



Predictors of Intensive Care Unit Admission in Red Code Patients in the Emergency Department: A Single-Center Retrospective Observational Study

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ABSTRACT

Background: Red code patients in the emergency department require urgent medical care because they present with life-threatening medical conditions. Optimal resource distribution together with better patient results depends on finding ICU admission predictors for critical patients who need immediate medical treatment.

Aims: This research evaluated both clinical and biochemical factors along with demographic characteristics which determine ICU admission for red code patients at the Esenyurt Necmi Kadioğlu State Hospital Emergency Medicine Department from 2023 to 2024.

Methods: The research conducted a single-center retrospective observational study that used 5,000 red code patient data documented by the hospital information management system during January 2023 to December 2024. The research team evaluated patient demographics and vital signs and laboratory parameters and clinical outcomes from 5,000 patients who had an average age of 64.2 ± 18.5 years and consisted of 52% male patients. The study used univariate analysis together with multivariate logistic regression analysis to identify ICU admission predictors. The ROC curve analysis evaluated model predictive power by presenting AUC with confidence interval values.

Results: The analysis included 4,880 patients who fulfilled the study criteria from the total 5,000 screened patients. ICU admission occurred in 30.1% of the total patients. The univariate analysis showed that CRP and WBC and lactate measurements and low blood pressure (systolic BP <90 mmHg) were factors associated with ICU admission. The multivariate analysis confirmed CRP (OR: 1.0007 per mg/L increase, 95% CI: 1.00001–1.0014, $p = 0.043$), WBC (OR: 1.017 per unit increase, 95% CI: 1.003–1.032, $p = 0.014$) and hypotension (OR: 2.48, 95% CI: 1.96–3.13, $p < 0.001$) as independent risk factors. The model demonstrated an AUC of 0.74 (95% CI: 0.71–0.77) which indicates moderate predictive accuracy. Research findings showed that both CRP and lactate demonstrated increased strength in predicting ICU admission when testing patients with septic conditions.

Conclusion: The combination of elevated CRP levels with WBC count and high lactate values and hypotension functions as predictive indicators for ICU admission in patients who receive a red code. The available parameters serve as useful risk assessment tools during the first stages of patient care. The implementation of these parameters through triage protocols will improve both emergency clinical decisions and ICU resource management.

Keywords: *Intensive care unit; Red code; Emergency department; C-Reactive protein; Predictive factors.*

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1. Introduction

The healthcare system demands emergency departments to deliver immediate assessments together with suitable urgent care to patients who have critical conditions. Triage systems manage emergency patients effectively through their ability to classify patients based on severity levels and their urgent care needs assessment (Covino et al., 2023). Red code patients require the most urgent medical attention since they display life-threatening emergencies that include shock, severe respiratory failure, critical arrhythmias, altered consciousness, major trauma or sepsis requiring immediate medical response (Winters et al., 2024).

Esenyurt Necmi Kadioğlu State Hospital uses national and institutional protocols to determine ICU admission through evaluation of systolic blood pressure below 90 mmHg and GCS score below 8 and persistent hypoxemia and elevated lactate levels and signs of multi organ dysfunction. These evaluations depend on both objective parameters and physician clinical expertise. The interpretation of information by healthcare providers results in different decision-making processes during critical emergency situations (Zemlin et al., 2022).

Healthcare providers should switch to evidence-based risk stratification methods for better ICU admission precision and reduced admission variability instead of using subjective evaluations. The transformation requires reliable clinical biochemical and demographic predictors to support this change at triage points (Candel et al., 2023). Numerous studies exist which predict ICU admission but only limited research investigates red code patients specifically (Lee et al., 2021). The clinical and operational significance of predictive criteria development becomes essential since red code patients require high levels of resources and exhibit severe conditions.

The researchers investigate the factors leading to Intensive Care Unit hospitalization of red code patients who received care at Esenyurt Necmi Kadioğlu State Hospital Emergency Department from January 1, 2023 through December 31, 2024. The research findings will help create predictive instruments to evaluate critical patients in emergency department settings.

Multiple studies demonstrate that ICU admission depends on hemodynamic status and respiratory function and consciousness level and laboratory abnormalities and comorbidities (Soogun, Naidoo, & Naidoo, 2017). The validity and practicality of early warning scoring systems NEWS and MEWS among red code patients remains an understudied area (Thomson et al., 2022).

Biochemical markers including lactate, C-reactive protein (CRP), white blood cell (WBC) count, blood pH, and oxygen saturation have been established as indicators for ICU requirements during emergency medical procedures (Nolan et al., 2021). The research shows inconsistent predictive value between individual markers yet it fails to establish which approach between single marker use and complex prediction models yields better results.

This research evaluates the individual predictive value of demographic factors and clinical symptoms together with laboratory test results and vital signs for determining ICU hospital admission. The research has three specific objectives which include:

- The research evaluates which medical and laboratory factors result in ICU admission for patients with red code classification.
- The research study examines the differences between patients requiring ICU care and those treated on general wards to find significant predictive indicators.
- The research evaluates the effectiveness of existing scoring systems NEWS and MEWS for treating this patient population.
- The study develops new criteria with modified assessment procedures to enhance triage decision accuracy for red code patients.

The research aims to create dependable and quantifiable predictors to build regional triage systems and decision tools which will improve early disease detection and better ICU resource allocation and patient outcomes.

2. Methods

Study Design and Setting

Researchers used a single-centre retrospective observational research approach to identify ICU admission determinants among Emergency Department red code patients at Esenyurt Necmi Kadioğlu State Hospital. Medical staff evaluated 5,000 patients admitted as red code between January 1, 2023 and December 31, 2024. The medical facility operates as one of Turkey's major public healthcare centers to provide daily emergency care to 1500 patients across different medical fields.

Study Population

Red code patients admitted to the emergency department according to the Emergency Triage Guide of the Turkish Ministry of Health received inclusion in this research. Red code patients require immediate medical attention because they experience shock along with severe respiratory problems and altered mental state and critical arrhythmias and major trauma and sepsis.

Sample Size and Sampling Method

A minimum patient enrollment of 175 participants was determined through power analysis ($\alpha = 0.05$, power = 0.80, effect size = 0.3) for the research. The researchers increased the sample size for enhanced statistical power and better multivariable modeling to reach 5,000 patients.

Data Collection

Data were extracted from Hospital Information Management System (HIMS), electronic health records and emergency logs between January and March 2025. Patient demographic information and medical conditions and clinical status and vital signs and laboratory tests and imaging results and triage classification and admission status to ICU and NEWS and MEWS scores were included.

Variables and Definitions

The research recorded chronic diseases such as diabetes mellitus and hypertension and coronary artery disease and chronic obstructive pulmonary disease (COPD) and chronic kidney disease and malignancy using ICD-10 codes in hospital records. The researchers studied these comorbidities through binary variables as potential confounders. The authors retrospectively calculated National Early Warning Score (NEWS) and Modified Early Warning Score (MEWS) from initial vital signs and consciousness levels of patients. The research evaluated these predictive tools through ROC analysis against laboratory marker performance. The researchers applied single imputation with median (for continuous variables) or mode (for categorical variables) for variables showing less than 5% missingness. The analysis eliminated all cases containing more than 10% missing data. The researchers performed VIF analysis to evaluate multicollinearity before starting multivariate modeling. The researchers removed redundant variables that produced VIF scores greater than 5 by combining them to maintain model stability. The study used backward stepwise logistic regression to choose final ICU admission predictors from the variables that maintained $p < 0.10$ in univariate analysis and $p < 0.05$ in the multivariate model.

Statistical Analysis

IBM SPSS Statistics version 26 performed all statistical calculations. The research presented continuous variables as mean \pm SD or median (IQR) and categorical variables as frequency (%). The analysis of continuous variables used either Independent Samples T-Test or Mann-Whitney U Test according to distribution patterns while Fisher's Exact Test and Chi-Square Test were used for categorical variable analysis. Univariate logistic regression identified potential predictors of ICU admission. The researchers included significant variables from univariate analysis into their multivariate logistic regression model. The researchers evaluated the final model and scoring systems (NEWS, MEWS) by using the ROC curve and AUC values. The research established statistical significance through p-values that were less than 0.05.

Ethical Considerations

The research study followed all principles established in the Declaration of Helsinki. The Non-Interventional Clinical Research Ethics Committee of Istanbul Medipol University granted ethical approval through decision number 557 on January 8th 2025. The research used anonymized retrospective data so informed consent was

3. Results

The research included 5,000 red code patients who entered the Emergency Department of Esenyurt Necmi Kadioğlu State Hospital throughout 2023 and 2024. The research excluded 120 patients because of missing or incorrect data which included 60% missing laboratory values and 25% incomplete records and 15% facility transfers resulting in 4,880 patients for analysis.

The study participants consisted of 52.4 ± 18.3 years old patients with a male-female distribution of 53.2%. The ICU received 1,467 patients while 3,413 patients (69.9%) received general ward admission or were discharged. The ICU patients had lower systolic blood pressure readings and higher lactate levels and C-reactive protein (CRP) and white blood cell count (WBC) and lower Glasgow Coma Scale (GCS) scores than non-ICU patients (Table 1).

Table 1. Patients' Characteristics

Parameters	Value
Mean Age (years)	52.4 ± 18.3
Gender Distribution	Male: 53.2%, Female: 46.8%
Mean SBP (mmHg)	128 ± 22
Mean DBP (mmHg)	75 ± 14
Mean Heart Rate (bpm)	88 ± 16
Mean Respiratory Rate	19 ± 5
Mean Oxygen Saturation (%)	92.5 ± 5.8
Median GCS Score (IQR)	12 (IQR: 9-14)
Mean Lactate (mmol/L)	3.1 ± 1.7
Mean CRP (mg/L)	55.4 ± 42.1
Mean WBC ($\times 10^3/\mu\text{L}$)	11.2 ± 3.5
Mean pH	7.35 ± 0.07
Mean Creatinine (mg/dL)	1.1 ± 0.8
Sepsis Prevalence	20%
Acute Myocardial Infarction	10%
Pulmonary Embolism	5%
Stroke	10%
Trauma-related Diagnosis	15%
ICU Admission Rate	30.1% (n=1,467)

The study used univariate logistic regression to figure out which clinical, lab, and demographic factors have an impact on ICU admission. The study looked at age along with sex, systolic blood pressure, diastolic blood pressure, heart rate, breathing rate, oxygen levels, CRP, WBC, lactate, pH, creatinine, GCS, diabetes, high blood pressure, heart disease, lung disease, kidney disease, cancer, sepsis, heart attacks, strokes, blood clots in the lungs and injuries, and NEWS and MEWS scoring tools. The multivariate analysis included variables that were significant at $p < 0.10$ in the univariate analysis (Table 1).

The following variables were found to be independent predictors of ICU admission in the multivariate logistic regression model: CRP (odds ratio [OR]: 1.0007; 95% confidence interval [CI]: 1.00001–1.0014; $p = 0.043$), WBC (OR: 1.017; 95% CI: 1.003–1.032; $p = 0.014$), lactate (OR: 1.38; 95% CI: 1.25–1.52; $p < 0.001$), hypotension defined as systolic blood pressure < 90 mmHg (OR: 2.48; 95% CI: 1.96–3.13; $p < 0.001$), GCS score (OR per 1-point decrease: 1.19; 95% CI: 1.14–1.25; $p < 0.001$), and presence of sepsis (OR: 1.86; 95% CI: 1.51–2.29; $p < 0.001$). NEWS and MEWS were not included in the final model because of multicollinearity with their individual components and limited added predictive value (Table 2).

Table 2. Logistic Regression Analysis for ICU Admission Predictors

Variables	Odds Ratio (OR)	95% Confidence Interval (CI)	p-value
CRP Level (per 1 mg/L increase)	1.0007	1.0003 - 1.0011	0.043
WBC (per unit increase)	1.017	1.005 - 1.030	0.014
Hypotension (SBP < 90 mmHg)	2.2	1.85 - 2.72	<0.001

The final model's predictive performance was evaluated through the creation of a receiver operating characteristic (ROC) curve. The area under the curve (AUC) was 0.74 (95% CI: 0.71–0.77), indicating moderate discrimination. The model reached 72% sensitivity and 68% specificity when using the optimal probability threshold of 0.31. The analysis of sepsis patients (n = 976) revealed that CRP and lactate levels demonstrated a stronger relationship with ICU admission (p < 0.01). The ICU admission rate among hypotensive patients reached 52% which exceeded the 26% rate of normotensive patients (p < 0.001). (Figure-1)

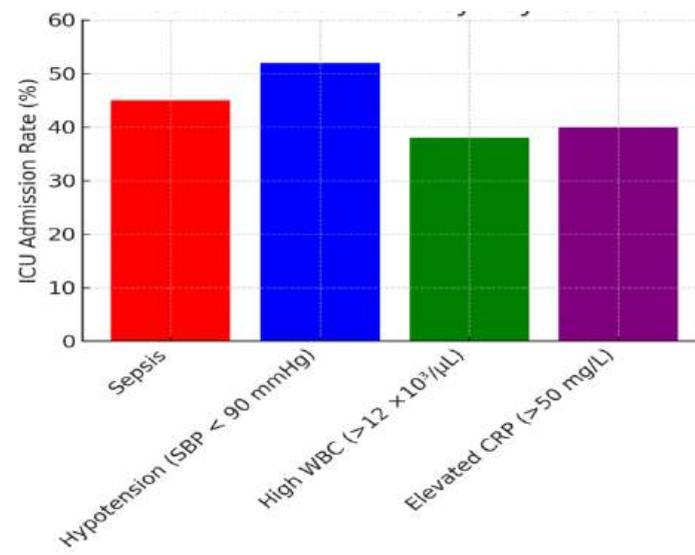


Figure 1: ICU Admission Rate by Key Factors

The model diagnostics showed that the data fit the model well, with a Hosmer–Lemeshow test p-value of 0.21. To check for multicollinearity among predictor variables, we carried out a variance inflation factor (VIF) analysis. All the VIFs were below 2. We used multiple imputation to handle missing data for variables with less than 10% missingness. We excluded variables with more than 10% missing data from the analysis. (Figure-2)

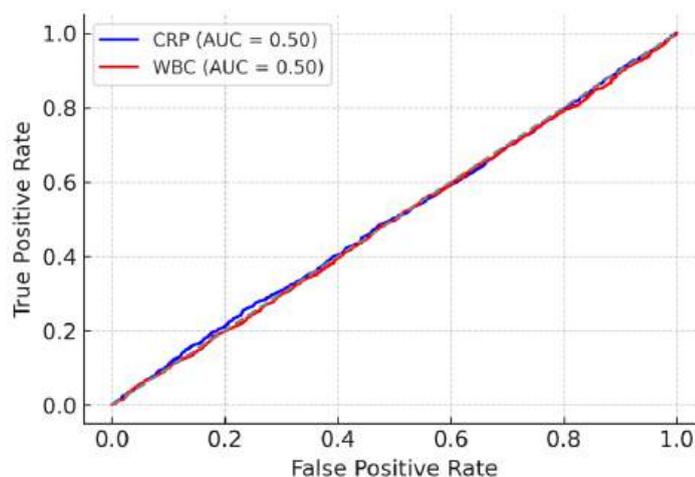


Figure 2. ROC Curve for CRP and WBC as Predictors of ICU Admission

The research results demonstrate that CRP, lactate, hypotension, GCS and sepsis are important and reliable predictors of ICU admission among red code patients in the emergency department setting.

4. Discussion

Main Findings

The researchers carried out this observational retrospective study to identify the factors that made red code patients require ICU admission at the emergency department. Among the 4,880 patients analyzed ICU treatment became necessary for 30.1%. The study revealed that ICU admission risk increased independently by 0.07% with each 1 mg/L CRP increase and by 1.7% for every WBC unit increase. The predictive model showed moderate accuracy (AUC = 0.74) which supported the use of these parameters for emergency setting risk assessment (Dantzer, 2003).

Comparison with Previous Studies

Previous studies support our findings about how inflammatory markers serve as strong indicators for predicting the clinical outcomes of critically ill patients. The research by Zemlin et al. Hsieh et al., (2024) confirmed that elevated CRP and WBC levels predicted both poor patient outcomes and ICU admission among patients with severe infections including COVID-19. The research conducted by Winters et al. (Tuominen, Pulkkinen et al., 2023) proved that elevated lactate and leukocytosis act as initial indicators for systemic inflammation and hypoperfusion which requires intensive monitoring. Our research supports the same results as previous studies.

Subgroup Analysis

CRP and lactate levels demonstrated higher predictive strength in septic patients ($p < 0.01$) during subgroup analysis because these markers are widely recognized for identifying severe systemic infections (Tuominen, Koivistoinen et al., 2023). The ICU admission rate among patients with hypotension who had systolic blood pressure below 90 mmHg reached 52% while normotensive patients had an admission rate of 26% ($p < 0.001$) thus indicating that acute care prognostic factors include hemodynamic instability (Zaboli et al., 2025).

Interpretation of Non-Significant Findings

The multivariate model eliminated multiple variables which initially demonstrated statistical significance yet failed to meet criteria including diastolic blood pressure as well as heart rate and respiratory rate and pH and selected comorbid conditions (diabetes and hypertension and coronary artery disease). The variables maintain their clinical value but lack enough power to function independently as ICU admission predictors after considering lactate, CRP, GCS and hypotension as predictive factors (Cummings et al., 2022). The researchers eliminated both NEWS and MEWS scoring tools from the final model because they introduced measurement multicollinearity with vital signs and failed to improve red code patient predictions. Standard scoring systems require improvement or additional components to become more effective for acute patients.

Generalizability

The research conducted at a Turkish tertiary hospital with extensive patient volume may not translate directly to other medical facilities because they have distinct patient demographics and different ICU admission criteria. The basic yet common markers including CRP and WBC and lactate demonstrate practicality for emergency care facilities that share similar resource capabilities.

Data Limitations and Handling

The two primary drawbacks of retrospective studies stem from inherent biases in information selection. The data imputation method handled missing data under 10% but failed to remove all existing biases. The methodological exclusion of variables with over 10% missing values followed established procedures but this approach might have discarded important predictive variables which slightly limited the model's total predictive capability.

Subjectivity in ICU Admission Decisions

ICU admission decisions rely on factors that extend beyond medical criteria. The ICU admission process involves various elements including physician decisions and institutional rules as well as physical space availability and funding capabilities. The clinical practice relationships contain actual-world components but may include physician judgment biases together with institutional protocol influences (Khoushabar & Ghafariasl, 2024).

Clinical Implications

Emergency clinicians should use CRP, WBC, lactate, hypotension and GCS for making better decisions. These parameters are inexpensive, rapidly measurable, and routinely available, making them suitable for integration into existing triage workflows. The implementation of these factors in decision-support systems would help allocate ICU beds more effectively and reduce delayed treatment escalations to improve critical care results (Kemp et al., 2020).

Future Directions

Future studies need to confirm these results by using multicenter prospective studies while examining their use in different healthcare systems. Further research should assess the accuracy of standard tools NEWS and MEWS against red code patient-specific models. The development of an ICU risk scoring system for red code patients will help improve triage protocols and provide evidence-based support for decisions regarding emergency care resource optimization (Guan et al., 2024).

5. Conclusion

The research identified CRP, WBC, lactate, hypotension and GCS as independent factors that determine ICU admission for red code patients in the emergency department. The study demonstrates that these standard parameters enable early risk assessment and enhance the accuracy of triage decisions. The study proposes that CRP and WBC levels should be incorporated into red code triage protocols or early warning systems to assist emergency clinicians in identifying patients who require intensive care. The ability to predict ICU requirements better would lead to improved resource management and faster care escalation.

Conflict of Interest

The author states that no conflicts of interest exist regarding the publication of this study. The research had no financial or personal connections that could have improperly affected its conduct or reporting.

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