JEMTAC
Journal of Emergency Medicine Trauma & Acute Care
A PEER REVIEWED JOURNAL

OPEN ACCESS

Research paper

The accuracy of NEWS-2 in the emergency prehospital setting in Saudi Arabia

Abdulrhman Alghamdi[1,2,3*], Abdullah Alshibani[1,2,3], Meshary Binhotan[1,2,3], Meshal Alharbi[1,2,3], Abdullah Alabdali[1,2,3], Saad Albaiz[1,2,3]

[1]Emergency Medical Services Department, College of Applied Medical Sciences, King Saud Bin Abdulaziz University for Health Sciences, Riyadh, Saudi Arabia
[2]King Abdullah International Medical Research Center, Riyadh, Saudi Arabia
[3]Ministry of National Guard Health Affairs, Riyadh, Saudi Arabia

*Email: Ghamdia@ksau-hs.edu.sa

https://doi.org/10.5339/jemtac.2024.3

Submitted: 06 April 2023
Accepted: 18 November 2023
Published: 29 February 2024

ABSTRACT

Introduction: Various early warning score tools have been developed to identify clinical deterioration in patients. This study assessed the predictive capacity of the National Early Warning Score 2 (NEWS-2) in the prehospital setting to predict death within 24 hours and 30-day intensive care unit admission.

Methods: A single-center observational retrospective study was conducted in the emergency medical services (EMS) of King Abdulaziz Medical City, Riyadh, Saudi Arabia. We included adult patients (› 18 years) who attended the emergency medical service. The primary outcome was 24-hour death and 30-day intensive care unit admission. Sensitivity, specificity, and negative/positive predictive values (NPV/PPV) were determined.

Results: The study comprised 1,343 eligible patients. NEWS-2 exhibited a sensitivity of 20% and a specificity of 80% for predicting 24-hour death and a sensitivity of 10% and a specificity of 80% for predicting 30-day intensive care unit admission. The area under the curve for predicting death was 0.529, and for intensive care unit admission was 0.456.

Conclusion: Our study underscores the limited utility of NEWS-2 as a predictor of 24-hour death and 30-day intensive care unit admission in adult patients utilizing the emergency medical service. Further extensive studies are warranted to corroborate this study's findings.

Keywords: NEWS-2 , ambulance, paramedic, prehospital

Cite this article as: Alghamdi A, Alshibani A, Hotan MB, Alharbi M, Alabdali A, Albaiz S. The accuracy of NEWS-2 in the emergency prehospital setting in Saudi Arabia. *Journal of Emergency Medicine, Trauma & Acute Care*. 2024(3):3 https://doi.org/10.5339/jemtac.2024.3

QSCIENCE
HAMAD BIN KHALIFA UNIVERSITY PRESS

INTRODUCTION

The population's demand for emergency medical service (EMS) assistance has increased over the past decade.[1-3] This surge in prehospital calls and patient volume necessitates a system for prioritizing patients and delivering prompt treatment. Complex and critical situations are routinely seen in the EMS, demanding swift decision-making with limited diagnostic tools.[4] Early warning score (EWS) tools are pivotal in predicting patient outcomes and supporting the necessary classification.[5]

Given the increased demand for EMS and the need to improve patient outcomes, it is essential to implement and use EWS in prehospital settings. EWS are tools that can be used to identify patients who are at risk of clinical deterioration. They are based on a combination of vital signs, such as respiratory rate, heart rate, blood pressure, and temperature.[5] A higher EWS score indicates a higher risk of deterioration. EWS can be used in both prehospital and hospital settings. In the prehospital setting, EWS can be used by paramedics to identify patients who need to be urgently transported to the emergency department (ED). In the hospital setting, EWS can be used by nurses and doctors to identify patients at risk of deterioration and needing closer monitoring and care.[6,7]

Different EWS tools have been developed over the past few years.[8] Generally, any EWS tool aims to identify critical patients and those at high risk for deterioration.[6,7] This process involves measuring the patient's physiological variables (such as heart rate and blood pressure) and other observations (e.g., level of consciousness), which provide a standardized score about the patient's condition.[9] The score facilitates decision-making by providing sufficient information about a patient's severity.[9,10] The patient's vital signs change before deteriorating.[11,12] The early detection of these variables can prevent adverse events for the patient through prioritizing the clinical intervention and response.[13,14] Finally, it is unclear whether NEWS-2 provides sufficient information in the context of the actual severity of the patient.

Despite the presence of different EWS tools, the National Early Warning Score 2 (NEWS-2) is the most frequently used EWS globally.[15] NEWS-2, an updated version of NEWS, has been evaluated in hospitals[16-19] and prehospital settings.[6,20,21] However, the evidence regarding using NEWS-2 in a prehospital setting is still limited, and standardized use is controversial.[4] Investigation into the use of NEWS-2 in the prehospital setting is recommended. The aim was to evaluate the diagnostic accuracy of the prehospital NEWS-2 for predicting the 24-hour death and 30-day intensive care unit (ICU) admission in adult patients who called the emergency ambulance services.

METHODS

Study Design and Population

This study adopted a single-center retrospective study design involving adult patients (aged >18 years) attended by emergency response crews and subsequently transferred to the ED. The primary outcome was 24-hour mortality, with a secondary focus on 30-day ICU admission. This study encompassed all patients transported via King Abdulaziz Medical City (KAMC) ambulances.

Data Collection

Prehospital data, including clinical data and treatment details, were manually extracted from written patient care reports by the study team. The study team undertook a meticulous verification process to ensure data accuracy. Other epidemiological, demographic, clinical, and outcome-related data were extracted from the hospital's electronic system. Patients with missing or incomplete first set of vital signs necessary for NEWS-2 calculation (as outlined in Table 1) and those without follow-up or outcome data within the electronic medical record (30-day) were excluded.

Study Setting

The study was conducted within the EMS department at King Abdulaziz Medical City (KAMC) in Riyadh from January 1, 2019, to December 31, 2019 (one year). KAMC in Riyadh stands as one of the leading healthcare facilities in Saudi Arabia, offering tertiary care services to patients nationwide. Among its critical services is the provision of EMS. Staffed by highly trained and experienced paramedics, emergency medical technicians (EMTs), and physicians, the EMS department at KAMC operates 24/7 to respond to emergencies. EMS at KAMC receives approximately 2,500 emergency calls annually.

Statistical Analysis

The data were stored in Excel version 16 (Microsoft Inc., Redmond, USA) and exported into SPSS version 23.0 (IBM, Armonk, USA) for analysis. NEWS-2 (Table 1) was calculated using SPSS and the first dataset of vital signs available from a prehospital setting. Patients with missing NEWS-2 scores were excluded from

Table 1. National Early Warning Score 2 (NEWS-2).

	3	2	1	0	1	2	3
Respiratory rate (bpm)	≤ 8		9–11	12–20		21–24	≥ 25
Spo2 Scale 1 (%)	≤ 91	92–93	94–95	≥ 96			
Spo2 Scale 2 (%)	≤ 83	84–85	86–87	88–92 ≥ 93 on air	93–94 on Oxygen	95–96 on Oxygen	≥ 97 on Oxygen
Air or oxygen		Oxygen		Air			
Systolic blood pressure	≤ 90	91–100	101–110	111–219			≥ 220
Pulse rate	≤ 40		41–50	51–90	91–110	111–130	≥ 131
Level of consciousness				Alert			CVPU
Temperature	≤ 35.0		35.1–36.0	36.1–38.0	38.1–39.0	≥ 39.1	

the study. For both outcomes, we calculated the sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), positive likelihood ratio, and negative likelihood ratio. We also calculated the area under the curve (AUC) of the receiver-operating characteristic (ROC) of the NEWS-2 scale for both outcomes. Similarly to previous studies, for both outcomes, a medium-risk cut-off of the NEWS-2 scale (NEWS-2 ≤ 5) was applied.[5] We used the TRIPOD Checklist to report the study results.[22]

Ethical Approval

This study was approved by the Institutional Review Board at King Abdullah International Medical Research Center, Riyadh, KSA (IRBC/1413/21).

RESULTS

Study Demographics

The study included 1,343 eligible patients, with a slight majority being female (57.9%). The age distribution revealed that the 18-33 years age group had the largest proportion (32.1%), followed by the 34-48 years group (25.7%), 49-61 years group (13.8%), 62-74 years group (15.4%), and + 75 years group (13.0%). Among the study cohort, only five died within 24 hours, while 20 were admitted to the ICU within 30 days.

The Ability of NEWS-2 to Predict Outcomes

The AUC for predicting death within 24 hours was 0.529 (Figure 1), while for predicting the 30-day ICU admission, it was 0.456 (Figure 1). Table 2 displays the cut-off points of NEWS-2 for death within

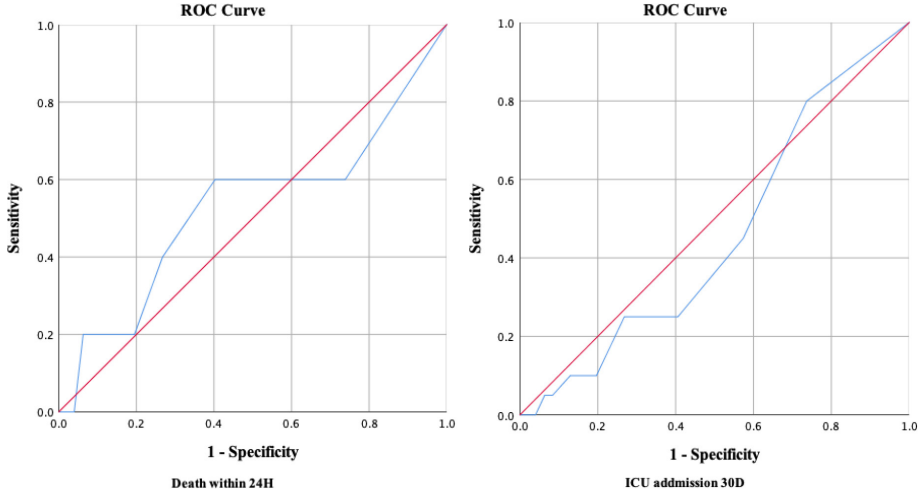

Figure 1. Receiver operator characteristic (ROC) curves for NEWS-2 ability to predict 24-hour death and 30-day ICU admission.

Table 2. Cut-off points of sensitivity and specificity for the NEWS-2 ability to predict 24-hour death and 30-day ICU admission.

Cut-offs (points)	24-hour death	30-day ICU admission
Sensitivity % (95% CI)	20% (1%–73%)	10% (1%–32%)
Specificity % (95% CI)	80% (78%–83%)	80% (78%–82%)
Positive predictive value % (95% CI)	0.00 % (0.00%, 2%)	1% (0.00%, 3%)
Negative predictive value % (95% CI)	100 % (99%, 100%)	98% (97%, 99%)
Positive likelihood ratio	1.03 (0.18, 5.94)	0.51 (0.14, 1.90)
Negative likelihood ratio	0.99 (0.64, 1.54)	1.12 (0.97, 1.30)

24 hours and the 30-day ICU admission regarding sensitivity and specificity. NEWS-2 exhibited low sensitivity for predicting death within 24 hours (20% sensitivity; 95% CI, 1–73) but acceptable specificity (80% specificity; 95% CI, 78–83) (Table 2). Similarly, its sensitivity for predicting 30-day ICU admission was even lower (10% sensitivity, 95% CI, 1–32), with 80% specificity (95% CI, 78–82) (Table 2). However, the 95% CI for NEWS-2 sensitivity to predict 30-day ICU admission was notably narrower than for death within 24 hours, with comparable specificity rates and 95% CI. A negative predictive value of 1.00 (95% CI, 0.99–1.00) and a positive likelihood ratio of 1.03 (95% CI, 0.18–5.94) were observed using these cut-off points for predicting death within 24 hours. Additionally, a negative predictive value of 0.98 (95% CI, 0.97–0.99) and a positive likelihood ratio of 0.51 (95% CI, 0.14–1.90) were observed to predict 30-day readmission.

DISCUSSION

The current study highlighted that utilizing NEWS-2 in the prehospital setting does not offer compelling evidence of its value in identifying severe patients or predicting mortality. However, looking in depth at the results could suggest that NEWS-2 may serve as a valuable rule-in rather than a rule-out tool. In other words, prehospital providers could use this tool to support their decision. This statement is supported by the acceptable specificity and high negative predictive value in our result for both 30-day ICU admission and mortality. The results from this paper should be interpreted cautiously, given the very low true prevalence observed.

While having a scale to predict severely ill patients would be beneficial, relying solely on limited information, such as vital signs and mental assessments, may constrain the score's utility. Many scores, for example, the stroke scale, are currently used in the prehospital setting for different patient conditions. These scores have been developed for a specific goal, indicating the challenge of aiming to use one scale to identify patients with severe illness.

A recent systematic review and meta-analysis revealed that NEWS-2 can predict short-term clinical deterioration. However, the long-term mortality was not accurately predicted in the prehospital setting.[23] Guan et al. attributed this discrepancy to the less critical nature of patients seen in prehospital settings compared to EDs, which could explain how the findings in the current study failed to predict short-term mortality by understanding the low true prevalence in the data. Others suggested the applicability of using the scores in the prehospital setting could be best with critically ill patients.[24] This agrees with the findings of this paper, as it was determined that the best application for the score is to rule-in, supported by the acceptable specificity and high NPV (i.e., SpPIn).[25]

Some studies only included patients for a short time of the year,[21] which could introduce seasonal bias. In addition, different EMS systems and dispatch protocols were used to retrieve the NEWS data from the patient PCR.[20] This could increase the heterogeneity of the data resources and make comparing the results difficult. A recent Australian study had similar results to the current study's findings.[26] Their focus was mainly on the association between the NEWS and retrieval activation.

Finding a tool or scale to identify the patients accurately could enhance patient care, from transporting the patient to the appropriate facility and promptly activating the critical care response team. Prehospital care in a proper setting is highly associated with enhancing patient care.

Limitations

Incomplete patient care data poses a significant limitation to this research study.

One of the primary challenges of incomplete patient care data is that it may not provide a comprehensive picture of the patient's health status. For instance, if a patient's medical history is missing or incomplete, researchers may be unable to identify pre-existing conditions that could affect their treatment outcomes. Similarly, if laboratory test results are missing, researchers may be unable to accurately assess the severity of a patient's condition or track changes in their health over time. In our diagnostic study, more than 800 patients had missing and incomplete prehospital data, which could skew the results and make it difficult to draw the study conclusion.

CONCLUSION

In conclusion, this single-center study presented findings demonstrating the limited utility of the NEWS-2 score as a reliable predictor of 24-hour mortality and 30-day ICU admission among adult patients in prehospital emergency settings. Nonetheless, conducting broader, multicenter studies to validate our findings is warranted.

CONFLICT OF INTEREST

The authors report no conflicts of interest in this work.

REFERENCES

[1] Lowthian JA, Jolley DJ, Curtis AJ, Currell A, Cameron PA, Stoelwinder JU, et al. The challenges of population ageing: accelerating demand for emergency ambulance services by older patients, 1995-2015. Med J Aust. 2011 Jun 6;194(11):574-8. doi: 10.5694/j.1326-5377.2011.tb03107.x.

[2] Jin R, Xia T, Liu X, Murata T, Kim KS. Predicting Emergency Medical Service Demand With Bipartite Graph Convolutional Networks. IEEE Access. 2021;9:9903-15. doi: 10.1109/ACCESS.2021.3050607.

[3] Al-Wathinani A, Hertelendy AJ, Alhurishi S, Mobrad A, Alhazmi R, Altuwaijri M, et al. Increased Emergency Calls during the COVID-19 Pandemic in Saudi Arabia: A National Retrospective Study. Healthcare (Basel). 2020 Dec 24;9(1):14. doi: 10.3390/healthcare9010014.

[4] Patel R, Nugawela MD, Edwards HB, Richards A, Le Roux H, Pullyblank A, et al. Can early warning scores identify deteriorating patients in prehospital settings? A systematic review. Resuscitation. 2018 Nov;132:101-111. doi: 10.1016/j.resuscitation.2018.08.028.

[5] Vergara P, Forero D, Bastidas A, Garcia JC, Blanco J, Azocar J, et al. 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 (Baltimore). 2021 Oct 8;100(40):e27325. doi: 10.1097/MD.0000000000027325.

[6] Shaw J, Fothergill RT, Clark S, Moore F. Can the prehospital National Early Warning Score identify patients most at risk from subsequent deterioration? Emerg Med J. 2017 Aug;34(8):533-537. doi: 10.1136/emermed-2016-206115.

[7] Kraaijvanger N, Rijpsma D, Roovers L, van Leeuwen H, Kaasjager K, van den Brand L, et al. Development and validation of an admission prediction tool for emergency departments in the Netherlands. Emerg Med J. 2018 Aug;35(8):464-470. doi: 10.1136/emermed-2017-206673.

[8] Ferrandini Price M, Arcos González P, Pardo Ríos M, Nieto Fernández-Pacheco A, Cuartas Alvarez T, Castro Delgado R. Comparison of the Simple Triage and Rapid Treatment system versus the Prehospital Advanced Triage Model in multiple-casualty events. Emergencias. 2018;30(4):224-30.

[9] Martín-Rodríguez F, Castro-Villamor MÁ, Del Pozo Vegas C, Martín-Conty JL, Mayo-Iscar A, Delgado Benito JF, et al. Analysis of the early warning score to detect critical or high-risk patients in the prehospital setting. Intern Emerg Med. 2019 Jun;14(4):581-9. doi: 10.1007/s11739-019-02026-2.

[10] Hoikka M, Länkimäki S, Silfvast T, Ala-Kokko TI. Medical priority dispatch codes-comparison with National Early Warning Score. Scand J Trauma Resusc Emerg Med. 2016 Dec 3;24(1):142. doi: 10.1186/s13049-016-0336-y.

[11] Flenady T, Dwyer T, Applegarth J. Accurate respiratory rates count: So should you! Australas Emerg Nurs J. 2017 Feb;20(1):45-47. doi: 10.1016/j.aenj.2016.12.003.

[12] Gao H, McDonnell A, Harrison DA, Moore T, Adam S, Daly K, et al. Systematic review and evaluation of physiological track and trigger warning systems for identifying at-risk patients on the ward. Intensive Care Med. 2007 Apr;33(4):667-79. doi: 10.1007/s00134-007-0532-3.

[13] Hogan H, Healey F, Neale G, Thomson R, Vincent C, Black N. Preventable deaths due to problems in care in English acute hospitals: a retrospective case record review study. BMJ Publishing Group Ltd; 2012. p. 737-45.

[14] Hillman KM, Bristow PJ, Chey T, Daffurn K, Jacques T, Norman SL, et al. Duration of life-threatening antecedents prior to intensive care admission. Intensive Care Med. 2002 Nov;28(11):1629-34. doi: 10.1007/s00134-002-1496-y.

[15] Martín-Rodríguez F, López-Izquierdo R, Del Pozo Vegas C, Sánchez-Soberón I, Delgado-Benito JF, Martín-Conty JL, et al. Can the prehospital National Early Warning Score 2 identify patients at risk of in-hospital early mortality? A prospective, multicenter cohort study. Heart Lung. 2020 Sep-Oct;49(5):585-591. doi: 10.1016/j.hrtlng.2020.02.047.

[16] Pimentel MAF, Redfern OC, Gerry S, Collins GS, Malycha J, Prytherch D, et al. A comparison of the ability of the National Early Warning Score and the National Early Warning Score 2 to identify patients at risk of in-hospital mortality: A multi-centre database study. Resuscitation. 2019 Jan;134:147-156. doi: 10.1016/j.resuscitation.2018.09.026.

[17] Lee YS, Choi JW, Park YH, Chung C, Park DI, Lee JE, et al. Evaluation of the efficacy of the National Early Warning Score in predicting in-hospital mortality via the risk stratification. J Crit Care. 2018 Oct;47:222-226. doi: 10.1016/j.jcrc.2018.07.011.

[18] Kivipuro M, Tirkkonen J, Kontula T, Solin J, Kalliomäki J, Pauniaho SL, et al. National early warning score (NEWS) in a Finnish multidisciplinary emergency department and direct vs. late admission to intensive care. Resuscitation. 2018 Jul;128:164-169. doi: 10.1016/j.resuscitation.2018.05.020.

[19] Spagnolli W, Rigoni M, Torri E, Cozzio S, Vettorato E, Nollo G. Application of the National Early Warning Score (NEWS) as a stratification tool on admission in an Italian acute medical ward: A perspective study. Int J Clin Pract. 2017 Mar;71(3-4). doi: 10.1111/ijcp.12934.

[20] Pirneskoski J, Kuisma M, Olkkola KT, Nurmi J. Prehospital National Early Warning Score predicts early mortality. Acta Anaesthesiol Scand. 2019 May;63(5):676-683. doi: 10.1111/aas.13310.

[21] Hoikka M, Silfvast T, Ala-Kokko TI. Does the prehospital National Early Warning Score predict the short-term mortality of unselected emergency patients? Scand J Trauma Resusc Emerg Med. 2018 Jun 7;26(1):48. doi: 10.1186/s13049-018-0514-1.

[22] Collins GS, Reitsma JB, Altman DG, Moons KM. Transparent reporting of a multivariable prediction model for individual prognosis or diagnosis (tripod): The tripod statement. Annals of Internal Medicine. 2015;162(1):55-63. doi: 10.1186/s12916-014-0241-z.

[23] Guan G, Lee CMY, Begg S, Crombie A, Mnatzaganian G. The use of early warning system scores in prehospital and emergency department settings to predict clinical deterioration: A systematic review and meta-analysis. PLoS One. 2022 Mar 17;17(3):e0265559. doi: 10.1371/journal.pone.0265559.

[24] Williams TA, Tohira H, Finn J, Perkins GD, Ho KM. The ability of early warning scores (EWS) to detect critical illness in the prehospital setting: A systematic review. Resuscitation. 2016 May;102:35-43. doi: 10.1016/j.resuscitation.2016.02.011.

[25] Pewsner D, Battaglia M, Minder C, Marx A, Bucher HC, Egger M. Ruling a diagnosis in or out with "SpPIn" and "SnNOut": a note of caution. BMJ. 2004 Jul 24;329(7459):209-13. doi: 10.1136/bmj.329.7459.209.

[26] Smith J, Andrew E, Smith K. Prehospital early warning scores are associated with requirement for medical retrieval services. Australasian Journal of Paramedicine. 2022;19:1-9. doi: 10.33151/ajp.19.956.