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REVIEW

Technological evolution of the nursing care process: case studies of artificial intelligence implementations in real clinical settings

Evolución tecnológica del Proceso de Atención de Enfermería: estudio de casos de Implementaciones de Inteligencia Artificial en entornos clínicos reales

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ABSTRACT

Artificial intelligence is redefining nursing care paradigms through practical implementations that demonstrate its transformative potential. This review article critically analyzes emblematic cases such as the TREWS system for sepsis at Johns Hopkins, fall prevention initiatives in Singapore, and triage projects in the British NHS, revealing common patterns in their clinical integration. The findings highlight that the success of these technologies depends fundamentally on their socio-technical design, where the ability to generate clinical confidence through accurate and actionable alerts is more decisive than isolated algorithmic performance. Two viable strategic models are identified: centralized top-down implementations, such as Singapore's systemic approach, and decentralized bottom-up approaches, represented by the NHS pilot strategy. The review concludes that AI does not replace but rather enhances nursing practice; however, its successful adoption requires overcoming challenges in professional training, ethical governance, and organizational adaptation. The immediate future will depend on developing hybrid skills that enable professionals to collaborate effectively with these intelligent systems.

Keywords: Nursing Care Process; Artificial Intelligence; Health Services Improvement; Digital Skills.

RESUMEN

La inteligencia artificial está redefiniendo los paradigmas de atención en enfermería mediante implementaciones prácticas que evidencian su potencial transformador. Este artículo de revisión analiza críticamente casos emblemáticos como el sistema TREWS para sepsis en Johns Hopkins, las iniciativas de prevención de caídas en Singapur y los proyectos de triaje en el NHS británico, revelando patrones comunes en su integración clínica. Los hallazgos destacan que el éxito de estas tecnologías depende fundamentalmente de su diseño sociotécnico, donde la capacidad de generar confianza clínica mediante alertas precisas y accionables resulta más determinante que el desempeño algorítmico aislado. Se identifican dos modelos estratégicos viables: implementaciones centralizadas de arriba hacia abajo, como el enfoque sistémico de Singapur, y aproximaciones descentralizadas de abajo hacia arriba, representadas por la estrategia de pilotos del NHS. La revisión concluye que la IA no sustituye, sino que potencia la práctica de enfermería, sin embargo, su adopción exitosa requiere superar desafíos en formación profesional, gobernanza ética y adaptación organizativa. El futuro inmediato dependerá de desarrollar competencias híbridas que permitan a los profesionales colaborar efectivamente con estos sistemas inteligentes.

Palabras clave: Proceso de Atención de Enfermería; Inteligencia Artificial; Mejora de los Servicios de Salud; Competencias Digitales.

INTRODUCTION

Artificial Intelligence (AI) is reconfiguring the foundations of healthcare, marking a transformation comparable to historical milestones such as the development of anesthesia or antibiotics.[1,2] This technology is driving the transition from a reactive care model toward a proactive, predictive, and personalized one, enabling nursing staff to anticipate clinical needs and optimize care processes.

The fundamental value of AI in nursing transcends the mere automation of routine tasks.[3,4] Its most significant impact lies in enhancing the cognitive capabilities of the professional: by delegating the analysis of large volumes of data and the identification of complex patterns to algorithms, technology frees up intellectual capital so that clinical staff can focus on contextualized interpretation, care-related decision-making, and direct human interaction.[5] This process not only increases operational efficiency but also substantially elevates the quality and safety of care, detecting risks and opportunities that frequently elude conventional human analysis.[6]

Validating the transformative potential of AI requires empirical evidence derived from real-world clinical settings.[7] The examination of specific implementations in various health systems globally offers crucial insights for assessing its tangible impact on nursing practice, patient safety, and resource optimization.[8] Furthermore, these cases reveal distinct implementation philosophies, ranging from focused interventions to comprehensive systemic integrations.

However, a critical gap exists between the theoretical potential of AI and the concrete evidence regarding its effective implementation in clinical nursing practice. While the literature extensively describes the technical capabilities of these systems, limited comparative analysis is available that comprehensively evaluates their real impact on workflows, decision-making, and care outcomes across diverse healthcare environments. This study seeks to address this gap through a qualitative and comparative analysis of AI implementation cases in international health systems. The primary objective is to identify the integration strategies between AI and the nursing care process employed by healthcare institutions.

DEVELOPMENT

Flagship Case Study: The Early Warning System for Sepsis (TREWS) at Johns Hopkins

Sepsis is a critical clinical challenge due to the difficulty of early detection, being one of the leading causes of hospital mortality globally.[9] Its diagnosis is complicated by the nonspecific nature of the initial signs, which often delay the initiation of antimicrobial treatment, a crucial step during the first hours of the condition.

To address this problem, the Johns Hopkins University team developed the Targeted Real-Time Early Warning System (TREWS), led by Dr. Suchi Saria.[10] This system uses machine learning algorithms that continuously analyze multiple variables from the electronic medical record, including vital signs, laboratory results, and medical history. Unlike fixed-rule-based systems—known to generate false alarms—TREWS uses a predictive model that identifies patients at risk of sepsis hours before conventional clinical criteria are met.[11]

The implementation of TREWS was notable for its seamless integration into clinical workflows, facilitating widespread adoption. An analysis of provider interactions showed that physicians or advanced practice providers evaluated 89 % of alerts, and 38 % of these were confirmed, reflecting high clinical acceptance.[12] The alerts, discreet but noticeable in the electronic record, not only notified the nursing team and physicians but also provided evidence-based

action guides, such as ordering blood cultures or initiating antibiotic therapy.

Clinical results demonstrated a substantial impact. In a prospective multicenter study, TREWS monitored 590 736 patients, identifying sepsis in 6 877 cases before the start of antibiotic therapy.[13] When a provider confirmed alerts within 3 hours, there was an absolute reduction in hospital mortality of 3,3 % (relative reduction of 18,7 %), along with decreases in organ failure and hospital stay.[13] In addition, the median time to the first antibiotic order was reduced by 1,85 hours compared with cases not confirmed promptly.[12] The system›s sensitivity reached 82 % in identifying sepsis,[12] and its accuracy, evidenced by confirmation rates of 33-50 %, far exceeded traditional systems, reducing alert fatigue. The success of TREWS lies in its socio-technical approach, which combines algorithmic accuracy with non-intrusive integration, building trust among professionals.

Workflow Optimization and Patient Safety: A Comparison Between Singapore and the NHS (United Kingdom)

A comparative analysis of artificial intelligence implementation strategies between Singapore and the British National Health Service (NHS) reveals two contrasting philosophies on technology integration in healthcare settings. While Singapore has adopted a centralized, systemic model, the NHS represents a decentralized approach based on local pilots, offering valuable insights into the scalability of these solutions.

The Singaporean healthcare system is characterized by its coordinated, nationwide implementation.[14,15] At Tan Tock Seng Hospital, PreSAGE technology combines thermographic sensors with AI algorithms to continuously monitor at-risk patients, achieving a 42 % reduction in falls and freeing up 300 minutes of nursing time per day previously spent on manual surveillance.[16] At the systemic level, the National University Health System has established a dual infrastructure with the Discovery AI platform for research and the Endeavour AI platform for real-time clinical operations, synchronized with the national electronic health record.[17]

In contrast, the British NHS has favored a bottom-up innovation model through its "AI in Health and Care Award" program.[18,19] This strategy has generated diversified initiatives according to specific local needs: Gloucestershire Hospital developed predictive models to identify patients at risk of prolonged stays; George Eliot Hospital implemented AI to streamline CT scan analysis; and Chapelford Medical Center adopted the Anima platform to optimize triage in primary care by integrating clinical data and evidence-based recommendations.[20]

This strategic dichotomy reflects contextual adaptations rather than the inherent superiority of any one model. The Singaporean approach prioritizes systemic integration and standardization. At the same time, the British strategy values local adaptation and progressive validation, demonstrating that the effectiveness of AI in nursing depends as much on technological design and implementation as on its suitability for the specific healthcare ecosystem.

Predictive models for fall prevention in hospitalization

Fall prevention is a priority challenge in hospital patient safety, where predictive models based on artificial intelligence have demonstrated superiority over traditional assessment methods. These tools enable more accurate, earlier identification of patients at risk, facilitating targeted preventive interventions by nursing staff.

A study conducted at Taichung Veterans General Hospital demonstrated the remarkable predictive potential of these systems.[21] Through retrospective analysis of data from more than 53,000 patients, multiple machine learning models were developed, with the one based on the Extreme Gradient Boosting (XGBoost) algorithm standing out for its exceptional performance. This model achieved an Area Under the Curve (AUC) of 0,990 and an overall accuracy of 95,11 %, metrics that significantly exceed conventional assessment scales. The implementation of such systems allows nursing staff to focus resources on high-risk patients and design science-based

personalized preventive strategies.

The robustness of this approach is supported by macro-level evidence.[22] A systematic review analyzing 22 studies on predictive models for falls confirmed the consistency of these findings, reporting that all models evaluated exceeded 70 % accuracy.

This convergence of results across diverse clinical contexts and methodologies suggests that fall prediction is a particularly suitable domain for machine learning. The ability of these systems to integrate multiple clinical variables in real time positions them as valuable tools for strengthening patient safety and optimizing the allocation of nursing resources.

Comparative analysis of these implementations reveals that artificial intelligence is fundamentally reshaping nursing practice through two main vectors: clinical anticipation through predictive models and process optimization through intelligent automation. Beyond specific metrics, the common denominator of success lies in approaching implementation as a socio-technical challenge where usability, professional trust, and integration into existing workflows ultimately determine the real impact. This transition to an AI-augmented care paradigm does not follow a single trajectory but adapts to specific organizational contexts, whether through centralized or decentralized approaches.

FINAL CONSIDERATIONS

Artificial intelligence demonstrates transformative potential in nursing when implemented as a cognitive augmentation tool that enhances—not replaces—human clinical judgment. The success of implementations critically depends on socio-technical factors: systems with high predictive accuracy but poor integration into workflows tend to have lower adoption than less sophisticated solutions better adapted to the clinical context. Viable implementation models have been identified: systemic-centralized approaches and decentralized pilot models, both effective when they prioritize reducing administrative burden and building clinical trust. The main challenges include developing hybrid skills in professionals, ensuring algorithmic fairness, and creating ethical frameworks for shared human-AI decision-making. The immediate future will require a focus on interoperability between systems and on developing standards to assess the real—not just technical—impact of these technologies on care outcomes.

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