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AI mindset transformation needs assessment for early warning system integration among emergency nurses

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Abstract

Background: The increasing complexity of emergency care and the persistent challenges in early hypovolemic shock detection highlight the need for innovative approaches to support clinical decision-making. The integration of artificial intelligence (AI) and Early Warning Systems (EWS) requires not only technological readiness but also transformation in nurses' mindset, knowledge, and clinical culture.

Purpose: To assess emergency nurses' needs for AI mindset transformation through EWS integration and explore the role of scientific clinical culture in supporting future AI implementation in emergency nursing practice.

Method: An exploratory mixed-methods design with a convergent approach involving 164 emergency nurses from hospital emergency departments. Quantitative data were collected using a structured questionnaire assessing perceptions of AI, EWS utilization, scientific clinical culture, and professional development needs. Qualitative data were obtained through open-ended questions. Quantitative data were analyzed using descriptive statistics, while qualitative data were analyzed using thematic analysis. The findings from both approaches were integrated to provide a comprehensive interpretation.

Results: The findings indicated substantial needs for AI mindset transformation among emergency nurses was categorized as high. The highest priority needs included strengthening collaboration among nurses, researchers, and hospital management; improving EWS training; increasing nurse participation in innovation development; and implementing practice-based learning. Participants demonstrated positive attitudes toward AI and acknowledged its potential to support clinical decision-making and emergency response. However, gaps remained in AI literacy, practical experience, and decision-support competencies. Qualitative findings revealed challenges in early hypovolemic shock detection, the need for continuous competency development, and the importance of collaborative innovation. The integrated findings identified scientific clinical culture, EWS integration, professional development, and stakeholder collaboration as essential components for AI readiness among emergency nurses.

Conclusion: This study provides empirical evidence for the development of a Living Lab-based AI-enhanced EWS model to strengthen emergency nursing practice and support early hypovolemic shock detection.

Keywords: Artificial Intelligence; Emergency Nurses; Early Warning System; Hypovolemic Shock; Scientific Clinical Culture.

INTRODUCTION

Emergency Departments (EDs) are among the most complex healthcare environments, where rapid assessment and timely clinical decision-making are essential to prevent patient deterioration. Among various emergency conditions, hypovolemic shock

remains a major contributor to morbidity and mortality due to reduced circulating blood volume, which compromises tissue perfusion and may rapidly progress to irreversible organ failure if not recognized promptly (Kim & Lee, 2018; Landesberg et al., 2015;

Suresh, 2022). Despite advances in emergency medicine, delayed recognition of clinical deterioration continues to contribute to adverse patient outcomes, prolonged hospitalization, increased healthcare costs, and preventable deaths (Jeon & Park, 2021).

Emergency nurses are often the first healthcare professionals to identify changes in patients' physiological conditions; therefore, their ability to conduct accurate and timely assessments is fundamental to maintaining patient safety. However, increasing patient volumes, high workloads, staff shortages, and variations in clinical experience may hinder the consistent recognition of early deterioration (Ahn et al., 2021; Weile et al., 2021).

To improve early detection, Early Warning Systems (EWS) have been widely implemented as standardized tools that integrate physiological parameters, including respiratory rate, heart rate, blood pressure, temperature, oxygen saturation, and level of consciousness, to generate clinical risk scores and support decision-making (Hou et al., 2020). Previous evidence has demonstrated that EWS improves the early identification of deteriorating patients and facilitates timely interventions, making it an important component of patient safety strategies (Kyriacos et al., 2011; Marchezini et al., 2017). Nevertheless, successful EWS implementation remains inconsistent because these systems often rely on manual documentation, score calculation, and interpretation. These processes increase the risk of human error, incomplete documentation, workflow disruption, and delayed clinical responses, particularly during periods of high workload (Day, 2003; El Khatib et al., 2022; Fox & Elliott, 2015; Veldhuis & Nanayakkara, 2021).

Recent advances in artificial intelligence (AI) have created new opportunities to enhance EWS performance through predictive analytics, machine learning, and intelligent clinical decision-support systems that can identify patterns of deterioration before obvious clinical manifestations occur (Rowland et al., 2022; Sarbadhikari & Pradhan, 2020). AI-assisted systems have demonstrated promising applications in emergency care by improving triage accuracy, predicting critical events, optimizing resource allocation, and supporting continuous patient monitoring (Nie et al., 2025; Wiedermann et al., 2023). Therefore, integrating AI with EWS has

considerable potential to improve early detection of hypovolemic shock through more accurate, individualized, and real-time clinical risk assessment.

However, successful AI implementation depends not only on technological capabilities but also on healthcare professionals' readiness to adopt and utilize these innovations. Previous studies indicate that nurses' perceptions, attitudes, trust, digital competencies, and willingness to collaborate with AI significantly influence implementation outcomes (Giovannelli et al., 2023). This readiness can be understood as AI mindset transformation, which involves cognitive, affective, and behavioral dimensions that shape how healthcare professionals perceive, accept, and integrate AI into routine clinical practice (Rahman Jabin & Hammar, 2022). In addition, organizational context plays an equally important role. A scientific clinical culture characterized by evidence-based practice, continuous learning, interdisciplinary collaboration, and reflective clinical decision-making can provide a supportive environment for adopting AI-based innovations and strengthening confidence in technology-assisted care (Günther et al., 2024).

Recognizing that technological innovation should be developed together with its end users, Living Lab approaches have increasingly been applied in healthcare to facilitate stakeholder participation, co-creation, and real-world implementation throughout the innovation process (Joore et al., 2024). This approach allows researchers, healthcare professionals, administrators, and technology developers to collaboratively identify implementation barriers, user expectations, and practical solutions, ensuring that digital innovations remain clinically relevant and acceptable.

Although previous studies have investigated AI adoption, digital health readiness, and EWS implementation separately, limited evidence has explored the intersection of these domains within emergency nursing practice. In particular, limited understanding exists regarding emergency nurses' needs for AI mindset transformation through AI-enhanced EWS implementation within a scientific clinical culture, especially in developing healthcare systems where digital transformation is expanding rapidly and requires effective integration of clinical data, technological infrastructure, and organizational

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processes to support healthcare innovation (Sangiorgi et al., 2024). This gap is significant because technological readiness alone may not guarantee successful implementation. Understanding nurses' perceived needs, competency gaps, organizational support, and opportunities for collaborative innovation is necessary before an AI-enhanced EWS model can be effectively developed. Such understanding is essential for designing user-centered interventions that facilitate AI adoption while strengthening patient safety and the quality of emergency care.

Therefore, this study represents the initial phase of a Living Lab-based model development project aimed at assessing emergency nurses' needs for AI mindset transformation through Early Warning System integration, identifying competency and implementation gaps, and exploring the role of scientific clinical culture and stakeholder collaboration in supporting future implementation. The findings are expected to provide empirical evidence for the co-creation of an AI-enhanced Early Warning System framework to support early detection of hypovolemic shock and contribute to the advancement of digital innovation, emergency nursing practice, and patient safety.

RESEARCH METHOD

A mixed-methods study employed a convergent design to assess emergency nurses' needs for artificial intelligence (AI) mindset transformation through Early Warning System (EWS) integration. As the preliminary phase of a Living Lab-based model development project, the study aimed to identify stakeholder needs, implementation barriers, and innovation opportunities for future model development. The study involved 164 registered emergency nurses working in hospital emergency departments across Indonesia who were actively engaged in patient monitoring, clinical assessment, and emergency decision-making. Participants were recruited using purposive sampling based on predefined eligibility criteria, including experience in emergency nursing practice and voluntary participation. Participants represented diverse educational backgrounds, professional experiences, and emergency nursing training.

Data were collected using a structured online questionnaire developed from literature related to AI, EWS, digital health readiness, and evidence-based nursing practice. The instrument consisted of

demographic characteristics and Likert-scale items (1 = strongly disagree to 5 = strongly agree) assessing AI readiness, AI-assisted clinical decision-making, EWS utilization, scientific clinical culture, professional development needs, and organizational support. Open-ended questions were included to explore participants' experiences, perceived barriers, expectations, and recommendations regarding AI-assisted emergency care. The questionnaire was reviewed by nursing academics and emergency care practitioners to ensure content relevance and clarity. As the instrument was specifically developed for this exploratory needs-assessment study, internal consistency reliability was not established before data collection, and this limitation was considered in interpreting the quantitative findings.

Quantitative data were analyzed using descriptive statistics, including frequencies, percentages, means, and standard deviations, to identify participant characteristics and priority needs related to AI mindset transformation and EWS integration. A gap analysis was conducted by comparing the perceived importance of AI-related competencies with participants' reported preparedness levels, where larger differences indicated higher priorities for intervention and professional development. Qualitative data from open-ended responses were analyzed using thematic analysis to identify themes related to AI readiness, implementation barriers, competency development, and emergency nursing practice. Quantitative and qualitative findings were integrated through comparison and convergence to provide a comprehensive understanding of nurses' needs and guide the development of an AI-enhanced EWS model within a scientific clinical culture.

Methodological rigor was maintained through triangulation of quantitative and qualitative findings, systematic documentation of analytical procedures, reflexive interpretation, and detailed reporting of the study context to support credibility, dependability, confirmability, and transferability. Ethical principles were maintained through voluntary participation, electronic informed consent, anonymity, confidentiality, secure data management, and adherence to the Declaration of Helsinki. Ethical approval was obtained from the institutional ethics committee (Approval No. 049/11/UNF/21.PN/11/V/2026).

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RESEARCH RESULTS

Table 1. Demographic Characteristics of Participants (N=164)

Variable	Results
Age (Mean±SD)(Range)(Year)	32.8±6.45 (23–52)
Gender (n%)	
Female	127/77.4
Male	37/22.6
Educational Background (n%)	
D3 Nursing	144/87.8
Bachelor of Nursing	6/3.7
Professional Nurse (Ners)	2/1.2
Master's Degree	1/0.6
Others	11/6.7
Emergency Training (n%)	
Yes	71/43.3
No	93/56.7

Table 1 presents the demographic characteristics of the 164 emergency nurses who participated in this study. The majority of participants were female (127/77.4%), had a Diploma in Nursing (D3) background (144/87.8%), and had never attended formal emergency nursing training (93/56.7%).

Table 2. Priority Needs for AI Mindset Transformation and EWS Integration

Rank	Development Need	Mean	Priority Level
1	Collaboration among nurses, researchers, and management	4.45	Very High
2	Additional EWS training	4.41	Very High
3	Nurse involvement in innovation development	4.37	Very High
4	Practice-based learning	4.35	Very High
5	Evidence-based practice resources	4.34	Very High
6	Scientific clinical culture strengthening	4.32	Very High
7	Simulation-based emergency training	4.30	Very High
8	Data-driven clinical evaluation	4.27	High
9	Clinical decision-support tools	4.26	High
10	Digital EWS integration	4.24	High

Table 2. presents the assessment of priority needs revealed that emergency nurses identified collaboration, competency development, and organizational support as the main requirements for AI mindset transformation and EWS integration. The highest-rated need was collaboration among nurses, researchers, and hospital management (M = 4.45), followed by additional EWS training (M = 4.41) and nurse involvement in innovation development (M = 4.37). Practice-based learning, evidence-based practice resources, and strengthening scientific clinical culture were also rated as very high priorities. These findings indicate that AI-enhanced EWS implementation requires not only technological readiness but also professional development, collaborative innovation, and supportive clinical environments.

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Table 3. AI-Related Perceptions and Readiness Among Emergency Nurses

Indicators	Mean
Need for AI training	3.88
Readiness to use AI in daily practice	3.87
AI can improve emergency response speed	3.82
AI can support clinical decision-making	3.81
Knowledge of AI concepts in healthcare	3.67
AI can improve patient safety	3.65
Hesitation toward AI-supported decision-making	3.40

Table 3. presents emergency nurses generally demonstrated positive perceptions toward AI utilization in emergency care. The highest-rated indicators were the need for AI training (M = 3.88) and readiness to use AI in daily practice (M = 3.87), followed by perceptions that AI could improve emergency response speed (M = 3.82) and support clinical decision-making (M = 3.81). However, lower scores in AI knowledge (M = 3.67) and hesitation toward AI-supported decision-making (M = 3.40) indicate that AI literacy and confidence remain important areas requiring improvement before widespread implementation.

Table 4. Gap Analysis Between Current and Expected Conditions

Domain	Current Condition	Expected Condition	Gap
AI Literacy	Moderate	High	Large
AI Utilization	Low–Moderate	High	Large
EWS Competency	Moderate	High	Moderate
Clinical Decision Support	Limited	AI-assisted	Large
Scientific Clinical Culture	Developing	Well-established	Moderate
Continuous Learning	Moderate	High	Moderate
Interdisciplinary Collaboration	Good	Excellent	Small

Table 4. demonstrates that the largest gaps were observed in AI literacy, AI utilization, and clinical decision-support capabilities. Although participants generally expressed positive attitudes toward AI, their reported knowledge and practical experience remained limited. Moderate gaps were identified in EWS competency and scientific clinical culture, indicating that foundational structures already exist but require further strengthening.

Qualitative Findings

The thematic analysis of open-ended responses identified four major themes related to AI mindset transformation, EWS integration, and future implementation of AI-enhanced emergency care.

Theme 1: Challenges in Early Detection of Hypovolemic Shock

Participants highlighted that early manifestations of hypovolemic shock were often subtle, nonspecific, and difficult to distinguish from other clinical conditions. Several nurses reported challenges in recognizing patient deterioration before significant physiological changes occurred. These findings indicate that early shock detection remains a complex clinical challenge and emphasizes the need for improved assessment support and early warning mechanisms in emergency settings.

Theme 2: Need for AI-Assisted Clinical Decision Support

Participants expressed positive expectations regarding the potential role of AI in supporting emergency nursing practice. They described AI as a tool that could provide automated alerts, assist triage processes, predict patient deterioration, and support more accurate clinical decision-making. Participants perceived AI-assisted systems as beneficial for reducing human error, improving response time, and enhancing the accuracy of emergency care decisions.

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Theme 3: Need for Continuous Training and Competency Development

Participants consistently emphasized the importance of continuous professional development before implementing AI-enhanced EWS systems. The identified training needs included hypovolemic shock assessment, EWS utilization, AI literacy, and emergency clinical reasoning. Nurses perceived competency development as a critical component to ensure that technological innovations could be effectively integrated into clinical practice.

Theme 4: Collaborative Innovation Through a Living Lab Approach

Participants supported the involvement of multiple stakeholders, including nurses, researchers, hospital management, and technology developers, in the development and evaluation of future AI-based innovations. This theme reflects the importance of participatory approaches that consider clinical experiences, user needs, and organizational contexts during the innovation process. The findings support the relevance of a Living Lab approach for developing clinically applicable and user-centered AI-enhanced EWS models.

Table 5. Quantitative and Qualitative Integration Matrix

Quantitative Findings	Qualitative Findings	Integrated Interpretation
High need for AI training (M=3.88)	Nurses requested AI education programs	Capacity building is essential before implementation
High support for EWS training (M=4.41)	Respondents reported difficulties identifying deterioration	EWS competency remains a critical issue
Positive perception of AI (M=3.82)	AI expected to improve clinical responses	AI acceptance is relatively high
High demand for collaboration (M=4.45)	Participants requested stakeholder involvement	Living Lab approach is appropriate
High need for decision-support tools (M=4.26)	Nurses desired automated alerts	AI-EWS may address current clinical gaps

The integration of quantitative and qualitative findings demonstrated consistent patterns across key domains of AI-enhanced EWS implementation. The findings indicate that emergency nurses require strengthened AI competencies, EWS-related skills, clinical decision support, and collaborative innovation. Quantitative results showing high needs for AI training, EWS training, stakeholder collaboration, and decision-support tools were supported by qualitative responses emphasizing the need for education, practical guidance, early deterioration recognition support, and stakeholder involvement. These converging findings highlight that successful AI-enhanced EWS development requires simultaneous attention to workforce capacity, organizational readiness, and user-centered implementation approaches.

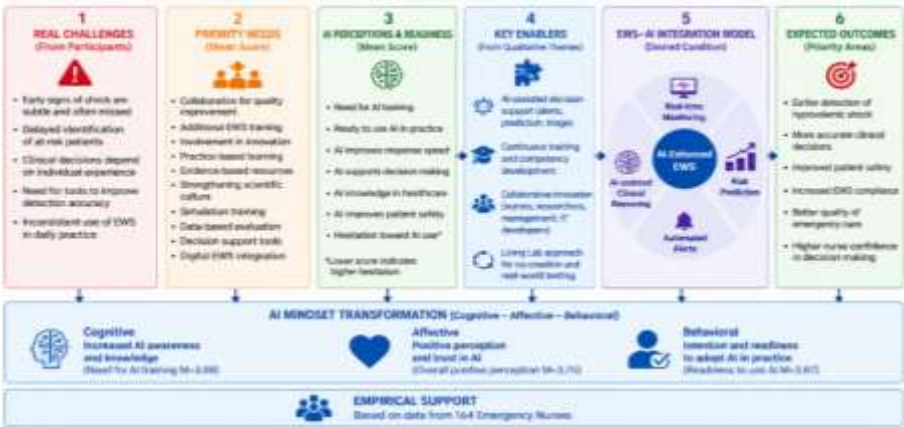


Figure 1. Needs-Based Framework Derived from Empirical Findings

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This figure illustrates the empirically derived framework developed from the integration of quantitative and qualitative findings. The framework highlights the relationships between clinical challenges, priority needs, AI readiness, key enablers, and the proposed AI-enhanced EWS development pathway. AI mindset transformation is positioned as a multidimensional process involving cognitive, affective, and behavioral components supported by scientific clinical culture and stakeholder collaboration.

DISCUSSION

As the preliminary phase of a Living Lab-based model development project, this study provides empirical evidence regarding emergency nurses' perceptions, expectations, and perceived needs related to AI-enhanced clinical support systems. Rather than evaluating the effectiveness of an AI-based intervention, the findings identify priority areas for workforce development, EWS strengthening, scientific clinical culture, and stakeholder collaboration that can support subsequent co-design and implementation involving healthcare professionals, researchers, and technology developers. Figure 1 presents the empirically derived framework generated through the integration of quantitative and qualitative findings.

The findings demonstrate that emergency nurses perceive AI mindset transformation and Early Warning System (EWS) integration as requiring multidimensional preparation, particularly in professional development, technological competency, clinical decision support, and collaborative innovation. The highest-rated needs were collaboration among nurses, researchers, and hospital management ($M = 4.45$), additional EWS training ($M = 4.41$), nurse involvement in innovation development ($M = 4.37$), and practice-based learning ($M = 4.35$). These findings suggest that AI implementation in emergency nursing should not be understood solely as a technological transition, but also as a process requiring professional readiness, organizational support, and evidence-based practice. This interpretation aligns with the growing recognition that digital technologies and data-driven clinical decision-making are increasingly influencing healthcare delivery and nursing practice (Antonacci et al., 2023).

This interpretation suggests that emergency nurses perceive innovation not merely as a technological issue but as a collaborative process requiring professional development, organizational support, and active stakeholder engagement (Gangl & Krychtiuk, 2023). A key implication of this study is that emergency nurses perceive scientific clinical culture as an essential foundation for AI-supported healthcare transformation. Participants highly valued evidence-based practice, data-driven clinical evaluation, continuous learning, and interdisciplinary collaboration as important elements for improving emergency care quality. The high ratings for evidence-based learning resources ($M = 4.34$), scientific clinical culture strengthening ($M = 4.32$), and clinical evaluation based on patient data ($M = 4.27$) indicate that nurses require supportive learning environments that encourage critical thinking, reflection, and continuous competency development. Furthermore, the preference for simulation-based training and real-world clinical practice suggests that experiential learning approaches may strengthen nurses' confidence in adopting emerging technologies. These findings indicate that emergency nurses are receptive to organizational environments that promote innovation, continuous improvement, and evidence-informed clinical decision-making (Azimirad et al., 2022; Sari et al., 2024). The importance of professional development and scientific clinical culture is further supported by previous evidence emphasizing evidence-based learning, simulation, data-driven evaluation, and continuous competency development as important components of healthcare improvement (Lashen et al., 2023).

Emergency nurses in this study demonstrated generally positive perceptions toward AI utilization in healthcare. Participants recognized the potential of AI to support clinical decision-making ($M = 3.81$), improve emergency response speed ($M = 3.82$), and assist daily clinical practice ($M = 3.87$). In addition, the high rating for AI-related training needs ($M = 3.88$) indicates that nurses are willing to engage with AI technologies and recognize the importance of developing relevant competencies. However, AI literacy remains an important challenge. Knowledge regarding AI concepts in healthcare received a relatively lower score ($M = 3.67$), while hesitation toward AI-supported decision-making was still

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observed ($M = 3.40$). These findings should be interpreted at the item level rather than as a composite measurement of AI readiness because the available data do not provide a validated composite score or sufficient information regarding item aggregation (Kemp et al., 2021; König & Suhr, 2023).

The relationship between AI acceptance and AI competency represents an important consideration for future implementation strategies. Although participants showed positive attitudes toward AI adoption, their knowledge and practical understanding of AI applications remained less developed. The combination of high readiness to use AI ($M = 3.87$), high demand for AI training ($M = 3.88$), and relatively lower AI knowledge scores ($M = 3.67$) suggests that the primary challenge may not be resistance toward AI but rather the development of practical competencies required for meaningful utilization. Therefore, future interventions should prioritize AI literacy development, hands-on training, and opportunities for clinical engagement rather than focusing only on increasing awareness. This finding supports a human-centered perspective of AI implementation, where technological advancement must be accompanied by professional capability, learning opportunities, and active involvement from healthcare professionals. Successful implementation consequently depends not only on technological sophistication but also on nurses' capacity and willingness to integrate AI systems into routine clinical practice.

Scientific clinical culture may function as an important organizational foundation that enables AI mindset transformation among emergency nurses. The findings indicate that participants valued evidence-based practice, interdisciplinary collaboration, data-driven clinical decision-making, and continuous professional learning as essential components of high-quality emergency care. This perception suggests that AI adoption requires a clinical environment that encourages knowledge exchange, critical evaluation, and reflective practice rather than relying solely on technological availability. The role of scientific culture in supporting healthcare improvement has been emphasized by previous studies, which highlight that evidence-based and learning-oriented organizations are more capable of adopting digital health innovations and sustaining

organizational change (Balkrishna et al., 2024; Gillett, 2006).

These findings are consistent with previous evidence showing that organizations with strong learning cultures and evidence-based practices are more successful in implementing digital health technologies because innovation is perceived as an opportunity to enhance professional practice rather than a disruption to existing workflows (Bonder & Martin, 2024). Within this context, scientific clinical culture may facilitate AI mindset transformation by encouraging nurses to trust objective data, critically evaluate AI-generated recommendations, and incorporate technology-assisted information into clinical decision-making processes (Mass-Hernández et al., 2022). The high ratings for scientific culture strengthening ($M = 4.32$), evidence-based practice resources ($M = 4.34$), and data-driven clinical evaluation ($M = 4.27$) further support the importance of embedding AI implementation within existing processes of evidence-informed practice and continuous learning. Furthermore, the high rating for collaboration among stakeholders ($M = 4.45$) suggests that emergency nurses prefer innovation processes based on participation and shared knowledge, supporting the relevance of Living Lab principles for future AI-enhanced EWS development.

These results indicate that strengthening Early Warning System (EWS) utilization and competency development remains a critical priority before or alongside AI integration. Although participants recognized EWS as an important tool for identifying patient deterioration, they reported ongoing challenges related to clinical assessment and timely recognition of hypovolemic shock. The high rating for additional EWS training ($M = 4.41$), together with the need for tools to improve shock detection accuracy ($M = 4.26$) and digital EWS integration ($M = 4.24$), indicates that current clinical practices require further support. These findings suggest that AI adoption strategies should not focus exclusively on technological deployment but should also address workforce competency development and organizational learning capacity (Melhem et al., 2023; Münter et al., 2023).

AI-enhanced EWS may provide an opportunity to overcome several limitations associated with conventional monitoring approaches, which often

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depend on manual calculation, periodic observation, and individual interpretation of physiological changes. Such processes may be affected by workload pressures, human error, and variability in clinical judgment, whereas AI-based systems have the potential to continuously analyze patient information, recognize subtle deterioration patterns, and provide real-time clinical risk alerts (Hou et al., 2020). Participants' strong preference for clinical decision-support tools further indicates that nurses perceive AI as a supportive technology rather than a replacement for professional judgment. This finding is consistent with previous evidence regarding AI-assisted clinical decision-making, where technology functions as an additional resource to improve assessment accuracy and reduce uncertainty during complex clinical situations (Muralitharan et al., 2021). Because EWS is already incorporated into emergency nursing workflows, integrating AI capabilities into existing systems may improve feasibility and reduce potential implementation barriers.

The qualitative findings further revealed persistent challenges in early hypovolemic shock detection. Participants described difficulties in identifying subtle physiological changes, distinguishing early shock manifestations from other clinical conditions, and making timely decisions under emergency conditions. These findings are consistent with previous studies indicating that compensatory physiological mechanisms may conceal early signs of hypovolemic shock, resulting in delayed recognition and intervention (Kyriacos et al., 2011). Quantitative findings supported these concerns, as participants reported delayed identification of patients at risk of shock in clinical practice ($M = 3.49$), while decision-making in shock management was perceived to rely considerably on individual clinical experience ($M = 3.82$). At the same time, the high demand for decision-support tools ($M = 4.26$) and digital EWS integration ($M = 4.24$) indicates a perceived need for additional support in emergency assessment processes.

These challenges highlight the potential contribution of AI-assisted monitoring systems in identifying hidden deterioration patterns and providing earlier clinical alerts. Recent developments in predictive analytics and machine learning have demonstrated promising applications for supporting timely recognition of patient deterioration, particularly

in emergency settings where rapid decision-making is essential (Sahu et al., 2024). However, technology alone is insufficient to ensure successful implementation. Participants also emphasized the importance of simulation-based training, AI education, and continuous competency development, indicating that effective adoption requires alignment between technological innovation and workforce preparedness (Ben Ida et al., 2021). Therefore, future strategies for improving hypovolemic shock detection should integrate AI-enhanced technologies with structured education, organizational support, and continuous evaluation.

The integrated findings demonstrate convergence rather than causal relationships between the quantitative and qualitative datasets. The results therefore support the identification of priority areas for subsequent model development rather than demonstrating the effectiveness of an AI-enhanced EWS intervention (Sriharan et al., 2024). Building on these findings, this study proposes a preliminary framework integrating implementation challenges, educational needs, scientific clinical culture, EWS integration, AI mindset transformation, and expected clinical outcomes. The framework conceptualizes AI adoption as a multidimensional process influenced by cognitive, affective, behavioral, and organizational factors rather than as a purely technological transition (Ren Kon et al., 2026). Furthermore, AI mindset transformation among emergency nurses should be approached as a human-centered organizational change process rather than solely as a technological intervention. Successful implementation requires simultaneous strengthening of professional competencies, organizational culture, collaborative learning environments, and user-centered innovation processes (Wachter, 2026).

The present evidence highlights the importance of Living Lab principles in supporting sustainable healthcare innovation through stakeholder engagement, co-creation, and iterative evaluation. The strong preference for collaboration among emergency nurses, researchers, hospital management, and technology developers suggests that involving end users throughout the design and implementation process may improve the relevance, acceptance, and applicability of AI-enhanced EWS technologies (Merino-Barbancho et al., 2023).

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Practically, the proposed framework should be considered an evidence-informed preliminary framework rather than a validated implementation model. It identifies AI literacy, EWS competency, scientific clinical culture, and stakeholder collaboration as priority areas for subsequent co-design, pilot implementation, and evaluation of AI-enhanced EWS using Living Lab methodologies (Fotis et al., 2023). As the initial phase of a Living Lab-based model development project, this framework provides an evidence-informed foundation for advancing AI-supported emergency nursing practice and improving patient safety.

CONCLUSIONS

Participants demonstrated positive perceptions of AI-supported clinical decision-making and expressed strong needs for EWS training, AI-related education, clinical decision-support tools, practice-based learning, and stakeholder collaboration. However, gaps in AI knowledge, practical competencies, and EWS-related capabilities remain important considerations for future implementation. The findings highlight the importance of scientific clinical culture, where evidence-based practice, continuous learning, data-driven evaluation, and interdisciplinary collaboration provide a supportive foundation for AI implementation. This study provides an evidence-informed preliminary framework integrating AI readiness, EWS competency, scientific clinical culture, and Living Lab principles to guide future development and implementation of AI-enhanced EWS in emergency nursing practice.

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