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Effect of Early Warning System Implementation on Patient Safety Through Early Detection of Clinical Deterioration Among Nurses at RSUD Kardinah Tegal

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ABSTRACT
The Early Warning System (EWS) is an early detection system for identifying clinical deterioration that plays a crucial role in improving patient safety. However, EWS implementation in hospitals continues to face several challenges, including poor compliance with documentation, inaccurate interpretation of EWS scores, and delays in clinical escalation. This study aimed to analyze the effect of Early Warning System implementation on improving patient safety through the early detection of clinical deterioration among nurses at RSUD Kardinah Tegal. This quantitative study employed a pre-experimental one-group pretest–posttest design without a control group. A total of 38 nurses were recruited using purposive sampling. The intervention consisted of strengthening EWS implementation through training, simulation, supervised clinical practice, and reinforcement of the clinical escalation algorithm. Data were collected using an EWS implementation observation checklist and a patient safety questionnaire, both of which had demonstrated satisfactory validity and reliability. Data were analyzed using descriptive statistics, the paired *t*-test, and Spearman's rho correlation, with a significance level of $p < 0.05$. The findings demonstrated that EWS implementation improved following the intervention, as indicated by a reduction in the proportion of poor implementation from 13.2% to 2.6% and an increase in the proportion of good implementation from 42.1% to 47.4%. The proportion of respondents with a good level of patient safety also increased from 73.7% to 86.8%. The paired *t*-test revealed a statistically significant difference in EWS implementation scores before and after the intervention ($t = -3.457$; $p = 0.001$). Furthermore, EWS implementation was positively correlated with patient safety ($r = 0.542$; $p < 0.001$). In conclusion, strengthening EWS implementation significantly improved EWS implementation and was positively associated with enhanced patient safety. Integrating EWS into hospital quality improvement programs is recommended as an effective strategy for the early detection of clinical deterioration and for supporting the achievement of Sustainable Development Goal (SDG) 3.

Keywords: Early Warning System; Patient Safety; Early Detection; Clinical Deterioration; Nurses

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INTRODUCTION

Hospitals are healthcare institutions that provide integrated promotive, preventive, curative, and rehabilitative services through outpatient, inpatient, and emergency care. As healthcare providers, hospitals are expected to deliver safe, high-quality, effective, and sustainable services to improve population health (Gualandi *et al.*, 2019). This expectation is consistent with the achievement of Sustainable Development Goal (SDG) 3, particularly the target of ensuring access to quality, safe, and patient-centered healthcare services as part of promoting healthy lives and well-being for all (World Health Organization, 2021).

In modern healthcare, the continuum of care emphasizes the continuity of services from health promotion, early detection, acute management, rehabilitation, to post-discharge follow-up, thereby ensuring comprehensive patient care (Vantissha, Azizah and Arifin, 2022).

Implementing this concept requires healthcare professionals, particularly nurses, to recognize changes in patients' clinical conditions as early as possible so that timely interventions can be provided before clinical deterioration occurs (Budiari,et all, 2019). Therefore, the quality of hospital services is determined not only by successful treatment outcomes but also by the healthcare system's ability to detect clinical risks early, prevent complications, and maintain patient safety (Altinay et al., 2023; Gartner et al., 2022).

Patient safety is a key indicator of healthcare quality and represents one of the fundamental dimensions of professional nursing practice. Despite numerous quality improvement initiatives, patient safety incidents, including adverse events, healthcare-associated infections, medical errors, and delays in patient management, continue to occur in hospitals (Parand et al., 2014; Arruum et al., 2021).These findings indicate that healthcare systems still require more effective approaches to identify clinical risks at an early stage and prevent adverse patient outcomes (Vincent and Coulter, 2002).

One of the most serious clinical events is Code Blue, which refers to cardiac or respiratory arrest requiring immediate resuscitation (Giwangkancana, 2025). Previous studies have demonstrated that most hospitalized patients who experience cardiac arrest exhibit physiological deterioration several hours before the event, including increased respiratory rate, changes in blood pressure, heart rate, oxygen saturation, and level of consciousness (Patil *et al.*, 2019) Failure of healthcare professionals, particularly nurses, to recognize these warning signs may delay clinical escalation, thereby increasing morbidity and mortality. Consequently, early detection systems have become an essential component of patient safety initiatives (Jackson, Janet & Grugan, 2018).

In response to this need, many hospitals have implemented the Early Warning System (EWS), a physiological scoring system based on respiratory rate, blood pressure, heart rate, body temperature, oxygen saturation, and level of consciousness. The resulting score serves as a basis for clinical decision-making, including patient monitoring and escalation of care according to the patient's level of clinical risk (Mathukia *et al.*, 2015) Previous studies have shown that EWS implementation improves the early recognition of patient deterioration, enhances the responsiveness of healthcare teams, and reduces the incidence of in-hospital cardiac arrest (Samani, Samani and Rattani, 2023).

However, the effectiveness of EWS implementation depends not only on the availability of the assessment tool but also on nurses' compliance with patient assessment procedures, the accuracy of score interpretation, adherence to clinical escalation protocols, and effective interprofessional communication (Rgn and Conway, 2023a) Several studies have reported poor compliance with EWS documentation, delayed clinical escalation, and suboptimal interprofessional coordination, limiting the effectiveness of EWS implementation (Danielle *et al.*, 2025) These findings suggest that successful EWS implementation requires a strong patient safety culture, effective clinical leadership, and an integrated healthcare delivery system (Nur and Santoso, 2018).

Most previous studies have focused on the validity of EWS instruments, compliance with EWS documentation, or the predictive ability of EWS for clinical outcomes such as mortality, intensive care unit (ICU) admission, and clinical deterioration. However, studies evaluating the effect of strengthening EWS implementation on improving patient safety as part of nursing care delivery remain limited, particularly in regional hospitals in Indonesia where EWS implementation has not yet been fully optimized (Masela1, Kosasih2 and Emaliyawati3, 2023) Consequently, there is still a significant knowledge gap regarding the extent to which strengthening EWS implementation can improve patient safety through the early detection of clinical deterioration in nursing practice.

A preliminary study conducted at RSUD Kardinah Tegal revealed that EWS implementation had not been consistently performed. Completion of the EWS scoring form did not fully comply with the established standard operating procedures, potentially leading to delays in detecting clinical deterioration and hindering timely

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clinical decision-making (Mirawati and Deswita, 2022) These findings indicate the need for strategies to strengthen EWS implementation in order to improve the quality of nursing care and patient safety.
Therefore, this study aimed to analyze the effect of Early Warning System implementation on improving patient safety through the early detection of clinical deterioration among nurses at RSUD Kardinah Tegal. This study is expected to provide empirical evidence regarding the effectiveness of strengthening EWS implementation in improving patient safety, reinforce evidence-based nursing practice, and contribute to healthcare quality improvement in line with the achievement of Sustainable Development Goal (SDG) 3, particularly the provision of safe, high-quality, and patient

METHODS

This study employed a quantitative approach using a pre-experimental one-group pretest–posttest design without a control group. All participants were assessed before (pretest) and after (posttest) the intervention without the inclusion of a comparison group. The intervention consisted of strengthening the implementation of the Early Warning System (EWS) through educational sessions on the concepts and objectives of EWS, training in physiological patient assessment, accurate measurement of vital signs, EWS score calculation, interpretation of EWS results, EWS documentation, clinical communication, and implementation of the clinical escalation algorithm according to the hospital's standard operating procedures (SOPs). The effectiveness of the intervention was evaluated by comparing EWS implementation and patient safety outcomes before and after the intervention.

Research Design and Sample

This study employed a *one-group pretest–posttest* design to evaluate changes in Early Warning System (EWS) implementation and patient safety practices following an EWS reinforcement intervention. The study was conducted in several inpatient wards at RSUD Kardinah Tegal, Indonesia, from May to July 2026. The study population comprised 376 nurses employed at the hospital, of whom 38 were selected using purposive sampling based on predefined eligibility criteria. Eligible participants were nurses who had worked at the hospital for at least six months, were directly involved in EWS implementation, provided informed consent, and completed all study procedures. Nurses who were on leave, undertaking educational programs or training during the study period, or did not complete the posttest assessment were excluded. Sample adequacy was evaluated using statistical power analysis for a paired-samples *t*-test. Assuming a two-tailed significance level of 0.05, a medium effect size (Cohen's $d = 0.50$), and a sample size of 38 participants, the estimated statistical power was approximately 85%. This estimate should be verified using appropriate statistical software and reported according to the assumptions used in the analysis. The findings were interpreted with consideration of the non-probability sampling method, limited generalizability, and potential confounding factors associated with the absence of a control group.
Data were collected using two instruments: an EWS implementation observation checklist and a patient safety questionnaire. The observation checklist assessed nurses' adherence to physiological patient assessment, accuracy of vital-sign measurements, EWS score calculation, interpretation of assessment findings, frequency of patient monitoring, completeness of clinical documentation, and compliance with clinical escalation algorithms. The patient safety questionnaire was administered at both pretest and posttest to assess changes in patient safety practices following the intervention. Content validity was evaluated through expert judgment, while item validity was assessed using the Pearson product–moment correlation test. Internal consistency was evaluated using Cronbach's alpha, with values of $\alpha \geq 0.70$ considered acceptable. The validity and reliability procedures and their results should be reported according to the assessments actually performed in this study.
Before data collection, research permission was obtained from the relevant institutions, and ethical approval was granted by the relevant Health Research Ethics Committee. The researcher coordinated with hospital management and head nurses to arrange the study schedule and data collection procedures. Eligible participants received information about the study objectives, procedures, potential benefits and risks, and their rights as research participants. Written informed consent was obtained before participation. Baseline assessments (*pretest*) were conducted using the EWS implementation observation checklist and the patient safety questionnaire. Participants subsequently received an EWS reinforcement intervention designed to strengthen their knowledge, practical skills, and adherence to standardized clinical procedures. The intervention comprised a 90-minute educational session, practical training, a 60-minute simulation of EWS score calculation, and supervised clinical practice. The intervention emphasized accurate physiological assessment, correct measurement and interpretation of vital signs, appropriate EWS score calculation, timely

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patient monitoring, complete clinical documentation, and adherence to the clinical escalation algorithm in accordance with the hospital's standard operating procedures (SOPs). Supervised clinical practice provided participants with opportunities to apply these principles in routine clinical settings.

Following completion of the intervention and the designated clinical implementation period, posttest assessments were conducted using the same instruments to evaluate changes in EWS implementation and patient safety scores. The collected data were checked for completeness and prepared for statistical analysis. To minimize potential observational bias, particularly the *Hawthorne effect*, the same checklist indicators and scoring criteria were used during pretest and posttest observations. Observations were conducted in the context of routine clinical practice, without additional assessment-related instructions that could influence nurses' behavior. Standardized assessment criteria were applied to promote measurement consistency and reduce observer subjectivity. Participants were informed about the study transparently without undue emphasis on the specific behaviors being assessed. Where applicable, the same observer conducted assessments at both time points to improve consistency. Nevertheless, the Hawthorne effect could not be entirely eliminated and was considered when interpreting the findings. Furthermore, the absence of a control group limited the extent to which observed changes could be attributed solely to the intervention. The findings were therefore interpreted cautiously, taking into account the purposive sampling method, potential confounding factors, and limited generalizability to other healthcare settings. Ethical principles were maintained throughout the study, including voluntary participation, informed consent, confidentiality, and respect for participants' rights in accordance with the approved research procedures.

Measures and Data Analysis

Data were analyzed using the Statistical Package for the Social Sciences (SPSS). Descriptive statistics were used to summarize participants' characteristics and study variables, including frequencies, percentages, means, standard deviations, minimum values, and maximum values.

Data normality was assessed using the Shapiro–Wilk test because the sample size was fewer than 50 participants. Differences between pretest and posttest scores were analyzed using the paired *t*-test for normally distributed data ($p > 0.05$) or the Wilcoxon signed-rank test for non-normally distributed data ($p < 0.05$). The association between Early Warning System (EWS) implementation and patient safety was examined using Spearman's rho correlation. Statistical significance was determined at a 95% confidence level with a significance threshold of $p < 0.05$.

RESULTS

Univariate analysis was performed to describe the characteristics of the participants and the distribution of the study variables, including Early Warning System (EWS) implementation and patient safety before and after the intervention.

Table 1. Distribution of Participants' Characteristics by Age Group at RSUD Kardinah Tegal

	Sex		Age			Educational level		Leghth of work experience			
	Male	Female	20-29	30-39	40-50	Nursing Diploma III	Nursing Bachelor degree	< 3 years	4-6 years	7-9 years	> 10 years
Frequency (n)	16	22	2	26	10	30	8	3	2	7	26
Percentage (%)	42.1	57.9	5.3	68.4	26.3	78.9	21.1	7.9	5.3	18	68.4

Source: Processed primary data, 2026

The characteristics of the respondents on Table 1 were assessed based on sex, age, educational level, and length of work experience. The findings indicate that the respondents were predominantly female, suggesting that women constituted the larger proportion of the nursing workforce involved in this study.

In terms of age most respondents were within the 30–39-year age group, indicating that the study participants were largely in the productive working-age category. This age distribution suggests that the majority of respondents had reached a relatively mature stage of professional development and were likely to have sufficient exposure to clinical practice.

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Regarding educational level, most respondents had a Nursing Diploma III qualification, while a smaller proportion had completed a bachelor's degree in nursing. This composition reflects the educational background of the nurses involved in the study and indicates that the respondents had formal professional preparation in nursing, although their levels of academic qualification varied.

Based on length of work experience, the respondents were predominantly nurses with more than ten years of professional experience. This finding indicates that most participants had considerable exposure to clinical practice and organizational procedures. Such experience may contribute to their familiarity with patient care processes, implementation of clinical procedures, and patient safety practices.

Table 2. Distribution of Participants' Characteristics by Workload Category

Workload category	Frequency (n)	Percentage (%)
Light	0	0
Moderate	28	73.7
Heavy	10	26.3
Total	38	100

Source: Processed primary data, 2026

The distribution of respondents by workload category in shows on

Table **2** that the majority of nurses experienced a moderate workload, while a small proportion experienced a heavy workload. No respondents were classified as having a light workload. The predominance of moderate workloads indicates that most nurses faced varying levels of work demands, while the presence of nurses with heavy workloads suggests differences in work intensity related to patient acuity, service characteristics, staffing availability, and the complexity of nursing care

High workloads may increase cognitive demands, divide attention, and affect concentration and clinical decision-making accuracy. In the context of Early Warning System (EWS) implementation, these conditions may hinder the consistent performance of physiological assessments, patient monitoring, documentation, EWS score interpretation, and timely adherence to clinical escalation algorithms. Therefore, effective EWS implementation depends not only on nurses' knowledge and clinical skills but also on a supportive work environment that promotes clinical vigilance and optimal responses. Workload management, regular training, adequate staffing, and clear escalation protocols should be considered to support early detection of clinical deterioration and improve patient safety. These findings should be interpreted as contextual information regarding nurses' workloads rather than as evidence of a causal relationship between workload and EWS implementation.

Table 3. Distributions of early warning system (EWS) implementation levels before dan after intervention

Action	Patient safety level			Total
	Poor	Moderate	Good	
Frequence Before Intervention	5	17	16	**38**
Frequence After Intervention	1	19	18	**38**

Source: Processed primary data, 2026

Table 4 the distribution of patient safety levels demonstrated a positive shift following the intervention. Before the intervention, the respondents were distributed across poor, moderate, and good patient safety categories, with the moderate and good categories representing the larger proportions.

Following the intervention, the proportion of respondents classified in the poor patient safety category decreased substantially, accompanied by an increase in both the moderate and good categories. The most notable improvement was observed in the good patient safety category, indicating a shift toward a more favorable level of patient safety after the intervention.

These findings suggest that the intervention was associated with an improvement in the overall patient safety profile among the participating nurses. The reduction in the poor category and the corresponding increase in

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the higher categories indicate that the intervention may have strengthened nurses' awareness and practices related to patient safety. This improvement is particularly relevant in the context of Early Warning System (EWS) implementation, which requires nurses to recognize changes in patients' clinical conditions, communicate findings appropriately, and initiate timely responses to prevent further deterioration.

Table 5. Distribution of Patient Safety Levels Before and After the Intervention among Nurses

Action	Patient safety level			Total
	Poor	Moderate	Good	
Before Intervention	0	10	28	38
After Intervention	0	5	33	38

Source: Processed primary data, 2026

Table 4 presents the distribution of patient safety levels among nurses before and after the intervention. Prior to the intervention, patient safety was predominantly classified at the good level, while the remaining respondents were categorized at the moderate level. No respondents were classified in the poor patient safety category.

Following the intervention, a favorable shift in patient safety levels was observed. The proportion of nurses classified at the good level increased, accompanied by a corresponding reduction in the moderate category. The poor category remained absent after the intervention.

Analysis Bivariate

Bivariate analysis was conducted to examine the differences in Early Warning System (EWS) implementation before and after the intervention and to determine the relationship between EWS implementation and patient safety.

Table 6. Results of the Paired t-Test

Group	Mean	t-test	Sig (2-tailed)
Implementation EWS Pre-post test	-5.842	-3.457	.001

Source: Processed primary data, 2026

The paired *t*-test results showed on table 5 statistically significant difference in EWS implementation scores before and after the intervention ($t = -3.457$; $p = 0.001$). The negative mean difference indicates that the posttest EWS implementation scores were higher than the pretest scores, as the calculation was based on pretest minus posttest values. These findings demonstrate that the intervention effectively improved EWS implementation among nurses at RSUD Kardinah Tegal.

Table 7. Correlation Analysis between Early Warning System (EWS) Implementation and Patient Safety

Variables	Correlation Coefficient (r)	p-value (2-tailed)	Result
EWS implementation and patient safety	0.542	0.000	Moderate

Source: Processed primary data, 2026

Correlation between Early Warning System Implementation and Patient Safety

Table **7** presents the correlation analysis between Early Warning System (EWS) implementation and patient safety among nurses. The analysis demonstrated a positive association between the two variables, indicating that better implementation of the EWS tended to be accompanied by better patient safety outcomes.

The magnitude of the correlation indicates a moderate relationship between EWS implementation and patient safety. The statistical test also demonstrated that the association was statistically significant. These findings suggest that nurses who demonstrated better implementation of the EWS also tended to report higher levels of patient safety.

The positive relationship may be explained by the role of EWS in supporting systematic patient assessment, early recognition of clinical deterioration, timely communication, and appropriate clinical response. Consistent

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implementation of EWS can facilitate structured monitoring of vital signs and changes in patients' clinical conditions, thereby supporting nurses in identifying potential deterioration at an earlier stage.

Although the correlation was statistically significant, the findings should be interpreted as an association rather than evidence of a causal relationship. Other factors, including workload, clinical experience, staffing conditions, organizational support, and patient characteristics, may also contribute to patient safety outcomes. Therefore, further studies using longitudinal or controlled designs are warranted to determine the extent to which improved EWS implementation contributes directly to patient safety.

DISCUSSION

This study demonstrated that strengthening Early Warning System (EWS) implementation significantly improved EWS practices among nurses at RSUD Kardinah Tegal. The paired *t*-test revealed a statistically significant difference between pre-intervention and post-intervention EWS implementation scores ($p = 0.001$). This finding suggests that the intervention enhanced nurses' adherence to physiological assessment, EWS score calculation and interpretation, and clinical escalation procedures in accordance with standard operating procedures (SOPs). Furthermore, EWS implementation was moderately and positively correlated with patient safety ($r = 0.542$; $p < 0.001$), indicating that better EWS implementation was associated with better patient safety practices.

The improvement following the intervention may be explained by enhanced nursing competencies through training, supervised clinical practice, and reinforcement of adherence to SOPs. These strategies can help nurses conduct physiological assessments more systematically, interpret clinical findings consistently, and initiate appropriate escalation responses. EWS therefore functions not merely as an assessment instrument but also as a clinical decision-support tool that links physiological observations with predefined clinical responses. This structured approach may facilitate earlier recognition of clinical deterioration and reduce delays in clinical management.

These findings are consistent with the concept of clinical deterioration, whereby physiological changes may precede cardiac arrest or other life-threatening events by several hours (Langkjaer *et al.*, 2021) . Systematic physiological monitoring enables healthcare professionals to recognize early signs of deterioration and initiate timely interventions(Massey, Chaboyer and Anderson, 2016) As a track-and-trigger system, EWS integrates physiological assessment findings with escalation algorithms to support timely, objective, and standardized responses to deteriorating patients (Sousa *et al.*, 2024).

Previous studies have similarly reported that EWS implementation can improve early recognition of clinical deterioration, accelerate clinical responses, and strengthen healthcare team coordination (Swami et al., 2023; Fitria et al., 2026) The contribution of the present study lies in evaluating strengthened EWS implementation as an intervention in nursing practice rather than focusing solely on instrument validity or documentation compliance.

The moderate positive correlation between EWS implementation and patient safety ($r = 0.542$; $p < 0.001$) suggests that EWS is an important component of safe nursing practice, although it should not be interpreted as the sole determinant of patient safety. Patient safety is influenced by multiple interacting factors, including healthcare professionals' competence and experience, workload, interprofessional communication, clinical leadership, safety culture, resource availability, and information technology support (Mcgaughey *et al.*, 2021) Consequently, improvements in patient safety require a multidimensional approach that combines effective clinical monitoring with organizational and system-level support.

An essential component of successful EWS implementation is the integration of physiological assessment findings with nurses' clinical judgment. Although EWS scores provide an objective basis for decision-making, nurses must also be able to recognize changes in patients' clinical conditions, communicate concerns effectively, and initiate timely escalation. (Massey *et al.*, 2025) emphasize the importance of recognizing clinical deterioration and communicating clinical concerns, while the qualitative synthesis by (Buke & Conway, 2023) highlights the roles of clinical judgment, interprofessional communication, and organizational support in EWS implementation. Accordingly, nurses' clinical concerns should be considered alongside objective findings, even when EWS scores have not reached the established escalation threshold. This approach does not replace standardized EWS criteria; rather, it supports comprehensive clinical assessment and appropriate escalation based on the patient's overall condition. EWS should therefore be regarded as a clinical decision-support tool rather than a substitute for professional nursing judgment.

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The practical implications of this study include the need to integrate EWS implementation into hospital quality improvement and patient safety programs. Continuous training, clinical supervision, compliance audits, simulation-based exercises in managing clinical deterioration, and regular evaluation of escalation procedures may help sustain nurses' competencies and adherence to established protocols. Furthermore, integrating EWS into electronic medical record systems may improve documentation accuracy, facilitate timely notification of rapid response teams, and support data-driven clinical decision-making. These strategies should be accompanied by effective interprofessional communication and organizational policies that enable nurses to escalate concerns promptly, including when clinical judgment indicates deterioration despite a relatively low EWS score.

The findings also have implications for Sustainable Development Goal (SDG) 3, particularly Target 3.8, which focuses on universal health coverage and access to quality essential healthcare services. By strengthening the early recognition of clinical deterioration and supporting timely clinical responses, EWS implementation may contribute to safer healthcare delivery and the prevention of avoidable complications. Its integration into hospital quality improvement initiatives can therefore support efforts to improve healthcare quality and strengthen health system resilience (Chung and Jung, 2024)

Several limitations should be considered when interpreting these findings. First, the one-group pretest–posttest design without a control group limits the ability to attribute the observed improvements exclusively to the intervention because other factors may have influenced the results. Second, the study was conducted at a single hospital with a relatively small sample of 38 nurses, limiting the generalizability of the findings to other healthcare settings. Third, the observed correlation between EWS implementation and patient safety does not establish a causal relationship. Future studies should employ stronger designs, including controlled quasi-experimental studies or randomized controlled trials where feasible, with larger samples across multiple hospitals. Further research should also assess whether improvements in EWS implementation translate into measurable patient outcomes, such as reduced delays in escalation, fewer unplanned intensive care admissions, and lower rates of in-hospital cardiac arrest.

Overall, this study indicates that strengthening EWS implementation can improve nurses' EWS practices and is associated with better patient safety practices. Sustainable implementation requires more than standardized scoring; it depends on nursing competence, adherence to clinical procedures, integration of clinical judgment, effective interprofessional communication, and organizational support. A comprehensive approach that combines these elements may strengthen the early detection of clinical deterioration and improve the quality and safety of nursing care.

Limitations and Future Research

This study has several limitations. First, the single-group pretest–posttest design without a control group limits the extent to which changes in EWS implementation and patient safety can be directly attributed to the intervention. Second, the relatively small sample size and the study's conduct at a single hospital limit the generalizability of the findings. Third, resource constraints, including staffing availability, training time, supporting facilities, and nurses' workload, may affect the consistency of EWS implementation. Suboptimal digital infrastructure, particularly limited integration of electronic medical records and automated alert systems, may also hinder clinical documentation, patient monitoring, and escalation of care. Furthermore, the short-term effectiveness of the intervention does not necessarily ensure the sustained implementation of EWS in routine clinical practice. Future studies should employ controlled, multicenter designs with larger sample sizes and evaluate clinical outcomes, including Code Blue events, unplanned transfers to the intensive care unit (ICU), length of hospital stay, and mortality. Longitudinal studies are also needed to assess the sustainability of the intervention and its replicability across healthcare facilities with diverse characteristics and resource capacities.

Declarations

Ethics approval: This study received ethical approval from the Health Research Ethics Committee (*Komite Etik Penelitian Kesehatan/KEPK*), Universitas Bhamada Slawi, with ethical clearance number 378/Univ.Bhamada/KEP.EC/VI/2026, prior to data collection.

All participants were informed about the objectives, benefits, study procedures, potential risks, and their rights as research participants. Participation was entirely voluntary, and written informed consent was obtained from each participant before enrollment. Participants' confidentiality and anonymity were maintained throughout

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the study, and participants were informed of their right to withdraw from the study at any time without any consequences for their employment status or the healthcare services they received.

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Author contributions:

All authors contributed to the conduct of the research and the preparation of the manuscript. Their contributions included the formulation of the research idea, development of the study design and methodology, data collection and analysis, interpretation of the findings, manuscript preparation, critical revision of the manuscript, and approval of the final version for publication. All authors are accountable for the content and scientific integrity of the article.

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