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Perception of Patient Safety and Error Reduction Through a Clinical Decision Support System (AI)

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Theme: Technologies for healthcare

Contribution to the discipline: This study provides empirical evidence of the impact of AI-based Clinical Decision Support Systems (CDSS-AI) in nursing. Specifically, the results indicate that CDSS-AI implementation is associated with improved patient safety perception and a reduction in staff-reported clinical errors. This study enriches empirical practice by employing AI built upon the principles of the Roy Adaptive Model. This approach enables nursing professionals to develop effective adaptive responses to the needs of complex clinical settings. In this way, it combines advanced technology with a robust conceptual framework for the discipline, thereby promoting safer, more efficient, and patient-centered care.

Abstract

Objective: To evaluate the impact of implementing artificial intelligence (AI) tools on patient safety perception and the reduction of clinical errors in care at two hospitals in Peru. **Materials and Methods:** A quasi-experimental quantitative design was used, with a non-randomized control group. Measurements were taken before and after the intervention. The sample consisted of 80 nurses (experimental group n=40; control group n=40), selected by purposive non-probability sampling from two public hospitals in Latin America. The experimental group used an AI-based Clinical Decision Support System (CDSS-AI) for 12 weeks. Validated tools were used to assess nurses' self-reported nursing errors and patient safety perception. **Results:** CDSS-AI intervention had a positive impact on participants in the experimental group, significantly improving patient safety perception and reducing the reported incidence of clinical errors. However, technical, ethical, and organizational challenges remain, exacerbated by the limited availability of explainable AI (XAI) models and insufficient training for healthcare workers in safely integrating these technologies into their workflows. **Conclusion:** Integrating AI into nursing services can be an important tool for improving patient safety, provided it is implemented within a clear ethical and regulatory framework, prioritizing algorithmic transparency, and encouraging active participation of professionals in the design and oversight of these systems.

Keywords (Source: DeCS)
Artificial intelligence; patient safety; nursing; clinical decision support systems; human factors; explainable artificial intelligence.

Percepción de la seguridad del paciente y de la reducción del error a través de un Sistema de apoyo para la toma de decisiones clínicas (IA)

Resumen

Objetivo: Evaluar el impacto de la implementación de herramientas de inteligencia artificial (IA) en la percepción de la seguridad del paciente y la reducción de errores clínicos en el cuidado, en dos hospitales de Perú. **Materiales y métodos:** Se usó un diseño cuasiexperimental cuantitativo, con un grupo de control no-aleatorio. Se tomaron medidas antes y después de la intervención. La muestra estuvo compuesta por 80 enfermeras (grupo experimental n=40; grupo control n=40), seleccionadas por muestreo intencionado no probabilístico, en dos hospitales públicos de América Latina. El grupo experimental usó un sistema de apoyo para la toma de decisiones clínicas basadas en IA (CDSS-AI, por sus siglas en inglés), durante 12 semanas. Se utilizaron herramientas validadas para evaluar las autorreportes de errores y de la percepción de seguridad del paciente de las enfermeras. **Resultados:** La intervención con el CDSS-AI tuvo un impacto positivo en los participantes del grupo experimental, al haber mejorado significativamente la percepción de la seguridad del paciente y reducido los reportes de incidencia de errores clínicos. Sin embargo, aún persisten los retos técnicos, éticos y organizacionales, que se exacerban por la limitada disponibilidad de modelos explicables de IA (XIA) y la insuficiente capacitación de los trabajadores de la salud para integrar estas tecnologías en sus flujos de trabajo. **Conclusión:** Integrar la IA en los servicios de enfermería puede ser una herramienta importante para mejorar la seguridad del paciente, siempre que se haga dentro de un marco ético y regulatorio claro, donde se priorice la transparencia algorítmica, y se incentive la participación activa de los profesionales en el diseño y supervisión de estos sistemas.

Palabras clave (Fuente DeCS)

Inteligencia artificial; seguridad del paciente; enfermería; Sistemas de apoyo a decisiones clínicas; factores humanos; inteligencia artificial explicable.

Percepção da segurança do paciente e da redução de erros por meio de um sistema de suporte à decisão clínica (IA)

Resumo

Objetivo: avaliar o impacto da implementação de ferramentas de inteligência artificial (IA) na percepção da segurança do paciente e na redução de erros clínicos no cuidado, em dois hospitais do Peru. **Materiais e métodos:** foi utilizado um desenho quantitativo quase-experimental, com um grupo de controle não randomizado. Medidas foram tomadas antes e depois da intervenção. A amostra consistiu em 80 enfermeiros (grupo experimental n = 40; grupo controle n = 40), selecionados por amostragem intencional não probabilística, em dois hospitais públicos da América Latina. O grupo experimental utilizou um sistema de suporte à decisão clínica baseado em IA (CDSS-AI, sigla em inglês) por 12 semanas. Ferramentas validadas foram usadas para avaliar os relatos de erros e a percepção da segurança do paciente por parte dos profissionais de enfermagem. **Resultados:** A intervenção com o CDSS-AI teve impacto positivo nos participantes do grupo experimental, melhorando significativamente a percepção da segurança do paciente e reduzindo a incidência de erros clínicos. No entanto, desafios técnicos, éticos e organizacionais permanecem, agravados pela disponibilidade limitada de modelos + de IA explicável (XAI) e pela falta de treinamento dos profissionais de saúde para integrar essas tecnologias em seus fluxos de trabalho. **Conclusão:** Integrar a IA nos serviços de enfermagem pode ser uma ferramenta importante para melhorar a segurança do paciente, desde que isso seja feito dentro de um marco ético e regulatório claro, em que a transparência algorítmica seja priorizada e a participação dos profissionais no desenvolvimento e na supervisão desses sistemas seja incentivada.

Palavras-chave (Fonte DeCS)
Inteligência artificial; segurança do paciente; enfermagem; sistemas de suporte à decisão clínica; fatores humanos; inteligência artificial explicável.

Introduction

The implementation of digital technology in healthcare has positioned artificial intelligence (AI) as a key element in optimizing clinical processes, improving decision-making, and enhancing patient safety. In the field of nursing, the implementation of AI-based solutions represents an unparalleled opportunity to assist staff in critical tasks, reduce the incidence of human error, and ensure more accurate and timely care.

However, despite growing interest and technological development, the implementation of AI in nursing practice still faces significant challenges related to its ethical, technical, and organizational integration. This motivation drives the need to generate scientific evidence that objectively evaluates its real impact on the quality and safety of care provided by nursing professionals.

The rapid integration of AI into healthcare systems has precipitated a paradigm shift in clinical practice, particularly within nursing care (1). AI technologies, encompassing machine learning algorithms, natural language processing, and predictive analytics, are designed to support decision-making processes, optimize clinical workflows, and enhance patient outcomes (2).

The nursing profession, historically characterized by human judgment and patient interaction, is currently confronted with the challenge and opportunity of integrating these tools into its daily practice (3). The objective of this integration is twofold: first, to reduce human error, and second, to increase patient safety (4).

The World Health Organization (WHO) defines patient safety as the prevention of avoidable harm during healthcare. In the nursing field, patient safety is closely related to proper medication administration, adherence to operating procedures, and rigorous record keeping (5). Errors in these areas can lead to adverse events, which can be caused by factors such as excessive workload, fatigue, and information overload among healthcare workers (6).

AI-based systems can serve as real-time assistants (7), providing Clinical Decision Support Systems (CDSS) that offer timely alerts and recommendations through data analysis. This directly reduces diagnostic and treatment errors (8, 9). Furthermore, AI is crucial in proactive risk management: its predictive models can identify early signs of disease deterioration or calculate risks (e.g., falls, infections) (10, 11), aiding in preventative measures and mitigating adverse events (12).

AI has a significant impact on medication safety, with automated systems capable of detecting dosage inconsistencies or drug interactions (13), thereby reducing medication errors and the psychological burden on healthcare workers (14, 15). Similarly, AI improves document quality through natural language processing (NLP) algorithms that can interpret and automatically complete clinical records (16). This helps standardize language and minimize omissions that could jeopardize safety (17).

However, the integration of AI is a socio-technological transformation that must be aligned with workflows, staff capabilities, and institutional culture (18, 19). Addressing ethical issues, including algorithmic transparency and data privacy, is crucial (20). A lack of training or a robust ethical and regulatory framework can generate resistance and even introduce new types of errors (21, 22, 23). Therefore, healthcare workers must actively participate in monitoring these systems to ensure fairness and patient rights (24).

Several studies have highlighted the need for transparency and interpretability in AI models. One pharmacovigilance study revealed limited integration of AI, posing risks and underscoring the urgency of using AI to optimize clinical decision-making (25). Nevertheless, the functional potential of AI has been demonstrated, particularly in sensor and device applications, as it is considered to have the potential to significantly reduce the incidence of adverse events, especially in challenging areas such as diagnostic errors and clinical deterioration (26).

However, effective integration requires addressing challenges related to human factors engineering (HFE); one study in this area demonstrated that misunderstanding or misuse of AI can seriously jeopardize safety. Therefore, it is concluded that designing AI systems based on ergonomic principles is crucial for minimizing errors and optimizing user-technology interaction (27).

The nursing profession is urged to play an active role in ethical and safety guidance regarding AI, including updating professional training and developing policies. A supplemental regulatory analysis recommends the development of guidelines and traceability mechanisms to examine the role of AI in adverse events (28).

A study concludes that clear policies, governance structures, and institutional commitment are crucial for mitigating the risks associated with their clinical application (29). Finally, experience in fields such as anesthesiology confirms that despite the excellent performance of AI in specific tasks, regulatory and ethical barriers remain, requiring further clinical validation before widespread adoption (30).

Despite the proven potential of AI, the incidence of adverse events in hospital care remains high, linked to medication errors, inadequate monitoring, or oversights in critical care procedures. A major challenge lies in effectively integrating these AI technologies into clinical workflows, often due to a lack of relevant knowledge, staff training, or clear policies.

This disconnect between the theoretical potential of AI and its practical application creates a significant evidence gap, at a local level, where validation and its impact on patient safety are not well documented. Against this backdrop, this study aimed to evaluate the impact of implementing AI tools on patient safety perception and the reported reduction in clinical nursing errors in two hospitals in Peru.

Materials and Methods

This study employed a quantitative quasi-experimental design with a non-randomized control group and included pre- and post-intervention measurements (pre-test/post-test). The aim was to evaluate the impact of implementing an AI-based clinical decision support system (CDSS-AI) on patient safety perception and the frequency of errors reported by caregivers. The study was conducted in two tertiary public hospitals in Latin America, chosen for their comparable workload and technical infrastructure.

This study included 160 registered nurses from two institutions. A purposive non-probability sampling method was used to select 80 participants, who were divided into an experimental group (EG) and a control group (CG), with 40 nurses in each group. Inclusion criteria were holding a valid nursing degree, at least two years of clinical experience, and possessing basic skills in using digital tools (assessed using a standardized checklist). Nurses who were rotating, undergoing training, or on extended leave during the study period were excluded.

The key focus of this intervention was to integrate a CDSS-AI into the workflow of the experimental team staff over 12 weeks. This system utilizes machine learning algorithms trained on historical patient data to generate real-time medication error alerts, detect early deterioration of the condition, and remind patients to adhere to their treatment plans. Prior to the intervention, the experimental team staff received 8 hours of system training (twice, 4 hours each time). The control group continued with traditional diagnostic and treatment procedures, using existing electronic health record systems without the AI module. The implementation of CDSS-AI was conducted in four phases: planning, system integration, training, and clinical deployment. The objective of this process was to ensure technological feasibility, staff engagement, and seamless integration into the existing nursing workflows. The intervention was conducted over a period of 12 weeks in the experimental group at Hospital A.

The following instruments were used:

- Nursing Error Assessment Scale (NEAS): A 12-item self-assessment tool used to measure the frequency and severity of errors reported by healthcare professionals in areas such as medication administration and monitoring. This scale has high internal consistency (Cronbach's alpha coefficient = 0.89).

- Patient Safety Index (PSI): A 10-item scale used to assess caregivers' perceptions of patient safety and the frequency of adverse events. This scale shows high internal consistency (Cronbach's alpha coefficient = 0.91).

In addition, incident reports from the hospital's quality department were referenced to verify the consistency of participants' self-reported data.

Statistical analysis was performed using IBM SPSS Statistics v27. Parametric tests were selected using the normality test (Kolmogorov- Smirnov Test) and the homogeneity of variance test (Levene test). The significance level for all statistical tests was set at $p < 0.05$.

Table 1. *Core Functionalities of the AI Clinical Decision Support System*

Functionality	Description	Technology Used
Medication Safety Alerts	Warns of drug interactions, allergies, and dosage deviations	Rule-based engine + ML
Patient Deterioration Detection	Predictive alerts based on vital signs and lab results	Random Forest Classifier
Protocol Adherence Monitoring	Tracks compliance with clinical guidelines in real time	Business logic layer + NLP
Risk Assessment	Calculates risk scores for falls and pressure ulcers	Logistic Regression
Documentation Assistant	Suggests and autocomplete entries in the nursing EHR system	Natural Language Processing

Source: Prepared by the authors.

Note. Machine learning (ML) and NLP are two distinct fields within the broader field of AI. The integration of these technologies with the EHR was facilitated by the utilization of HL7-FHIR standards, thereby ensuring seamless interoperability and data integrity.

The AI system employed was a customized module, integrated into the existing Electronic Health Record (EHR) platform via an API. The model utilizes supervised ML algorithms that have been trained on anonymized patient data from the previous five years. The following key functionalities were identified: Real-time alerts for medication interactions, allergies, and dosage errors. Early warning scores for patient deterioration are determined based on vital signs. The monitoring of protocol adherence is of paramount importance in the domains of hygiene, wound care, and documentation.

All nurses participating in the experimental group underwent eight hours of training, distributed in two four-hour sessions. These included theoretical overviews of AI in healthcare, system interface navigation, simulation of clinical cases, and troubleshooting exercises. To facilitate this process, a printed guide and mobile-accessible video tutorials were also provided. The implementation of the AI system was supported continuously by an expert team, which included an informatics nurse, an IT specialist, and a clinical educator.

The implementation of the AI system occurred in a phased manner, initially introducing it to low-risk departments, specifically internal medicine, followed by a more extensive deployment across surgical and emergency care units. The implementation team conducted a weekly review of the following: daily monitoring logs, user feedback, and performance analytics.

To ensure ethical compliance in the implementation of the CDSS-AI, we have obtained formal authorization from the nursing directors and heads of nursing departments of the two participating public hospitals. All participating nursing staff were fully informed of the research objectives, procedures, and the voluntary nature of their participation, ensuring it would not interfere with their work.

Prior to the pre-testing phase, we obtained written informed consent (IC) from each participant. We used alphanumeric codes to ensure the confidentiality and anonymity of responses, guaranteeing complete separation of scale (NEAS and PSI) data from professional identification information. Regarding the handling of sensitive information, patient clinical data used to train the AI model was anonymized and aggregated beforehand, complying with healthcare industry data protection regulations.

Results

The findings indicated a statistically significant decline in nursing error rates and a substantial enhancement in patient safety indicators among the experimental group participants following the implementation of the CDSS-AI.

In the experimental group, the mean frequency of reported nursing errors decreased significantly from the pre-test ($M = 6.2$, $SD = 1.4$) to the post-test ($M = 2.4$, $SD = 1.2$), $t(39) = 8.73$, $p < .001$. The effect size was substantial (Cohen's $d = 1.38$), indicating a significant practical impact of the intervention. In contrast, the control group exhibited no substantial alteration in error rates from the pre-test ($M = 6.1$, $SD = 1.6$) to the post-test ($M = 5.8$, $SD = 1.5$), as evidenced by a non-significant result ($t(39) = 1.12$, $p = .266$).

Table 2. *Pretest and Post-test Comparison of Nursing Errors Between Experimental and Control Groups*

Group	Measurement	Mean (M)	Standard Deviation (SD)	t	p
Experimental	Pretest	6.2	1.4		
	Post-test	2.4	1.2	8.73	< .001
Control	Pretest	6.1	1.6		
	Post-test	5.8	1.5	1.12	.266

Source: Prepared by the authors.

Note. The following table illustrates a comparison of the frequency of nursing errors before and after the implementation of the AI intervention. A substantial decrease was evident in the experimental group.

Regarding patient safety, the Patient Safety Index scores in the experimental group increased significantly from the pre-test ($M = 68.3$, $SD = 5.9$) to the post-test ($M = 89.7$, $SD = 6.4$), $t(39) = -9.14$, $p < .001$, representing a large effect size ($d = 1.75$). In contrast, the control group demonstrated stability in their scores, exhibiting a non-significant increase from the pre-test ($M = 67.9$, $SD = 6.1$) to the post-test ($M = 69.1$, $SD = 5.8$), as indicated by the $t(39) = -1.03$, $p = .306$.

Table 3. *Pretest and Post-test Comparison of Patient Safety Index Scores Between Experimental and Control Groups*

Group	Measurement	Mean (M)	Standard Deviation (SD)	*t*	*p*
Experimental	Pretest	68.3	5.9		
	Post-test	89.7	6.4	-9.14	< .001
Control	Pretest	67.9	6.1		
	Post-test	69.1	5.8	-1.03	.306

Source: Prepared by the authors.

Note. The following table illustrates the enhancement in Patient Safety Index scores prior to and following the intervention. Statistically significant improvements were demonstrated exclusively by the experimental group.

The findings of this study demonstrate a direct correlation between the enhancements observed in the experimental group and the implementation of the AI system.

Moreover, an analysis of institutional incident reports demonstrated a 53% reduction in adverse events related to nursing errors in the experimental group, in contrast to a mere 4% reduction in the control group.

The findings demonstrated a 53.1% decrease in AEs in the experimental group (from 64 to 30), while the control group exhibited a mere 3.8% reduction (from 52 to 50). This finding serves to reinforce the prevailing notion of the efficacy of AI tools within authentic clinical environments.

Table 4. *Adverse Events Reported in Institutional Records Before and After Intervention*

Group	Time	No. of Adverse Events	Percentage Change (%)
Experimental	Pre	64	
	Post	30	-53.1%
Control	Pre	52	
	Post	50	-3.8%

Source: Prepared by the authors.

Note. The following table presents a compendium of adverse events associated with nursing practice, as reported by hospitals. A substantial decrease was observed in the experimental group following the integration of AI.

A post-intervention survey was administered to the experimental group using a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree) to assess perceived usefulness and satisfaction with the AI tool. The results indicated a high level of acceptance:

- A resounding 87.5% of participants expressed agreement or strong agreement that the AI tool enhanced their clinical decision-making skills.
- A significant proportion of respondents reported a reduction in their workload following the implementation of the new system.
- A survey of 85% of respondents indicated that they believed it improved patient safety.

The following table presents hospital-reported adverse events associated with nursing practice. A substantial decrease was observed in the experimental group following the integration of AI.

Table 5. *Nurse Perceptions of the AI-Based Clinical Decision Support System (n = 40)*

Survey Item	Mean (M)	SD	Agreement (%)
The AI system improved my clinical decision-making	4.45	0.62	87.5%
The system reduced my documentation and administrative workload	4.58	0.49	92.5%
The system helped prevent potential patient safety incidents	4.43	0.71	85.0%
I would recommend continued use of the AI system in clinical settings	4.65	0.55	95.0%

Source: Prepared by the authors.

Note. The data were collated using a 5-point Likert scale, with 1 representing 'strongly disagree' and 5 representing 'strongly agree'. The percentage of agreement is calculated by including responses of 'agree' and 'strongly agree.'

A repeated measures ANOVA confirmed significant group-by-time interaction effects for both nursing errors ($F(1,78) = 42.17$, $p < .001$, $\eta^2 = .351$) and patient safety ($F(1,78) = 55.84$, $p < .001$, $\eta^2 = .417$). These findings serve to confirm the robustness of the AI intervention effect over time and across metrics.

Furthermore, Pearson correlation analysis demonstrated a strong inverse relationship between nursing errors and patient safety scores ($r = -0.72$, $p < .001$), suggesting that a reduction in errors directly improves safety perceptions.

Discussion

Our findings on the impact of AI in CDSS on nurses' safety perceptions are consistent with previous research, highlighting the potential of AI and the inherent challenges of its effective integration into clinical workflows. The literature consistently indicates that while AI is rapidly developing, the application of XAI models remains insufficient (25). Our findings also reflect this concern, pointing to the inherent risks of opacity in some predictive models that could undermine professional confidence and limit the effectiveness of automated decision-making.

As previous research (26) has shown, the application of assistive technologies such as sensors and vital sign monitors is crucial for optimizing data collection and predictive analytics. However, our findings emphasize that these technological advancements are insufficient without clinical validation and continuous monitoring. Like the previous findings on the inaccuracy of event detection systems (e.g., sepsis detection) (29), our results suggest a discrepancy between the expected safety outcomes generated by AI and the actual perceived safety outcomes, underscoring the need for enhanced algorithm validation in real-world clinical settings.

From a nursing perspective, our findings align with the cautionary tale that the widespread use of technological tools is not always accompanied by a thorough critical assessment of their impact on patient safety (28). While CDSS-AI has the potential to reduce workload, these findings underscore the urgent need for nurses to play an active role in guiding the ethical and safety aspects of AI. This implies a pressing need for nurses to receive specialized training to effectively manage these tools without compromising the quality of care.

Furthermore, this study highlights the importance of HFE principles in the interaction between clinicians and AI systems (27). The study confirms that applying HFE is crucial for optimizing the understanding of complex systems and seamlessly integrating them into workflows, enabling professionals to benefit from the potential of AI without introducing new errors. These findings are consistent with research emphasizing the need for clear guidelines for the safe implementation of AI and effective governance structures to oversee its use and mitigate risks (29, 30). Traceability mechanisms and robust regulatory frameworks must be implemented to ensure that AI systems not only optimize efficiency but also make a significant contribution to improving patient safety.

Study Limitations

A significant limitation of this study is the use of a quasi-experimental design and purposeful non-probability sampling. This design itself introduces selection bias, as the lack of randomization cannot ensure comparability between the experimental and control groups at baseline. Therefore, the observed post-test score differences (perceived safety and reported errors) may be attributable, at least in part, to existing confounding factors (e.g., organizational culture or employee acceptance of change), rather than solely to the CDSS-IA intervention itself.

A major limitation to the internal validity of this study lies in the nature of the variables measured. Impact assessments used NEAS and perceived safety (PSI), rather than objective clinical outcome measures for patients (e.g., actual infection rates or morbidity). While this approach is necessary given logistical complexities and is effective for assessing user acceptance and perceived effectiveness, it limits the ability to infer a direct causal relationship between the reduction in adverse events at the population level. Furthermore, relying on self-reporting introduces the risk of social expectation bias, where participants in the experimental group may overstate the perceived effect by reporting a lower error frequency due to familiarity with the new technology.

Finally, this study has ethical and methodological limitations. Although authorization from hospital administration and informed consent from participants were obtained, the lack of explicit formal approval from a research ethics committee constitutes a fundamental limitation. This deficiency affects the rigor and generalizability of the research plan and must be considered when assessing the robustness of the study.

Conclusion

The study concludes that the implementation of a CDSS-AI has had a positive impact on nursing staff. Specifically, the experimental group showed significantly improved patient safety awareness and a significantly lower reported rate of clinical errors. However, because the application of AI in clinical practice is still in its early stages, and the results are limited to the perception and behavior of nursing staff, the goal of assessing its direct impact on objectively reducing adverse events has only been partially achieved.

Clearly, the lack of transparency in algorithm implementation, such as the limited application of XAI, remains a challenge that must be overcome to build trust and achieve the full adoption of this technology.

This study emphasizes that the implementation of AI in healthcare urgently requires guidance from appropriate regulatory, ethical, and training frameworks. The findings suggest that technology integration must adhere to ergonomic and HFE principles, which are crucial for minimizing the risk of human error in system interpretation and improving the decision-making capabilities of healthcare professionals.

Active participation from institutions in developing safety policies, governance standards, and continuous monitoring mechanisms to mitigate risks is essential. For artificial intelligence to become a powerful tool for ensuring patient safety, we must focus on overcoming technical and organizational barriers through continuous clinical validation and traceability of automated decision-making.

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