Brilliance
Research of Artificial Intelligence

E-ISSN : 2807-9035
Volume 6, Number 4, November 2026
https://doi.org/10.47709/brilliance.v6i4.9884

Implementation of a NEWS 2-Based Early Warning System for Multiparameter Vital Sign Monitoring

Yultrisna[1*], Aditya Wardhani[2], Muhammad Al Ghazali[3]
[1,2,3,]Politeknik Negeri Padang, Indonesia
[1*]yultrisna@pnp.ac.id, [2]Aditya@pnp.ac.id

open access

***Corresponding Author**

Article History:
Submitted: 23-10-2026
Accepted: 03-11-2026
Published: 07-11-2026

Keywords:
NEWS2; vital signs; ESP32; Internet of Things; early warning system.

Brilliance: Research of Artificial Intelligence is licensed under a Creative Commons Attribution-NonCommercial 4.0 International (CC BY-NC 4.0).

ABSTRACT

Integrated vital-sign monitoring can support earlier recognition of physiological deterioration when measurements are converted into a consistent track-and-trigger score. This study designed and implemented an Internet of Things (IoT)-based multiparameter monitoring prototype that calculates the National Early Warning Score 2 (NEWS2). A MAX30102 measured peripheral oxygen saturation (SpO_2), two MLX90614 sensors measured body temperature and respiratory rate, and an OMRON HEM-7156T supplied systolic/diastolic blood pressure and pulse rate to an ESP32 through Bluetooth Low Energy. The ESP32 transmitted data over Wi-Fi and MQTT to a Node.js backend, PostgreSQL/TimescaleDB storage, and a React dashboard; NEWS2 results were returned to a 20×4 LCD, LEDs, and a buzzer. Thirty paired measurements were used for sensor comparison, while the complete system was evaluated on 31 participants aged 20–81 years. The mean absolute differences were 0.26 percentage points for SpO_2, 0.07 °C for temperature, and 0.40 breaths/min for respiratory rate. Corresponding MAPE values were 0.26%, 0.19%, and 2.58%. The 31-participant dataset produced mean values of 14.77 breaths/min, 97.99% SpO_2, 84.77 bpm, 37.36 °C, and 121.65 mmHg systolic pressure. Total NEWS2 scores ranged from 0 to 4, and all participants were categorized as low risk without a single red score. Simulated scores of 6 and 9 verified medium-risk, high-risk, and single-red-score alert branches. The prototype demonstrated end-to-end technical feasibility, but the reported agreement and risk outputs are not a clinical validation and require calibrated references, repeated measurements, broader cohorts, and formal clinical evaluation

INTRODUCTION

Vital-sign monitoring is central to the early recognition of physiological deterioration because changes in respiratory rate, oxygen saturation, systolic blood pressure, pulse rate, body temperature, and consciousness may precede serious clinical events. The National Early Warning Score 2 (NEWS2) standardizes these observations into an aggregate track-and-trigger score. Recent validation studies have reported useful discrimination for clinical deterioration and mortality in emergency and general-ward populations, although performance varies by outcome and clinical setting (Vergara et al., 2021; Alhmoud et al., 2023; Chen et al., 2025). These findings support NEWS2 as a structured assessment aid, while reinforcing that it must be interpreted alongside clinical judgement.

NEWS2 combines respiratory rate, oxygen saturation, supplemental-oxygen status, systolic blood pressure, pulse rate, temperature, and level of consciousness or new confusion. Each physiological parameter contributes a weighted score, which is aggregated to indicate the level of concern and guide an appropriate response. Reliable use therefore depends on complete and timely measurements, correct data entry, and consistent score calculation (Welch et al., 2022; Reichl et al., 2024).

Digital and automated approaches have been investigated to reduce the workload and potential calculation errors associated with manual early-warning scoring. A study of a digital NEWS2 system in a cardiac specialist setting described automated score calculation and display within clinical workflows (Alhmoud et al., 2023). A wearable-based pilot study also found substantial agreement between automatically generated and conventional NEWS2 values, while identifying signal-quality and data-availability challenges (Reichl et al., 2024). Such studies indicate the potential of technology-assisted monitoring but do not remove the need for sensor validation and clinical oversight.

The practical value of NEWS2 depends not only on its predictive performance but also on the quality of measurement and the response process. Recent studies have evaluated NEWS2 in emergency departments and general wards, including external validation in COVID-19 populations and large-scale evaluation of deterioration outcomes (Zarama et al., 2024; Chen et al., 2025). Other work has shown that digital early-warning systems can improve the availability and visibility of scores, although their effect on downstream clinical outcomes depends on workflow integration (Alhmoud et al., 2023).

This is an Creative Commons License This work is licensed under a Creative Commons Attribution-NonCommercial 4.0 International License.

Brilliance
Research of Artificial Intelligence

E-ISSN : 2807-9035
Volume 6, **Number** 4, November 2026
https://doi.org/10.47709/brilliance.v6i4.9884

In healthcare practice, an Early Warning System supports the structured recognition of changes in patient condition and helps staff determine the urgency of reassessment or escalation. Recent work has discussed EWS implementation and patient-safety processes in Indonesian settings, while digital NEWS2 studies emphasize the importance of workflow integration and clear clinical response (Astuti et al., 2022; Simanjuntak et al., 2023; Alhmoud et al., 2023). However, an automated score should remain a decision-support output rather than a substitute for professional assessment.

NEWS2 has been evaluated in different clinical contexts. Vergara et al. (2021) reported its prognostic value in an emergency-department cohort, while Sofwan et al. (2023) evaluated its ability to predict mortality among adult COVID-19 patients in Yogyakarta. Zarama et al. (2024) subsequently compared NEWS2 with other indices for predicting adverse outcomes in emergency-department patients with COVID-19. These studies provide a rationale for using NEWS2 as the scoring framework in a monitoring prototype, but their clinical findings cannot be transferred directly to the present engineering test sample.

LITERATURE REVIEW

Recent literature covers three related areas: clinical validation of NEWS2, digital or wearable generation of early-warning scores, and implementation of EWS in routine care. Clinical validation studies have assessed NEWS2 in emergency and inpatient populations (Vergara et al., 2021; Sofwan et al., 2023; Zarama et al., 2024; Chen et al., 2025). Their results support the usefulness of NEWS2 for risk stratification, while also showing that predictive performance depends on the outcome being assessed and the population under study. Riccalton et al. (2025) further mapped proposed NEWS2 modifications and highlighted the potential value of trend information and selected demographic variables, while emphasizing the need for further validation.

Research on digital monitoring has moved beyond manual score calculation. Alhmoud et al. (2023) examined digital NEWS2 in a cardiac specialist setting, and Reichl et al. (2024) investigated a wearable-based approach for automatically generating NEWS2. These studies are relevant to the present work because they demonstrate the feasibility of combining physiological measurements with automated scoring. They also highlight important constraints, including measurement quality, missing data, and the need to compare automated outputs with conventional measurements. Continuous multiparameter monitoring research has also explored real-time risk alerts using wearable sensors (Eisenkraft et al., 2023).

In Indonesia, published work has examined NEWS2 validation and EWS implementation (Sugiyarto et al., 2021; Astuti et al., 2022; Simanjuntak et al., 2023; Sofwan et al., 2023). International research has also investigated digital EWS documentation and continuous multiparameter monitoring (Wong et al., 2024; Eisenkraft et al., 2023). These studies provide context for the importance of consistent assessment and training. However, the present study addresses a different engineering objective: integrating multiple vital-sign acquisition devices, an ESP32-based communication layer, automated NEWS2 calculation, digital documentation, and local alerts into a prototype intended for clinical simulation learning.

The implementation of EWS is influenced by staff knowledge, completeness of observations, monitoring frequency, and the availability of an integrated support system. Indonesian studies have reported challenges in EWS implementation and the need to strengthen monitoring processes (Simanjuntak et al., 2023). Recent reviews and digital-system evaluations also emphasize the importance of trend information, data quality, and integration with clinical workflows (Riccalton et al., 2025; Wong et al., 2024).

Despite these developments, there remains a practical need for an integrated prototype that combines multiparameter acquisition, NEWS2 calculation, a web-based history and trend display, and local alerts in a clinical-simulation learning environment. The current study therefore focuses on system development and technical testing rather than clinical prediction or validation. Its contribution is the integration of sensor-derived measurements with manually entered NEWS2 inputs, automated scoring, and multi-channel presentation of results.

Existing research has largely evaluated clinical implementation or automated monitoring in hospital settings. The present study differs by developing an integrated, learning-oriented prototype for a clinical simulation laboratory. It combines sensor acquisition, ESP32-based communication, NEWS2 calculation, web-based documentation, and local alert outputs. The study evaluates technical feasibility and measurement comparison; it does not claim clinical validation or proven detection of acute deterioration.

METHOD

This study used a Research and Development (R&D) approach with an engineering-based system-development model adapted from the Borg and Gall stages. The workflow comprised needs analysis, system design, prototype development, limited field testing, data collection, and data analysis. Needs analysis included a literature review, observations of vital-sign monitoring activities, and discussions with lecturers and clinical instructors. System design covered the hardware architecture, NEWS2 calculation logic, and dashboard interface. Prototype development integrated the sensors, ESP32 firmware, communication services, database, and dashboard. Limited testing and data collection used device experiments and measurements from participants. The workflow is summarized in Figure 1.

This is an Creative Commons License This work is licensed under a Creative Commons Attribution-NonCommercial 4.0 International License.

Brilliance
Research of Artificial Intelligence

E-ISSN : 2807-9035
Volume 6, **Number** 4, November 2026
https://doi.org/10.47709/brilliance.v6i4.9884

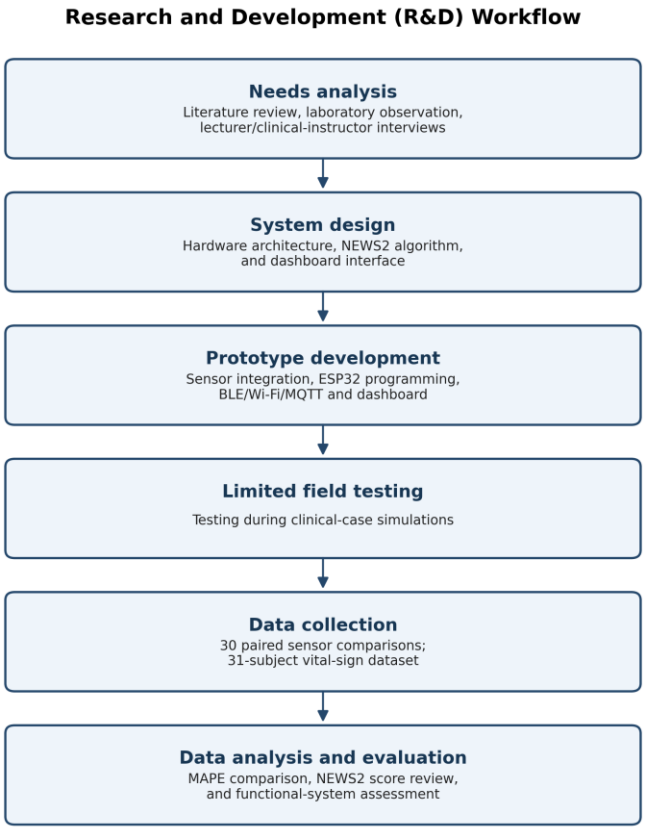


Figure 1. Research and development workflow of the NEWS2-based multiparameter monitoring prototype

Sensor comparison used 30 paired samples (P002–P031) for SpO_2, body temperature, and respiration rate. Measurements were compared with a commercial oximeter, thermometer/thermogun, and manual respiratory counting, respectively. The manuscript reports mean absolute percentage error (MAPE) and MAPE-derived accuracy (100% − MAPE). The complete prototype dataset comprised 31 participants aged 20–81 years. System evaluation also considered the reported operation of BLE and MQTT communication, database storage, dashboard functions, Excel export, LCD, LEDs, and buzzer. NEWS2-related inputs not acquired directly by sensors—including ACVPU, oxygen status, oxygen device/flow, and SpO_2 scale—were entered through the dashboard. These procedures evaluate technical feasibility and do not constitute clinical validation.

RESULT

Prototype Development and System Integration

The developed prototype integrates multiparameter vital-sign acquisition with automated National Early Warning Score 2 (NEWS2) calculation. The hardware uses an ESP32 as the controller, a MAX30102 sensor for oxygen saturation (SpO_2), two MLX90614 sensors for body temperature and respiration-rate estimation, and an OMRON HEM-7156T blood-pressure monitor connected through Bluetooth Low Energy (BLE). The system transfers measurements through Wi-Fi and MQTT to a backend and web dashboard. A local LCD, LED indicators, and a buzzer provide on-device information and alerts.

The online dashboard supports administrator and patient access, active-patient selection, display of real-time vital signs, manual entry of NEWS2-related parameters, score calculation, measurement-history storage, trend visualization, and Excel export. Consciousness level (ACVPU), oxygen status, oxygen device/flow, and NEWS2 SpO_2 scale are entered through the dashboard, while sensor-derived measurements are received from the device. Functional tests reported in the progress report showed that BLE and MQTT communication, data storage, dashboard functions, Excel export, LCD, LED, and buzzer operated according to the design.

Sensor Comparison Results

Comparative testing was conducted on 30 samples (patient IDs P002–P031) for SpO_2, body temperature, and respiration rate. The sensor measurements were compared with a commercial oximeter, a thermometer/thermogun, and manual respiratory counting, respectively. Table 1 summarizes the reported mean absolute percentage error (MAPE) and the accuracy calculated as 100% minus MAPE.

This is an Creative Commons License This work is licensed under a Creative Commons Attribution-NonCommercial 4.0 International License.

Brilliance
Research of Artificial Intelligence

E-ISSN : 2807-9035
Volume 6, Number 4, November 2026
https://doi.org/10.47709/brilliance.v6i4.9884

Table 1. Summary of sensor comparison results

Parameter	Sensor / method	Comparator	MAPE	Accuracy based on MAPE
Oxygen saturation (SpO_2)	MAX30102	Oximeter	0.26%	99.74%
Body temperature	MLX90614	Thermometer/thermogun	0.19%	99.81%
Respiration rate	MLX90614 on mask	Manual count for 60 s	2.58%	97.42%

The smallest reported error was observed for body-temperature measurement (MAPE 0.19%), followed by SpO_2 (0.26%). Respiration-rate estimation had the largest error (2.58%). For temperature, the report also gives a mean absolute error of 0.07 °C. The reported mean respiration rate in the comparison set was 14.87 breaths/min for both the sensor and manual method, although individual readings differed by up to one breath/min in the listed samples.

Vital-Sign Measurements and NEWS2 Scores

Vital-sign measurements were collected from 31 subjects aged 20–81 years. The mean age was 28.71 years; 27 subjects (87.10%) were male and four (12.90%) were female. Across the sample, the reported averages were 14.77 breaths/min for respiration rate, 97.99% for SpO_2, 84.77 beats/min for pulse rate, 37.36 °C for body temperature, and 121.65 mmHg for systolic blood pressure. Subject identifiers were used in place of full names in the report.

The calculated NEWS2 totals ranged from 0 to 4, with a reported mean score of 1.00. All 31 measurements were classified as low risk, and no single red score was recorded. These findings describe the tested sample only and do not establish performance for patients with acute deterioration. NEWS2 Calculation and Alert-Branch Verification The documented functional tests indicate that the prototype completed the intended data path: measurements from the devices were transferred to the backend, stored, displayed on the dashboard, and presented through the local LCD and alert components. The progress-report summary also records simulated NEWS2 totals of 6 and 9 to exercise the medium- and high-risk alert branches. A separate single-parameter red-score condition was reported as tested. These simulated cases provide evidence that the alert logic was exercised beyond the low-risk participant dataset; they are software/functional checks and must not be interpreted as observations of clinical deterioration in participants.

Table 2. Summary of documented NEWS2 and system functional-test evidence.

Test evidence	Reported input/condition	Reported output or interpretation
Participant dataset	31 participants; NEWS2 totals 0–4	All observations low risk; no single red score
Simulated aggregate score	NEWS2 total = 6	Medium-risk alert branch exercised
Simulated aggregate score	NEWS2 total = 9	High-risk alert branch exercised
Single-parameter trigger	One parameter assigned a red score (3)	Single-red-score alert branch exercised
End-to-end functional test	BLE, MQTT, database, dashboard, Excel export, LCD, LED, buzzer	Reported to operate according to the design

DISCUSSION

The comparison results indicate that the prototype produced measurements close to the selected reference methods in the tested sample. The MAPE-derived accuracy was highest for body temperature (99.81%) and SpO_2 (99.74%), while respiration-rate estimation was lower (97.42%). This difference is consistent with the distinct measurement approaches: SpO_2 is derived from optical signals, temperature is measured non-contact, and respiration rate is inferred from temperature changes in inhaled and exhaled air near the mask. Respiration-rate estimation may therefore be more sensitive to sensor placement, airflow, breathing pattern, and environmental temperature. These factors should be examined in further validation. The pattern is consistent with recent work showing that automated NEWS2 generation is technically feasible, while data quality and agreement between wearable or sensor-derived measurements and conventional observations remain important concerns (Reichl et al., 2024). The present MAPE values are based on the comparison procedure reported in the source progress report; they should not be interpreted as clinical-grade accuracy without calibration, repeatability analysis, and agreement testing using appropriate statistical methods.

The participant dataset contained only low-risk NEWS2 totals (0–4). Therefore, it cannot establish sensitivity, specificity, or predictive performance for moderate- or high-risk deterioration. The simulated scores of 6 and 9 and the single-red-score condition demonstrate that the programmed alert branches were exercised, but simulation of score inputs is not equivalent to validation in patients. This distinction is important because recent large-scale validation studies have shown that NEWS2 performance differs by outcome and time window (Chen et al., 2025), and a recent emergency-department study reported limitations in using NEWS2 alone to predict time-critical treatment (Goodacre et al., 2025). This limitation is consistent with recent literature noting that NEWS2 performance varies with the population, outcome, and scoring context (Forster et al., 2022; Riccalton et al., 2025).

The system's main contribution is the integration of sensor acquisition, NEWS2 scoring, and digital documentation within one learning-oriented prototype. Instead of viewing vital signs as separate values, users can see

This is an Creative Commons License This work is licensed under a Creative Commons Attribution-NonCommercial 4.0 International License.

E-ISSN : 2807-9035
Volume 6, **Number** 4, November 2026
https://doi.org/10.47709/brilliance.v6i4.9884

them alongside partial scores, total score, risk category, and single-red-score status. The dashboard's trend chart and measurement history may also support teaching activities in which students interpret changes over time. Local outputs through the LCD, LEDs, and buzzer complement the web interface and provide a visible indication of system status.

The NEWS2 results should be interpreted cautiously. All tested subjects were classified as low risk, and the sample did not contain a single red score. Consequently, these data demonstrate the system's operation under the observed measurement conditions but do not verify how reliably it identifies moderate- or high-risk cases. Further testing should use controlled clinical simulation scenarios representing a wider range of vital-sign abnormalities and should verify score outputs against independently calculated NEWS2 values, including oxygen-scale selection, supplemental-oxygen status, and ACVPU inputs.

Several limitations are evident from the progress report. First, the sensor-comparison sample consisted of 30 measurements, whereas the broader vital-sign and NEWS2 analysis involved 31 subjects. Second, the subjects were predominantly male and the mean age was relatively young, limiting the representativeness of the sample. Third, the reported accuracy values are calculated as 100% minus MAPE and should be understood as error-derived indicators rather than a complete clinical validation of each sensor. Fourth, the system combines automated sensor readings with manually entered NEWS2 parameters, so incorrect or incomplete manual inputs may affect the final score. Finally, the prototype is intended as a monitoring and educational aid and is not a substitute for professional clinical assessment or medical diagnosis.

Overall, the findings support the technical feasibility of integrating multiparameter vital-sign monitoring with NEWS2 calculation, dashboard visualization, data storage, and local alerts. The next stage should prioritize testing with simulated deterioration cases, assessment of repeatability and communication reliability, and verification of the complete NEWS2 workflow before any broader clinical use.

CONCLUSION

This study developed and tested a multiparameter vital-sign monitoring prototype integrated with National Early Warning Score 2 (NEWS2) calculation for use as a learning aid in clinical simulation laboratories. The prototype combined sensor-based measurements, data transfer through BLE and MQTT, a web dashboard, measurement-history storage, and local outputs through an LCD, LEDs, and a buzzer. Functional testing reported that these components operated according to the design. In the sensor comparison tests, the reported MAPE values were 0.26% for SpO_2, 0.19% for body temperature, and 2.58% for respiration rate, corresponding to MAPE-derived accuracy indicators of 99.74%, 99.81%, and 97.42%, respectively. Among the 31 subjects assessed, the NEWS2 total scores ranged from 0 to 4, with a reported mean of 1.00; all measurements were classified as low risk and no single red score was recorded.

These results indicate the technical feasibility of integrating multiparameter vital-sign monitoring and NEWS2 scoring into a single educational prototype. However, the current findings do not establish performance in detecting moderate- or high-risk clinical deterioration because all tested subjects were classified as low risk. Further work should include controlled simulation scenarios covering a broader range of abnormal vital signs, verification of NEWS2 calculations and manual inputs, and additional testing of sensor repeatability and system reliability. The prototype should be regarded as a monitoring and educational aid, not as a replacement for professional clinical assessment or medical diagnosis.

REFERENCES

Alhmoud, B., Bonnici, T., Melley, D., Patel, R., & Banerjee, A. (2023). Performance of digital early warning score (NEWS2) in a cardiac specialist setting: Retrospective cohort study. *BMJ Open, 13*(3), e066131. https://doi.org/10.1136/bmjopen-2022-066131

Astuti, L. P., Trisyani, Y., & Mirwanti, R. (2022). Implementasi early warning system (EWS) dalam mendeteksi perburukan akut pada pasien dewasa di ruang rawat inap rumah sakit. *Journal of Telenursing (JOTING), 5*(2). https://doi.org/10.31539/joting.v5i2.6356

Chen, L., Sun, Y., Kuek, S. Y., Chew, M. F., Tan, H. L., & Ho, S. (2025). Predictive performance and temporal dynamics of National Early Warning Score 2 (NEWS2) in detecting clinical deterioration in general ward: A large-scale validation study in Singapore. *Resuscitation Plus, 26*, 101120. https://doi.org/10.1016/j.resplu.2025.101120

Eisenkraft, A., Goldstein, N., Merin, R., Fons, M., Ben Ishay, A., Nachman, D., & Gepner, Y. (2023). Developing a real-time detection tool and an early warning score using a continuous wearable multi-parameter monitor. *Frontiers in Physiology, 14*, 1138647. https://doi.org/10.3389/fphys.2023.1138647

Forster, S., McKeever, T. M., Churpek, M., Gonem, S., & Shaw, D. (2022). Predicting outcome in acute respiratory admissions using patterns of National Early Warning Scores. *Clinical Medicine, 22*(5), 409–415. https://doi.org/10.7861/clinmed.2022-0074

Goodacre, S., Sutton, L., Fuller, G., Trimble, A., & Pilbery, R. (2025). Accuracy of the National Early Warning Score version 2 (NEWS2) in predicting need for time-critical treatment: Retrospective observational cohort study.

This is an Creative Commons License This work is licensed under a Creative Commons Attribution-NonCommercial 4.0 International License.

E-ISSN : 2807-9035
Volume 6, **Number** 4, November 2026
https://doi.org/10.47709/brilliance.v6i4.9884

Emergency Medicine Journal, 42(6), 396–402. https://doi.org/10.1136/emermed-2024-214562

Reichl, J. J., Leifke, M., Wehrli, S., Kunz, D., Geissmann, L., Broisch, S., Illien, M., Wellauer, D., von Dach, N., Diener, S., Manser, V., Herren, V., Angerer, A., Hirsch, S., Hölz, B., & Eckstein, J. (2024). Pilot study for the development of an automatically generated and wearable-based early warning system for the detection of deterioration of hospitalized patients of an acute care hospital. *Archives of Public Health, 82*(1), 179. https://doi.org/10.1186/s13690-024-01409-y

Riccalton, V., Threlfall, L., Ananthakrishnan, A., Cong, C., Milne-Ives, M., Le Roux, P., Plummer, C., & Meinert, E. (2025). Modifications to the National Early Warning Score 2: A scoping review. *BMC Medicine, 23*(1), 154. https://doi.org/10.1186/s12916-025-03943-0

Simanjuntak, I., Noviestari, E., Kamil, H., & Sarvita, S. (2023). Optimalisasi pelaksanaan early warning system (EWS) di ruang rawat inap RS X. *Journal of Telenursing (JOTING), 5*(2). https://doi.org/10.31539/joting.v5i2.7932

Sofwan, F., Kurniawaty, J., & Adiyanto, B. (2023). Validasi National Early Warning Score 2 (NEWS2) dewasa untuk memprediksi mortalitas pasien COVID-19 di RSUP Sardjito Yogyakarta. *Jurnal Komplikasi Anestesi, 9*(3), 29–36. https://doi.org/10.22146/jka.v9i3.8335

Sugiyarto, S., Sumardino, S., & Anggayuni, I. (2021). Penerapan National Early Warning Score 2 (NEWS2) dalam mengidentifikasi penurunan kondisi pasien COVID-19 di IGD: Literature review. *Bima Nursing Journal*. https://jkp.poltekkes-mataram.ac.id/index.php/bnj/article/view/889

Vergara, P., Forero, D., Bastidas, A., Garcia, J.-C., Blanco, J., Azocar, J., Bustos, R.-H., & Liebisch, H. (2021). Validation of the National Early Warning Score (NEWS)-2 for adults in the emergency department in a tertiary-level clinic in Colombia: Cohort study. *Medicine, 100*(40), e27325. https://doi.org/10.1097/MD.0000000000027325

Welch, J., Dean, J., & Hartin, J. (2022). Using NEWS2: An essential component of reliable clinical assessment. *Clinical Medicine, 22*(6), 509–513. https://doi.org/10.7861/clinmed.2022-0435

Wong, D. C.-W., Bonnici, T., Gerry, S., Birks, J., & Watkinson, P. J. (2024). Effect of digital early warning scores on hospital vital sign observation protocol adherence: Stepped-wedge evaluation. *Journal of Medical Internet Research, 26*, e46691. https://doi.org/10.2196/46691

Zarama, V., Quintero, J. A., Barbosa, M. M., Rodriguez, S., Angel, A. M., Muñoz, A. M., Muñoz, J. A., Maya-Portillo, D., & Rosso, F. (2024). NEWS2, S/F-ratio and ROX-index at emergency department for the prediction of adverse outcomes in COVID-19 patients: An external validation study. *The American Journal of Emergency Medicine, 83*, 101–108. https://doi.org/10.1016/j.ajem.2024.07.006

This is an Creative Commons License This work is licensed under a Creative Commons Attribution-NonCommercial 4.0 International License.