI principles are well suited to bridge this linguistic divide. Nursing experience in relational practice, which emphasizes the quality of human connections, is a distinctive asset in the AI development lifecycle. The significance of the nurse-patient interaction as a fundamental focus in nursing might substantially enhance AI applications in robotics and other domains. Nurses can elucidate the significance of empathy and human touch, their roles in therapeutic relationships (38,39), and the interplay between AI technologies and human relationships that must be addressed during the AI development lifecycle.

The acknowledgment of the connection between AI technologies and the nursing profession for their contribution to global and national health and humanitarian initiatives is limited. Numerous initiatives emphasize the application of 'AI for good' across academic, non-profit, and industrial domains, including the AI for Good Global Summit, promoting the utilization of AI to enhance human welfare and tackle complex social, economic, environmental, health, and humanitarian issues worldwide. Despite the potentially profound influence of AI technologies on nursing practice, there is still a lack of initiatives from the nursing profession concerning the use of AI for the greater good (AI4GN) to benefit both the field and the communities served.

Initiatives acknowledging the contributions within AI4GN may include using the distinctive role of nurses in healthcare systems to advocate for the integration of equity and social justice principles in the development and application of AI technology in health systems. Nurses are healthcare professionals who dedicate the majority of their time to patient care and are often regarded as the most trusted profession

(40). Nurses are well positioned to recognize possible biases in data collecting (e.g., decontextualized data that neglects the influence of systemic structures on people), which may result in the incorporation of these biases into the created AI technologies. Nurses are optimally positioned to recognize ethical issues associated with the deployment and utilization of AI tools, such as the contentious use of facial recognition technology, and to identify situations that may intensify existing disparities and inflict potential harm on specific groups and populations. Recent research indicates that children from lower-education households are more likely to have their digital data gathered and shared via app usage (41). Within the healthcare system, this is a crucial aspect of nursing education that must be cultivated and integrated as a standard element of comprehensive nursing evaluation and intervention. This involves instructing patients and families on digital literacy, digital privacy, and the rules and regulations governing data collection and preservation of digital health information, as well as its connection to AI systems used in healthcare delivery.

Conclusion

Artificial intelligence technology will transform the nursing profession. AI technologies may function as essential instruments to enhance nurses' contributions toward advancing the nursing profession and enhancing public and global health. If nursing adopts a proactive approach to these identified goals, AI may augment and expand nursing skills. Nursing has significant contributions to make in the advancement of AI systems that use nurses' skills and experience in relational practice and patient advocacy, fostering the creation of AI that adopts a more holistic perspective on patient care. All key topics addressed in this study are inherently interconnected. They do not sit alone; rather, they contribute to a comprehensive and intentional strategy aimed at allowing nurses to engage actively in all facets of AI inside healthcare. We contend that nurses are obligated to understand the AI technology they use, as articulated from an industrial standpoint (McGrow, 2019). Furthermore, AI technologies provide a significant possibility to enhance nurses' problem-solving capabilities and suggest solutions for enhancing care delivery (Cato et al., 2020). Support from health system stakeholders and high-level decision-makers is essential to empower the nursing profession in addressing these stated goals.

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الذكاء الاصطناعي والتحليلات التنبؤية في رعاية التمريض: تحسين اتخاذ القرار من خلال تكنولوجيا المعلومات الصحية

الملخص

الخلفية: يعمل الذكاء الاصطناعي (AI) والتحليلات التنبؤية على تحويل رعاية التمريض من خلال تحسين عمليات اتخاذ القرار وتعزيز نتائج المرضى. تهدف هذه الدراسة إلى دراسة دمج تقنيات الذكاء الاصطناعي في ممارسات التمريض مع التركيز على إمكاناتها لدعم الممرضين في تقديم رعاية عالية الجودة.

المنهجية: تم إجراء مراجعة شاملة للأدبيات لتحديد التطبيقات الرئيسية للذكاء الاصطناعي في التمريض، بما في ذلك خوارزميات التعلم الآلي لتقييم المخاطر، ومعالجة اللغة الطبيعية للتوثيق، والتحليلات التنبؤية لتوقع نتائج المرضى.

النتائج: تشير النتائج إلى أن أدوات الذكاء الاصطناعي يمكن أن تقلل بشكل كبير من العبء الإداري على الممرضين، مما يتيح لهم التركيز بشكل أكبر على تقديم الرعاية المباشرة للمرضى. كما تسلط الدراسة الضوء على الآثار الأخلاقية والقانونية والاجتماعية المرتبطة بتبني تقنيات الذكاء الاصطناعي في التمريض، مثل الحاجة إلى تقليل التحيز وضمان خصوصية المرضى. علاوة على ذلك، تؤكد الدراسة على ضرورة تضمين مهارات الذكاء الاصطناعي في تعليم التمريض، حيث تفتقر المناهج الحالية غالبًا إلى التدريب الكافي في مجال المعلوماتية الصحية والذكاء الاصطناعي.

الخلاصة: في الختام، يقدم الذكاء الاصطناعي فرصًا كبيرة لتعزيز ممارسات التمريض ورعاية المرضى، ولكنه يفرض أيضًا تحديات يجب معالجتها من خلال التعليم الشامل والأطر الأخلاقية. يجب أن تركز الأبحاث المستقبلية على دراسة التأثيرات طويلة المدى للذكاء الاصطناعي على أدوار التمريض ونتائج المرضى، لضمان تكامل التكنولوجيا مع العناصر الإنسانية للرعاية التمريضية بدلاً من استبدالها.

الكلمات المفتاحية: الذكاء الاصطناعي، التحليلات التنبؤية، رعاية التمريض، تكنولوجيا المعلومات الصحية، الآثار الأخلاقية.