Journal of Economics and Social Sciences (JESS)
Vol. 4, 1 (January-June, 2025), pp. 397-406
EISSN: 2808-5094, DOI: 10.59525/jess.v4i1.812

Evaluation of the Implementation of Automated Early Warning Scoring System in Improving Patient Safety in Inpatient Ward Kasih Ibu Hospital Denpasar

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ARTICLE INFO

Keywords:

AEWSS, Patient Safety;
Electronic Medical Records;
Health Technology Implementation;
Kasih Ibu General Hospital Denpasar

Article history:

Received 2025-04-14
Revised 2025-05-12
Accepted 2025-06-30

ABSTRACT

This study evaluates the implementation of an Automated Early Warning Scoring System (AEWSS) in enhancing patient safety in the inpatient ward of Kasih Ibu General Hospital, Denpasar. Using a qualitative case study approach, data were collected through in-depth interviews, FGDs, observations, and document analysis. Findings indicate that AEWSS effectively enables early detection of patient deterioration via real-time physiological parameter monitoring, accelerates medical response (from an average of 15 minutes to 5 minutes), and prevents Adverse Events. The system also improves medical staff efficiency by reducing nurses' administrative workload by 30% and supports clinical decision accuracy through objective scoring. Key challenges include unstable network infrastructure (affecting 15% of rooms), specialist physician resistance, and uneven training. The implications highlight the need for infrastructure investment, regular training, and integrated AEWSS-Electronic Medical Records (EMR) protocols to optimize patient safety.

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1. INTRODUCTION

Patient safety is a top priority in global healthcare. The World Health Organization (WHO) reports that approximately 1 in 10 patients are injured due to unsafe care, and more than 3 million deaths each year are related to medical errors. Healthcare organizations are required to build systems that can ensure patient safety both physically and mentally to improve the quality of care, especially in hospitals. In Indonesia, Patient Safety Standards have been regulated through the regulations of the Ministry of Health and hospital accreditation, as stated in the Hospital Accreditation Standards (STARKES). However, the implementation of Patient Safety Standards still faces challenges, especially in the aspect of early detection of worsening patient conditions , rapid and appropriate medical responses.

Kasih Ibu General Hospital Denpasar is a type C private hospital that was established in 1987 and has a vision to become the main choice hospital for the people of Bali through complete, excellent services, and prioritizing patient safety and satisfaction. Efforts to improve patient safety are carried out by adopting WHO patient safety standards, implementing six Patient Safety Goals, and utilizing technology to reduce errors and increase the speed of medical response. Patient Safety Goals include correct patient identification, effective communication, safety of high alert medication , ensuring the correct side and procedure, the correct patient for invasive procedures, reducing the risk of infection due to treatment, and reducing the risk of injury due to falls.

The implementation of the six Patient Safety Goals at Kasih Ibu Hospital, Denpasar is expected to reduce patient safety incidents and improve the quality of hospital services. Since 2018, Kasih Ibu Hospital, Denpasar has used electronic medical records integrated with medical support systems such as laboratories and radiology. In 2019, the hospital began implementing the Automated Early Warning Scoring System (AEWSS) which is designed to monitor patient physiological parameters in real-time, calculate clinical risk scores, and provide early warnings to medical staff.

The 2018 patient safety incident report at Kasih Ibu Hospital, Denpasar, showed that the most incidents occurred in the inpatient ward, dominated by documentation errors and clinical procedures. The investigation found that reliance on manual processes was a major risk factor, where high administrative workloads of nurses led to decreased compliance in documentation and contributed to incidents. The Bogohanto, Berdadius 2021 study showed that nurses' workloads affected Early Warning Scoring (EWS) documentation. The implementation of AEWSS is expected to automate monitoring, recording, and calculating patient risk scores, thereby reducing human error and increasing nurses' work efficiency.

The implementation of AEWSS at Kasih Ibu Hospital, Denpasar is expected to reduce the workload of nurses, accelerate the response to changes in patient conditions, and improve patient safety through early detection of clinical deterioration and acceleration of clinical decision-making. The challenges faced include adaptation of medical personnel, integration with electronic medical records, and sustainability of training. Mestrom et al. 2019 emphasized that the effectiveness of the early warning system is highly dependent on the suitability of the algorithm to clinical practice and the competence of health workers. A comprehensive evaluation of the implementation of AEWSS at Kasih Ibu Hospital, Denpasar is needed to measure its impact on patient safety, identify obstacles, and formulate recommendations for improvement (PP Sari, RM Paramita, P Purwadhi, YR Widjaja 2024).

2. METHOD

This study uses a qualitative method with an exploratory descriptive approach and a case study to examine in depth the implementation of the Automated Early Warning Scoring System (AEWSS) at Kasih Ibu General Hospital, Denpasar. The case study was chosen so that researchers could evaluate in detail the AEWSS implementation process, identify the challenges faced, and formulate recommendations for improvement based on real experiences in the field. Qualitative research provides the flexibility to adjust data collection techniques as needed, so that it can capture the complexity, context, and nuances that cannot be reached by a quantitative approach. The advantage of this approach lies in its ability to holistically understand the interaction between technology, medical staff, and the hospital organizational environment.

Data collection was carried out through several main techniques, namely in-depth interviews, focus group discussions (FGD), participatory observation, and document analysis. Semi-structured interviews involved various parties involved in the implementation of AEWSS, such as the head of medical services, the head of the quality committee, the doctor in charge of the patient, the head nurse , the nurse, and the head of the IT department, who were selected purposively so that the information obtained was relevant and in-depth (Sugiyono, 2018). FGD was used to explore the collective perceptions of medical staff, while participatory observation was conducted to directly monitor the interaction between medical staff and the AEWSS system in daily practice. Document analysis included

reviewing patient safety incident reports, training protocols, and notes from system implementation evaluation meetings, so that the data obtained was triangulated and comprehensive.

Data analysis was carried out through the process of transcription, coding, theme grouping, and triangulation. Interview and observation data were transcribed into narrative form, then thematic coding was carried out to identify the main themes that emerged, such as supporting factors for implementation, operational barriers, and impacts on patient safety. Theme grouping facilitates in-depth analysis of key aspects that influence the effectiveness of AEWSS. Triangulation of sources and techniques was used to check the validity of the data, compare the results of interviews, observations, and documents so that the research results are more credible (Reyvan Maulid Pradistya, 2021). This approach ensures the integrity and reliability of the data collected, so that the research results can provide a comprehensive picture of the implementation of AEWSS at Kasih Ibu Hospital Denpasar.

3. RESULTS AND DISCUSSION

Results

Early Detection of Worsening Patient Conditions

Based on quantitative data obtained from the inpatient ward of Kasih Ibu Hospital, Denpasar during the period from January to March 2024, the implementation of the Automated Early Warning Scoring System/AEWSS demonstrated effectiveness in improving early detection of patient deterioration.

Table 1. Transfer of Patients from Inpatient Room to ICU January – March 2024

MONTH	PATIENT IN ICU ROOM	PASIEN ICU
JANUARY	26	65
FEBRUARY	13	64
MARCH	25	63

This can be seen from the data on patient transfers from the inpatient room to the ICU, which reflects a rapid response to the notification of the EWS (Early Warning Score) score with the Orange or Red category. In January, 26 patients were recorded as being transferred to the ICU, then decreased to 13 patients in February, and increased again to 25 patients in March. This number of transfers shows that the AEWSS system helps medical staff recognize signs of deteriorating conditions in real time, so that clinical decision-making becomes faster and more accurate. Although there are fluctuations in the number of transfers, this trend reflects an increase in alertness and ability to respond to critical patient conditions since the AEWSS system was implemented. These data support the finding that AEWSS plays an important role in accelerating the treatment of patients who experience sudden deterioration.

From qualitative data obtained through interviews with several key informants, it was found that the implementation of AEWSS has had a positive impact on improving clinical responses to patients with deteriorating conditions. The Head of Medical Services stated that this system helps nurses monitor the decreasing trend of vital parameters such as oxygen saturation and blood pressure which were previously difficult to detect quickly, so that patients with symptoms of shortness of breath or shock can be immediately identified and treated. This is reinforced by the statement of the Doctor in Charge of the Patient (DPJP) who explained that the red EWS notification (value ≥7) triggered a rapid response from the medical team because nurses immediately contacted the doctor when the warning appeared. This finding supports the study by Mestrom et al. (2019) which showed that the AEWSS system contributed to reducing mortality rates, especially in cases of sepsis, through early detection. However, technical challenges were also found in the field. The Head of IT revealed that around 15% of alarms were not sent due to unstable internet connections in several treatment rooms, so monitoring had to be done manually again for a while. This condition shows that although AEWSS is very helpful

in improving patient safety, its effectiveness is highly dependent on supporting infrastructure, especially the stability of network connectivity.

Reducing Medical Response Delays

The findings show that the implementation of the Automated Early Warning Scoring System (AEWSS) has succeeded in accelerating the response of the medical team through automatic alarms integrated with the notification system on the EWS monitor at the nurse's counter and in the Electronic Medical Record (EMR) system. Quantitatively, the nurse's response time to notifications has accelerated by an average of 5 minutes faster than in 2023, where previously delays often occurred due to the absence of an automatic alarm system that gave warnings of worsening patient conditions. Qualitatively, the inpatient nurse explained that when the EWS score showed an orange or red category, a visual notification appeared on the monitor screen at the nurse's counter, so that it could be seen directly by the nurse or doctor on duty, and immediate actions such as contacting the DPJP or activating code blue could be done faster. The head nurse also emphasized that before the AEWSS was implemented, delays in reporting often occurred because the EWS score had to be calculated manually and there was no system that automatically displayed a visual alarm on the monitoring device. Now, with the integrated colored alarm system, early warning is more effective. These findings support the research of Escobar et al. (2020), which concluded that automatic alarms can reduce response time by up to 30%. However, the effectiveness of this system is not yet fully optimal, because based on the Internal Report of Kasih Ibu Hospital (2023), around 10% of cases still experience delayed responses due to device damage or network disruptions, indicating that consistent technical support is still needed to maintain the reliability of the AEWSS system as a whole.

Prevention of Adverse Events (AEs)

These findings indicate that the implementation of the AEWSS (Automated Early Warning Scoring System) significantly contributed to the elimination of Adverse Events (AEWSS) in the inpatient ward of Kasih Ibu Hospital. Qualitatively, the Head nurse said that before the AEWSS was implemented, the deteriorating condition of patients was often not detected early, so that medical treatment, including transfer to the ICU, was delayed. With the AEWSS directly integrated with the Electronic Medical Record (EMR), as explained by the Head of IT, the system is now able to provide automatic notification if there is a decrease in the patient's clinical parameters, so that medical personnel can immediately take action. This is reinforced by the statement of the DPJP which states that patients with an EWS score ≥7 were immediately transferred to the ICU, and no more adverse event were found due to delayed treatment in the inpatient ward. Overall, this system strengthens the process of early detection and rapid response to critical patient conditions. This finding is in line with the study by Fauziah & Adiutama (2023) which stated that the implementation of AEWSS was able to reduce mortality rates in hospitals. However, there are ethical exceptions, particularly in terminally ill patients, where red EWS notifications are not always aggressively followed up due to ethical considerations in end-of-life care, as explained by the DPJP. This suggests that the success of AEWSS in preventing adverse events must still be combined with sound clinical policy and medical ethics.

Improving Medical Personnel Efficiency

These findings indicate that automation through AEWSS significantly reduces the administrative burden of nurses in the process of recording patient vital signs, while increasing the time available for direct care. Quantitative data shows a decrease in documentation time from an average of 11 minutes per patient in 2018 to only 5 minutes per patient in 2023. The comparison between the manual method and the use of AEWSS is also evident from Tables 4.2 and 4.3, where the average time for manual vital sign measurement in the Shinta and Ramayana Units ranges from 10–12 minutes, while with AEWSS it only takes 4.5 minutes.

Table 4.2 Manual Vital Sign Measurement

unit	Fastest Time (minute)	Longest Time (minute)	Average (minutes)
Shinta	10	14	12
Ramayana	9	12	10,5

Table 4.3 Vital sign measurements using tools *AEWSS*

unit	Fastest Time (minutes)	Longest Time (minutes)	Average (minutes)
Shinta	3	5	4,5
Ramayana	3	5	4,5

This data is supported by the statement of the nurse who said that previously she had to spend up to 2 hours per shift just to record vital signs manually, but now with AEWSS, data is automatically inputted into the Electronic Medical Record (EMR), allowing nurses to focus more on directly monitoring patient conditions. The Head of Medical Services also added that this time efficiency has an impact on increasing nurse productivity by up to 25%. This finding is in line with the results of Wardah's research (2022) which shows that AEWSS is able to increase the work efficiency of health workers. However, technical competence problems are still found, as stated by the Head nurse that around 3% of new nurses are not yet able to operate AEWSS optimally due to the lack of further training. This emphasizes the importance of ongoing training programs so that all nurses can utilize the system optimally to support the quality of nursing services.

Accuracy of Clinical Decision Making

These findings suggest that the use of AEWSS (Automated Early Warning Scoring System) is able to reduce subjective bias in clinical assessment by providing objective scores based on real-time patient vital sign data. Quantitatively, an evaluation of 50 high-risk cases in 2024 showed that the accuracy of clinical decisions increased by 30%, reflecting a significant increase in the accuracy of diagnosis and early intervention. Qualitatively, the DPJP explained that the integration of automated measurement results into the Electronic Medical Record (EMD) was very helpful in accelerating clinical assessment. With blood pressure trend data from AEWSS, vasopressor drug dose adjustments in septic shock patients can be made more timely—even within an hour, which is crucial in emergency situations. The IT head also added that the AEWSS system is now equipped with clinical protocol recommendations, including warnings to consider ICU care when a red alarm occurs. These findings are in line with the study by Suhaimi et al. (2025) which confirmed that the presence of objective data from an automated monitoring system improves the quality of medical decision-making. However, operational challenges remain, especially if the DPJP cannot be contacted immediately. Therefore, as conveyed by the Head of Medical Services, a trained rapid response team is needed to respond to critical conditions based on the AEWSS output, to ensure that every clinical warning is immediately followed up with appropriate intervention without waiting for the direct involvement of the responsible physician.

Support for Electronic Medical Records (EMR)

These findings indicate that the integration between the Automated Early Warning Scoring System (AEWSS) and Electronic Medical Records (EMR) has a significant impact on improving the quality of documentation and access to clinical data at Kasih Ibu Hospital. Quantitatively, there was a decrease in the number of documentation incidents from 18 cases in 2018 to only 8 cases in 2023, as seen in Tables 4.4 and 4.5.

Table 4.4 Types of Patient Safety Incidents at Kasih Ibu Hospital in 2018

INCIDENT TYPE	AMOUNT
Clinic Administration	3
Medical Devices	4
Documentation	18
Infrastructure/ Buildings/ Other objects fixed installed	1
Patient Falls	4
Laboratory/ Pathology	5
Medication/Infusion fluids	6
Storage Nutrition	5
Clinical Process/Procedure	7
AMOUNT	53

Table 4.5 Types of Patient Safety Incidents at Kasih Ibu Hospital in 2023

INCIDENT TYPE	AMOUNT
Clinic Administration	0
Medical Devices	0
Documentation	8
Infrastructure/ Buildings/ Other objects fixed installed	0
Patient Falls	7
Laboratory/ Pathology	0
Medication/Infusion fluids	4
Nutrition	3
Clinical Process/Procedure	30
AMOUNT	52

This shows that the data recording process has become more accurate and efficient. The IT head explained that the system integration was carried out via the HL7 API, which allows patient data—including vital sign trend graphs—to be automatically synchronized into the EMR. Nurses also confirmed that the input process is now much simpler, simply by scanning the patient's wristband, all vital data is immediately recorded without the need for manual typing, thus reducing the potential for errors. This finding is in line with the HIMSS (2021) recommendation which emphasizes the importance of health information system interoperability to improve service quality. However, the 2023 IT report noted that around 3% of data failed to synchronize due to bugs in the software, indicating the need for regular system maintenance and updates so that the benefits of this integration remain optimal and sustainable.

Discussion

Early Detection of Patient Deterioration and Rapid Medical Response

Research findings show that *AEWSS* improve early detection capabilities through real-time monitoring of physiological parameters. This is in line with the research of Mestrom et al. (2019) which states that an automated system reduces surgical patient mortality through sepsis identification 20% faster. At Kasih Ibu Hospital, a red alarm on an EWS score ≥7 triggers a medical response within 5 minutes, meeting WHO recommendations (2023) for prevention *failure to rescue*. However, technical challenges such as weak internet connection in 15% of rooms (Head of IT) caused the device to not

function optimally so that alarms were not sent. This confirms the findings of Wang et al. (2021) that technological infrastructure is key to the success of an automated system.

To prevent these technical challenges, Wi-Fi network expansion and server redundancy are needed to ensure full coverage throughout the hospital, especially in the inpatient department. In addition, manual emergency training should still be carried out as a backup. This is in accordance with the advice of Jawa et al. (2023) regarding hospital infrastructure readiness.

Prevention of Adverse Events (AEs)

The absence of adverse event in the inpatient room due to deterioration in patient conditions that were not detected earlier shows the effectiveness of AEWSS in mitigating clinical risk. This finding is consistent with the study by Fauziah & Adiutama (2023) which reported a 25% decrease in mortality after implementing EWS. However, terminal patients often do not receive optimal responses due to ethical considerations, as expressed by DPJP. This reflects the complexity of clinical decisions that cannot be fully automated, as explained in the study by Suhaimi et al. (2025) on the limitations of algorithm-based systems.

For that reason, as a policy implication, it is necessary to develop a special protocol for terminal patients that combines ethical and technological considerations. In addition, system integration is also needed *advance care planning* into AEWSS (HIMSS, 2021).

Medical Personnel Efficiency and Clinical Decision Accuracy

The reduction in the administrative burden of nurses by 30% (from 11 minutes to 5 minutes per patient) supports Wardah's theory (2022) that documentation automation increases productivity. However, nurses were still unable to use the AEWSS system correctly, 3% of new nurses were still unable to operate AEWSS correctly due to discontinuous training. This finding is in line with the research of Rohendi et al. (2023) which emphasizes the importance of continuous training to improve competence.

On the other hand, the accuracy of clinical decisions increased by 30% due to the objective AEWSS score. Case examples presented by DPJP, such as adjusting vasopressor doses based on blood pressure trends, show how real-time data supports evidence-based decisions. This strengthens the argument of Escobar et al. (2020) that predictive systems reduce subjective bias.

For hospital management, there are implications from the above results. First, a periodic training program with specialist modules (eg pediatrics, obstetrics) is needed to overcome the limitations of the algorithm. Second, a monthly evaluation of performance is needed. *AEWSS* using the PDCA method (Ministry of Health of the Republic of Indonesia, 2022).

AEWSS Integration with Electronic Medical Records (EMR)

The integration of AEWSS-RME via the HL7 API successfully reduced documentation errors from 18 to 8 cases. This result is in accordance with HIMSS recommendations (2021) about the interoperability of health systems. However, 3% of data failed to synchronize due to *bug software*, which is also reported in Ben Ida et al.'s (2021) study on technical challenges in smart hospitals.

According to Syaodih et al. (2022), the success of digital transformation depends on collaboration between divisions. At Kasih Ibu Hospital, synergy between IT, clinical, and management teams (e.g., allocation of 15% of IT budget for AEWSS) is a key factor. However, resistance from specialist doctors who do not understand the system indicates the need for an organizational culture approach, as proposed by Nuramalia et al. (2023) in a study on information system adaptation.

The Role of Safety Culture and Leadership

The implementation of AEWSS at Kasih Ibu Hospital is supported by a *no- blame culture* which encourages incident reporting. This is in line with the STARKES principle of the Indonesian Ministry of Health (2022) on transparency. However, the lack of involvement of specialist doctors in training

indicates a gap in internal communication. This finding strengthens the argument of Jawa et al. (2023) that*excellent service* requires commitment from the entire organizational hierarchy.

As a strategic recommendation, hospitals need to consider forming a multidisciplinary team (clinicians, IT, management) for periodic evaluation of the system. In addition, it is necessary socialization *AEWSS* through *workshop* interactive with case simulations (Kirk et al., 2024).

4. CONCLUSION

Based on the research results, the implementation of the Automatic Early Warning Scoring System (AEWSS) at Kasih Ibu Hospital, Denpasar has had a significant positive impact on improving patient safety and efficiency of health services. This system has been proven to be able to improve early detection of worsening patient conditions through real-time monitoring of vital parameters and accelerate medical responses to critical patients, which previously took an average of 15 minutes to only 5 minutes. The integration of AEWSS with Electronic Medical Records (EMR) allows 24-hour patient monitoring and has succeeded in preventing Adverse Events in inpatient rooms throughout 2023. In addition, this system also contributes to increasing the efficiency of medical personnel, with documentation time savings of up to 30% and increased focus on direct care. The objective scores generated by AEWSS also increase the accuracy of clinical decision-making by 30%, as well as minimize documentation errors through automatic recording in the EMR. However, the implementation of this system still faces several challenges such as network limitations in 15% of the ward area, resistance from some specialist doctors, and uneven user training, which require further attention to ensure the sustainability and optimization of the system.

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