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Integrating Big Data and Artificial Intelligence in Nursing Management of Immune-Mediated Diseases: Associations with Clinical Decision-Making and Patient Monitoring.

Integración de Big Data e inteligencia artificial en la gestión de enfermería de trastornos inmunitarios: asociaciones con la toma de decisiones clínicas y el monitoreo de pacientes.

Integração de Big Data e inteligência artificial na gestão de enfermagem de distúrbios imunológicos: associações com a tomada de decisões clínicas e o monitoramento do paciente.

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Author Contributions

A. Conceptualization, methodology, investigation, data curation, formal analysis, writing original draft, writing, review and editing, visualization, project administration, supervision.

ABSTRACT

Introduction. Immune-mediated diseases (IMDs) require individualized nursing management because of heterogeneous clinical manifestations and complex biological mechanisms. This study examined associations between Big Data and Artificial Intelligence (AI)-supported nursing management, clinical outcomes, patient monitoring, clinical decision-making, and nurse usability. **Methodology.** A multicenter cross-sectional study was conducted in five public referral hospitals in West Sulawesi, Indonesia, from February to December 2024. Participants included 300 adults with rheumatoid arthritis, systemic lupus erythematosus, or Crohn's disease and 55 registered nurses. An AI-enabled decision-support platform integrated electronic health records, laboratory data, wearable-device metrics, and molecular biomarkers. Clinical outcomes and nurse perceptions were assessed using standardized measures and the Technology Acceptance Model. **Results.** AI-supported nursing management was associated with shorter symptom-resolution time (8.0 ± 2.1 vs. 13.0 ± 3.5 days; $p < 0.001$) and lower hospital readmission (25.3% vs. 34.7%; $p < 0.001$). The AI model demonstrated 91.2% predictive accuracy for disease-flare risk. Among nurses, 89.1% rated the system highly useful, 85.5% found it easy to operate, 83.6% reported strong decision-making support, and 90.9% intended to continue using it. **Discussion.** Integrating clinical, molecular, and wearable data through AI may strengthen symptom monitoring, early recognition, and evidence-informed nursing decisions. High nurse acceptance indicates favorable usability. However, organizational readiness, digital literacy, interoperability, and ethical governance remain important. **Conclusions.** AI-supported nursing management was associated with favorable clinical and professional outcomes. AI may support precision nursing when complementing professional judgment. Longitudinal multicenter studies are needed to confirm clinical effectiveness.

Keywords: Artificial Intelligence; Big Data; Decision Support Systems, Clinical; Immune System Diseases; Nursing Informatics; Monitoring, Physiologic; Nursing care; Systems Biology.

RESUMEN

Introducción. Los trastornos inmunitarios, como lupus eritematoso sistémico, artritis reumatoide y la enfermedad de Crohn, requieren cuidados de enfermería individualizados debido a la heterogeneidad de sus manifestaciones clínicas y complejos mecanismos inmunológicos. Los avances en Big Data e inteligencia artificial ofrecen oportunidades de mejora en el monitoreo de pacientes y la toma de decisiones clínicas basadas en la evidencia. Este estudio examina la asociación entre la integración de estas tecnologías en la gestión de enfermería y el monitoreo de pacientes, la toma de decisiones clínicas y la facilidad de uso para el personal de enfermería. **Metodología.** Se llevó a cabo un estudio de corte transversal multicéntrico en cinco hospitales de Sulawesi occidental, Indonesia, entre febrero y diciembre de 2024. Los participantes incluyeron adultos con trastornos inmunitarios confirmados por un médico y 55 profesionales de enfermería brindando atención directa. Una plataforma de apoyo a la toma de decisiones clínicas integró historias clínicas electrónicas, monitoreo mediante dispositivos portátiles y datos de laboratorio para producir predicciones de riesgo individualizadas. Los desenlaces incluyeron la detección de exacerbaciones, desempeño del monitoreo de síntomas, precisión predictiva y la usabilidad para el personal de enfermería. Se considero estadísticamente significativo un valor $p < 0.05$. **Resultados.** La gestión de enfermería asistida por inteligencia artificial se asoció con detección temprana de exacerbaciones (32.4%), alta precisión predictiva para el apoyo a la toma de decisiones relacionadas con el tratamiento (87.6%) y mejoras en el desempeño del monitoreo de síntomas (diferencia de medias = 18.5%, $p < 0.001$). El 81.8% de los profesionales de enfermería reportó una alta usabilidad del sistema y el 78.2% consideró a la plataforma funcional para los flujos de trabajo clínicos rutinarios. **Discusión.** La integración de datos clínicos, moleculares y procedentes de dispositivos vestibles mediante la inteligencia artificial puede mejorar el seguimiento de los síntomas, la detección precoz y la toma de decisiones de enfermería basadas en la evidencia. El alto grado de aceptación por parte del personal de enfermería indica una usabilidad favorable. Sin embargo, la preparación de la organización, la alfabetización digital, la interoperabilidad y la gobernanza ética siguen siendo aspectos importantes. **Conclusiones.** La integración de Big Data e inteligencia artificial a la gestión de enfermería se asoció con mejoras en el monitoreo de pacientes, fortalecimiento del apoyo a la toma de decisiones clínicas y alta usabilidad para el personal de enfermería. Al ser un estudio de corte transversal, no se pueden inferir relaciones causales. Se requieren estudios multicéntricos longitudinales para confirmar estos hallazgos y evaluar la efectividad clínica a largo plazo.

Palabras clave: Inteligencia Artificial; Macrodatos; Sistemas de Apoyo a Decisiones Clínicas; Enfermedades del Sistema Inmune; Informática Aplicada a la Enfermería; Monitoreo Fisiológico; Cuidados de Enfermería; Biología de Sistemas.

RESUMO

Introdução. Distúrbios imunológicos, como lúpus eritematoso sistêmico, artrite reumatoide e doença de Crohn, exigem cuidados de enfermagem individualizados devido à heterogeneidade de suas manifestações clínicas e aos complexos mecanismos imunológicos. Os avanços em Big Data e inteligência artificial oferecem oportunidades para aprimorar o monitoramento dos pacientes e a tomada de decisões clínicas baseadas em evidências. Este estudo examina a associação entre a integração dessas tecnologias na gestão de enfermagem e o monitoramento dos pacientes, a tomada de decisões clínicas e a facilidade de uso para a equipe de enfermagem. **Metodologia.** Foi realizado um estudo transversal multicêntrico em cinco hospitais em Sulawesi Ocidental, Indonésia, entre fevereiro e dezembro de 2024. Os participantes incluíram adultos com distúrbios imunológicos confirmados por médico e 55 profissionais de enfermagem que prestavam assistência direta. Uma plataforma de apoio à tomada de decisões clínicas integrou prontuários eletrônicos, monitoramento por meio de dispositivos vestíveis e dados laboratoriais para produzir previsões de risco individualizadas. Os resultados incluíram detecção de exacerbações, desempenho de monitoramento de sintomas, precisão preditiva e usabilidade para a equipe de enfermagem. Um valor de $p < 0{,}05$ foi considerado estatisticamente significativo. **Resultados.** A gestão de enfermagem assistida por inteligência artificial foi associada à detecção precoce de exacerbações (32,4%), alta precisão preditiva no apoio à tomada de decisões relacionadas ao tratamento (87,6%) e melhorias no desempenho do monitoramento de sintomas (diferença média = 18,5%, $p < 0{,}001$). 81,8% dos profissionais de enfermagem relataram alta usabilidade do sistema, e 78,2% consideraram a plataforma funcional para fluxos de trabalho clínicos rotineiros. **Discussão.** A integração de dados clínicos, moleculares e de dispositivos vestíveis por meio de inteligência artificial pode aprimorar o monitoramento de sintomas, a detecção precoce e a tomada de decisões de enfermagem baseadas em evidências. O alto nível de aceitação por parte dos profissionais de enfermagem indica uma usabilidade favorável. No entanto, a preparação organizacional, a alfabetização digital, a interoperabilidade e a governança ética continuam sendo considerações importantes. **Conclusões.** A integração de Big Data e inteligência artificial na gestão de enfermagem esteve associada a melhorias no monitoramento de pacientes, ao fortalecimento do apoio à tomada de decisões clínicas e à alta usabilidade para os profissionais de enfermagem. Por se tratar de um estudo de corte transversal, não é possível inferir relações causais. São necessários estudos longitudinais multicêntricos para confirmar esses achados e avaliar a eficácia clínica a longo prazo.

Palavras-chave: Inteligência Artificial; Big Data; Sistemas de Apoio a Decisões Clínicas; Doenças do Sistema Imunitário; Informática em Enfermagem; Monitorização Fisiológica; Cuidados de Enfermagem; Biologia de Sistemas.

Introduction

Immune-mediated diseases represent a heterogeneous group of chronic conditions characterized by dysregulated immune responses, in which immune effector cells target healthy tissues, leading to persistent inflammation, progressive organ damage, and multisystem impairment. Common IMDs include systemic lupus erythematosus, rheumatoid arthritis, multiple sclerosis, psoriasis, and inflammatory bowel diseases, which collectively contribute to substantial global morbidity, reduced health-related quality of life, and rising healthcare expenditure. Epidemiological estimates indicate that immune-mediated inflammatory disorders affect approximately 5–10% of the world's population, with prevalence continuing to rise due to demographic shifts, environmental exposures, and improved diagnostic capacity (1,2). Despite major advances in therapeutic modalities, clinical management remains challenging due to variable disease phenotypes, fluctuating activity, overlapping manifestations, heterogeneous treatment responses, and complex underlying immune mechanisms.

The proliferation of digital health technologies has reshaped approaches to chronic disease care. Big Data derived from electronic health records, laboratory information systems, diagnostic imaging, wearable sensors, genomic sequencing, and environmental monitoring provides unprecedented opportunities to characterize disease heterogeneity and map individual patient trajectories. Artificial intelligence, particularly supervised machine learning algorithms, enables integration and synthesis of these high-dimensional datasets to support predictive analytics, risk stratification, personalized treatment planning, and clinical decision support. Within IMD care, AI-assisted methods have demonstrated utility in identifying flare patterns, forecasting therapeutic response, and facilitating earlier clinical intervention through data-driven insights (3–5).

These technological developments align closely with systems biology frameworks, which examine disease through integrated analysis of molecular, cellular, physiological, and environmental interactions rather than isolated biological events. Multi-omics profiling – encompassing genomics, transcriptomics, proteomics, metabolomics, and immunophenotyping – has substantially advanced understanding of the biological networks driving IMD pathogenesis. When paired with AI capable of processing complex datasets, systems biology enables identification of novel biomarkers, classification of disease subtypes, development of prognostic models, and delivery of precision care tailored to individual patient needs (6, 7).

Although AI and Big Data have been increasingly investigated in rheumatology, immunology, and precision medicine, most published research focuses on diagnostic algorithms, therapeutic prediction, or physician-facing decision-support tools. Comparatively limited attention has been directed toward implementation of AI-assisted systems within nursing practice, where continuous patient assessment, symptom monitoring, health education, care coordination, and long-term follow-up form the foundation of disease management. Consequently, evidence remains scarce regarding how AI-enabled platforms can be integrated into routine nursing workflows, how nurses perceive their usability, and whether such integration correlates with improved monitoring and decision-making (8, 9).

Nurses occupy a central role in multidisciplinary IMD care, as they continuously evaluate disease activity, recognize early signs of deterioration, promote treatment adherence, coordinate cross-specialty care, and support self-management. The emergence of nursing informatics and AI-supported decision tools offers an opportunity to strengthen these responsibilities by synthesizing complex clinical and biological information for point-of-care use. Importantly, AI is intended to complement rather than replace professional clinical judgment, preserving holistic, patient-centered care while providing timely, evidence-based insights. Understanding how these technologies can be effectively embedded into nursing practice is essential for advancing precision nursing and optimizing outcomes for people living with chronic IMDs (10, 11).

Despite growing global interest in AI-driven healthcare, critical knowledge gaps persist regarding real-world implementation in IMD nursing management, particularly in middle-income settings where digital health transformation remains ongoing (26). Few studies have concurrently evaluated clinical outcomes alongside nurse acceptance and usability within routine practice (14,15,30,31). Addressing these gaps is necessary to inform implementation strategies and guide responsible integration of digital innovations into nursing services (12).

Accordingly, this multicenter cross-sectional study aimed to examine associations between integration of Big Data and AI-assisted technologies into nursing management of IMDs and selected clinical and professional outcomes. Specific objectives were to evaluate nurses' perceived usability and acceptance of AI-enabled systems, assess associations with clinical decision-making and patient monitoring, and examine patient-related outcomes including symptom control, flare detection, and hospital readmission. This work contributes to the expanding field of nursing informatics and provides empirical evidence on the role of AI-supported systems biology approaches in advancing precision nursing for immune-mediated conditions (16,17,20–23).

Methodology

Study design and setting

This multicenter quantitative cross-sectional study analyzed associations between AI-integrated nursing management and predefined clinical and professional outcomes among patients with IMDs. Given the observational design, all findings are interpreted as statistical associations rather than causal inferences (25). Data collection was conducted between February and December 2024 at five public referral hospitals across urban and rural settings in West Sulawesi, Indonesia. Each participant contributed one set of observations, and all analyses were performed using cross-sectional statistical frameworks (32).

Participants

A purposive sample of 300 adult patients (≥18 years) with confirmed IMDs was recruited from rheumatology, gastroenterology, and internal medicine outpatient clinics. Diagnostic distribution was: rheumatoid arthritis (n=132), systemic lupus erythematosus (n=98), and Crohn's disease (n=70). All diagnoses were verified by specialist physicians using internationally accepted criteria and supported by standardized immunological investigations documented in electronic health records. In addition, 55 registered nurses directly involved in IMD care delivery participated in usability evaluations (13).

Inclusion Criteria: Age ≥18 years; confirmed diagnosis of systemic lupus erythematosus, rheumatoid arthritis, or Crohn's disease; regular follow-up at participating facilities; complete clinical, laboratory, and biomarker datasets suitable for AI processing; and written informed consent.

Exclusion Criteria: Severe cognitive impairment or communication barriers; incomplete or unextractable clinical/molecular data; withdrawal of consent; or concurrent advanced illness likely to confound outcome assessment.

AI system development and validation

The AI-enabled clinical decision-support system was developed using supervised machine learning algorithms implemented in Python (Python Software Foundation, Wilmington, DE, USA). Predictor variables included sociodemographic characteristics, disease duration, laboratory biomarkers, transcriptomic and proteomic profiles, medication history, wearable device metrics, and prior hospitalization records (6).

Preprocessing steps included duplicate removal, imputation of missing values (for variables with <10% missing data), feature normalization, outlier detection, and standardization of all input variables (9). The full dataset was randomly partitioned into training (80%) and internal validation (20%) subsets. Five-fold cross-validation was applied to minimize overfitting and confirm model robustness. Performance metrics included sensitivity, specificity, overall predictive accuracy, and area under the receiver operating characteristic curve (AUC). Individualized risk estimates for disease flare and symptom progression were presented to nurses via a secure, interactive dashboard integrated with existing hospital information systems (13).

Variables and outcome measures

The primary independent variable was exposure to AI-supported nursing management, defined as incorporation of AI-generated insights into routine nursing assessment and monitoring. Primary outcomes were: early detection of disease flare-ups, symptom-monitoring performance, frequency of disease-related hospital readmission, and nurse-reported system usability. Symptom-monitoring performance was categorized as mild, moderate, or substantial improvement based on standardized clinical documentation. Usability was assessed using the Technology Acceptance Model (TAM), measuring perceived usefulness, perceived ease of use, and behavioral intention to use on a 5-point Likert scale (17). Covariates included age, sex, diagnosis, disease duration, and prior experience with digital health tools.

Data collection

Clinical data were extracted from electronic health records, including sociodemographic details, disease history, laboratory results, pharmacotherapy, and hospitalization events. Multi-omics data (transcriptomic, proteomic) were retrieved from institutional laboratory databases. Wearable devices continuously recorded heart rate, physical activity, and sleep parameters. All multimodal datasets were aggregated within the AI platform to generate personalized risk predictions for use during routine nursing care.

Prior to implementation, participating nurses completed standardized training covering dashboard navigation, digital health principles, interpretation of AI outputs, and documentation protocols (30). During clinical practice, nurses reviewed AI-generated recommendations alongside conventional clinical assessments; final clinical decisions remained the full professional responsibility of the treating team. Post-implementation, nurses completed validated usability questionnaires and optional semi-structured interviews to assess feasibility, acceptability, and barriers to use. The assessment tool demonstrated excellent internal consistency (Cronbach's $\alpha = 0.87$) following expert content validation by three nursing informatics specialists (31).

Bias control

Selection bias was minimized by recruiting sites from diverse geographic and service-delivery settings. Information bias was reduced through standardized data extraction protocols and use of validated measurement instruments. Observer bias was addressed via uniform operational definitions and pre-specified coding frameworks. Potential confounding was adjusted for using multivariable regression models incorporating diagnosis, disease duration, age, sex, and prior digital health exposure (22).

Statistical analysis

All analyses were conducted using IBM SPSS Statistics Version 26. Continuous variables were summarized as mean ± standard deviation; categorical variables as frequencies and percentages. Associations between AI-supported care and categorical outcomes were examined using chi-square tests; continuous outcomes via one-way analysis of variance. Multivariable logistic and linear regression was performed to adjust for relevant confounders. All statistical tests were two-tailed, with significance defined as $p < 0.05$. Model performance was summarized using sensitivity, specificity, predictive accuracy, positive and negative predictive values, AUC, and corresponding 95% confidence intervals (25). Consistent with study design, all findings are reported as associations, not causal effects (23).

Results

Participant characteristics

A total of 300 patients with immune-mediated diseases were included in the analysis, comprising individuals diagnosed with rheumatoid arthritis (n = 132), systemic lupus erythematosus (n = 98), and Crohn's disease (n = 70). Among all eligible participants, incomplete demographic or clinical information was identified in 12 cases (4.0%), primarily involving disease duration and follow-up records. Variables with less than 10% missing data were addressed using multiple imputation, whereas records with substantial missing information were excluded according to the predefined exclusion criteria. In addition, 55 registered nurses participated in the evaluation of AI system usability and clinical integration (Table 1).

Variation in demographic and clinical characteristics was observed across diagnostic groups, particularly regarding disease duration and previous exposure to digital health technologies. These differences were considered potential confounding factors and were therefore adjusted for in the multivariable analyses.

Clinical outcomes associated with AI-supported nursing management

Integration of AI-supported nursing systems was associated with favorable clinical indicators across the study population. Participants managed within AI-supported nursing workflows demonstrated shorter symptom-resolution intervals (8.0 ± 2.1 days) compared with historical institutional reference values (13.0 ± 3.5 days), corresponding to an observed difference of 5.0 days (38.5%; $p < 0.001$). Likewise, disease-related hospital readmission was lower among patients receiving AI-supported monitoring (25.3%) than corresponding institutional reference rates (34.7%; $p < 0.001$).

Multivariable regression analyses adjusting for age, sex, diagnosis, disease duration, and previous exposure to digital health technologies demonstrated that AI-supported nursing management remained independently associated with improved symptom outcomes and lower readmission frequency ($p < 0.05$ for all adjusted models).

The AI predictive model demonstrated satisfactory diagnostic performance during internal validation, with a predictive accuracy of 91.2%, accompanied by high sensitivity and specificity for identifying patients at increased risk of disease flare-ups. These findings indicate that the integration of electronic health records, wearable-device information, and molecular biomarkers enabled reliable prediction of disease activity and may support earlier recognition of clinical deterioration within routine nursing assessment.

Because the present investigation employed a cross-sectional design, these findings should be interpreted as statistically significant associations rather than evidence of causal effects.

Nurses' perceptions of AI system usability and acceptance

Perceived usefulness

Most nurses (89%) rated the AI-supported platform as highly useful for clinical decision support, symptom monitoring, and individualized care planning. An additional 9% considered the system moderately useful, whereas only 2% perceived limited benefit.

Participants consistently reported that AI-assisted dashboards facilitated access to integrated patient information, supported interpretation of complex clinical data, and improved efficiency during routine nursing assessments. These findings demonstrate strong perceived usefulness of AI technologies within nursing workflows.

Perceived ease of use

Overall, 85% of respondents described the platform as intuitive and easy to operate. Approximately 13% reported that moderate training was required before achieving confidence in system navigation, whereas only 2% experienced operational difficulties.

Several nurses emphasized that integration with the existing electronic health record infrastructure facilitated implementation within routine clinical practice. Nevertheless, respondents also identified the need for ongoing technical support, periodic software updates, and continuing education to maintain efficient system utilization.

Clinical decision-making support

Most nurses reported that the AI platform strongly supported clinical decision-making (83.6%), with a smaller proportion indicating moderate support (14.5%), and only 1.8% reporting no perceived support.

Perceived efficiency of symptom monitoring

Nurses noted improved efficiency in symptom monitoring with the AI-assisted system (87.3%), while 10.9% observed no substantial change, and only 1.8% reported reduced efficiency.

Behavioral intention to continue ai utilization

Acceptance of AI-supported nursing technologies was consistently high. Overall, 92% of participants expressed willingness to continue using the system in future clinical practice, 6% moderately agreed, and only 2% reported reluctance to continue its use.

Nurses indicated that AI-assisted monitoring and predictive analytics complemented clinical assessment by supporting earlier identification of patient deterioration and more individualized nursing interventions. However, participants consistently emphasized that AI-generated recommendations should complement, rather than replace, professional nursing judgment and person-centered care.

Need for additional technical support

A minority of nurses (25.5%) indicated a need for ongoing technical support, while the majority (74.5%) felt sufficiently supported to use the system independently.

Collectively, these findings indicate favorable acceptance of AI-assisted technologies among nurses with respect to perceived usefulness, operational feasibility, usability, and future implementation within routine clinical practice, as summarized in Table 2.

Discussion

The present study examined the association between the integration of Big Data and AI-supported systems into nursing management and selected clinical and nursing outcomes among patients with IMDs. Overall, the findings indicate that AI-assisted nursing workflows were associated with more favorable patient-monitoring indicators, lower hospital readmission frequency, high predictive performance for disease flare identification, and strong acceptance among nurses. Given the cross-sectional design, these findings should be interpreted as statistically significant associations rather than evidence of causal relationships.

The observed associations may be explained by the capacity of AI systems to integrate multiple sources of clinical information into a unified decision-support platform. By simultaneously processing electronic health records, laboratory biomarkers, wearable-device data, and molecular information, AI-assisted systems provide a more comprehensive representation of disease activity than conventional assessment based solely on clinical manifestations. For nurses, timely access to integrated information may facilitate earlier recognition of potential disease deterioration, support prioritization of high-risk patients, and strengthen evidence-informed clinical decision-making. These findings are consistent with previous studies reporting that AI-assisted clinical decision-support systems can enhance patient monitoring, improve risk stratification, and support precision medicine in chronic immune-mediated conditions (12–15).

An important contribution of this study is the emphasis on the evolving role of nurses within digitally enabled healthcare systems. Rather than functioning solely as providers of direct patient care, nurses increasingly serve as coordinators of complex clinical information, interpreters of AI-generated recommendations, and facilitators of individualized care planning. The high levels of perceived usefulness, ease of use, and intention to continue AI utilization observed among participating nurses suggest that appropriately designed AI systems may be successfully integrated into routine nursing practice. These findings reinforce the growing importance of nursing informatics competencies, digital literacy, and continuous professional education in preparing nurses to effectively use emerging digital technologies while maintaining holistic, patient-centered care (16–18).

The incorporation of systems biology into nursing management represents another noteworthy finding. Integration of transcriptomic, proteomic, and immunological biomarker information with AI-based predictive analytics enabled a more comprehensive assessment of disease activity beyond conventional clinical observations. This multidimensional approach is consistent with the principles of precision nursing, in which biological, clinical, behavioral, and environmental information is synthesized to support individualized care planning. Similar observations have been reported in previous studies demonstrating that AI-assisted multi-omics integration may improve disease characterization, facilitate prediction of therapeutic response, and support personalized management strategies for immune-mediated diseases (19-22). Although the present study was not designed to evaluate causal effectiveness, the observed associations suggest that integrating systems biology into nursing workflows may represent a promising direction for future nursing practice.

The present findings are also broadly consistent with reports from Latin American and other middle-income healthcare settings, where digital transformation initiatives have increasingly been adopted despite resource limitations (26-29). Previous studies have demonstrated that successful implementation of AI in clinical practice depends not only on algorithmic performance but also on institutional readiness, interoperability of digital health systems, multidisciplinary collaboration, and workforce preparedness. The favorable acceptance reported by nurses in the present study therefore likely reflects both technological usability and organizational support for digital innovation.

Despite these encouraging findings, successful implementation of AI-supported nursing systems requires careful consideration of several practical challenges. First, healthcare organizations must ensure interoperability between AI platforms, electronic health records, laboratory information systems, and wearable-device infrastructure to enable efficient data integration. Second, continuous education and competency development are necessary to ensure that nurses possess sufficient digital literacy to critically interpret AI-generated recommendations. Third, governance frameworks addressing data privacy, cybersecurity, algorithm transparency, and ethical accountability remain essential for maintaining patient trust and ensuring responsible AI implementation (24). Importantly, AI should function as a clinical decision-support tool that complements rather than replaces professional nursing judgment, thereby preserving person-centered care and shared clinical decision-making.

Several methodological limitations should be acknowledged when interpreting these findings. First, the cross-sectional design precludes conclusions regarding temporal relationships or causality between AI-supported nursing management and observed patient outcomes. Second, purposive sampling may have introduced selection bias by preferentially recruiting participants from institutions with greater technological readiness or stronger interest in digital health innovation. Third, nurses' perceptions were measured using self-administered questionnaires and therefore remain susceptible to information bias and socially desirable responses despite anonymous data collection procedures. Fourth, although multivariable analyses adjusted for major demographic and clinical characteristics, residual confounding from unmeasured variables—including institutional digital maturity, disease severity, organizational culture, and prior AI experience—cannot be completely excluded. Finally, because the study was conducted in referral hospitals within a single Indonesian province, generalizability to healthcare settings with different organizational structures, technological resources, or patient populations should be interpreted cautiously.

These limitations also identify important priorities for future research. Prospective longitudinal studies and multicenter investigations involving more diverse healthcare systems are needed to determine whether the observed associations remain consistent over time and across different clinical contexts. Experimental and implementation-science studies would further clarify the effectiveness, cost-effectiveness, sustainability, and scalability of AI-supported nursing interventions. In addition, future investigations should evaluate patient-reported outcomes, implementation barriers, ethical considerations, and organizational factors influencing successful adoption of AI-assisted nursing systems.

Overall, this study contributes to the growing body of evidence supporting the integration of Big Data, systems biology, and AI-assisted technologies into nursing management of immune-mediated diseases. The findings suggest that AI-supported systems may strengthen patient monitoring, facilitate evidence-informed clinical decision-making, and support precision nursing when implemented within an appropriate organizational and ethical framework. Nevertheless, these observations should be interpreted within the limitations of the study design, and additional longitudinal and multicenter research is required before broader conclusions regarding clinical effectiveness can be established (27, 33)

Conclusions

This multicenter cross-sectional study contributes to the growing evidence regarding the integration of Big Data and AI into the nursing management of immune-mediated diseases. The findings indicate that AI-supported nursing systems were associated with more favorable patient-monitoring indicators, enhanced clinical decision support, high predictive performance for disease flare identification, and positive nurse-reported usability and acceptance. These observations suggest that integrating multidimensional clinical, molecular, and digital health information through AI-assisted platforms may support evidence-informed and individualized nursing care within the framework of precision nursing.

Importantly, AI should be regarded as a clinical decision-support resource that complements, rather than replaces, professional nursing judgment. The successful implementation of AI-assisted nursing systems depends not only on algorithmic performance but also on appropriate organizational infrastructure, digital literacy, interdisciplinary collaboration, ethical governance, and sustained institutional support.

Because this study employed a cross-sectional observational design, the reported findings represent statistical associations and should not be interpreted as evidence of causal relationships between AI integration and clinical outcomes. In addition, the use of purposive sampling and the inclusion of hospitals from a single geographical region may limit the generalizability of the findings to other healthcare settings.

Future multicenter, longitudinal, and implementation-focused studies involving more diverse patient populations are warranted to confirm these associations, evaluate the long-term clinical effectiveness and cost-effectiveness of AI-assisted nursing interventions, and identify organizational, ethical, and technological factors that influence the successful integration of AI into routine nursing practice. Such investigations will further advance the development of nursing informatics and precision nursing for patients with immune-mediated diseases.

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Conflict of interest

The authors declare that they have no conflicts of interest.

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Ethical Considerations

Ethical approval was obtained from the Ethics Committee of Makassar Health Polytechnic (Approval No. EC/8739/02/2024; Minutes Registration No. 2024/EC-POLKES/8739-MIN-24).

All participants provided written informed consent before enrollment.

The study complied with the Declaration of Helsinki and national ethical guidelines concerning confidentiality, voluntary participation, and participants' right to withdraw at any stage without affecting their medical care.

Participant confidentiality and data privacy were strictly maintained throughout the study. Personal identifiers were removed from all datasets prior to analysis, and all collected information was stored securely and used solely for research purposes.

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Table 1. Sociodemographic and Clinical Characteristics of Participants (n = 300)

Variable	n (%) or Mean ± SD
Age (years)	42.6 ± 11.8
Sex	
Female	214 (71.3)
Male	86 (28.7)
Primary Diagnosis	
Rheumatoid Arthritis	132 (44.0)
Systemic Lupus Erythematosus	98 (32.7)
Crohn's Disease	70 (23.3)
Disease Duration	
<2 years	58 (19.3)
2–5 years	121 (40.3)
>5 years	109 (36.4)
Missing	12 (4.0)
Hospital Readmission During the 6 Months Before AI-Assisted Nursing Management	104 (34.7)
Hospital Readmission During the 6 Months After AI-Assisted Nursing Management*	76 (25.3)
Mean Symptom Resolution Time Before AI-Assisted Nursing Management (days)	13.0 ± 3.5
Mean Symptom Resolution Time After AI-Assisted Nursing Management (days)*	8.0 ± 2.1

Abbreviations: AI = Artificial Intelligence; SD = Standard Deviation.

Source: prepared by authors

Table 2. Nurses' Perceptions of AI Integration in Immune-Mediated Disease Management (n = 55)

Variable	Category	n (%)
Perceived Usefulness	Very useful	49 (89.1)
	Somewhat useful	5 (9.1)
	Limited usefulness	1 (1.8)
Ease of Use	Easy to operate	47 (85.5)
	Requires moderate training	7 (12.7)
	Difficult to operate	1 (1.8)
Clinical Decision-Making Support	Strongly supported clinical decisions	46 (83.6)
	Moderately supported clinical decisions	8 (14.5)
	No perceived support	1 (1.8)
Perceived Efficiency of Symptom Monitoring	Improved efficiency	48 (87.3)
	No substantial change	6 (10.9)
	Declined efficiency	1 (1.8)
Intention to Continue Using AI Systems	Yes	50 (90.9)
	Uncertain	4 (7.3)
	No	1 (1.8)
Need for Additional Technical Support	Yes	14 (25.5)
	No	41 (74.5)

Abbreviations: AI = Artificial Intelligence.

Source: prepared by authors