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Research Article

The Relationship Between the National Early Warning Score (NEWS) and Critical Care Unit Admission in Emergency Department: A Cross- Sectional Study

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Abstract

Purpose: The National Early Warning Score (NEWS) relates to the recovery and outcomes of emergency department (ED) patients. However, it is not known whether the NEWS score affects intensive care unit (ICU) admissions of ED patients.

Patients and methods: We performed a secondary analysis of a multinational, observational study (TRIAGE study, March 2013-October 2014) using data from the public DATADRYAD database. The subjects were selected according to inclusion and exclusion criteria. We employed multivariate logistic regression models to determine the relationship between the NEWS score and ICU admission of ED patients.

Results: A total of 1,278 patients were analyzed, of whom 168 (13.15%) were admitted to the ICU, with an age of 67±17 years. In contrast, 1,110 participants (86.85%) were not admitted to the ICU with an age of 65±18 years. In the non-adjusted model, the odds ratio (OR) of ICU admission was 1.25, and the 95% confidence interval (CI) was 1.17-1.34 ($p<0.01$). One unit increment in the NEWS could be interpreted with a 25% increment in the incidence of ICU admission. There was an increased risk for the prevalence of ICU admission as the cutoff point for the NEWS was elevated ($p<0.001$). Participants with higher NEWS scores had experienced more risk of ICU admission (OR=3.28, 95% CI: 2.06-5.22) ($p<0.01$).

Conclusion: The cross-sectional study of NEWS score independently associates with ICU admission among ED patients. The NEWS score evaluation provides a rapid, simple, and accurate screening method to improve the detection and response to clinical deterioration in ED patients.

Keywords: The NEWS score; Independently factor; ICU admissions; Emergency department patient

Introduction

The emergency department (ED) receives a large number of critically ill patients, whose physical condition is complex and progresses rapidly and severely. Moreover, there are more adverse outcomes in ED patients [1], including acute deterioration, sometimes unexpected cardiac arrest, and even death [2]. Therefore, a simple, rapid, and effective assessment tool is essential for the triage and referral of ED patients and evaluating whether need to be admitted to the intensive care unit (ICU) to reduce adverse outcomes [3]. In recent years, there has been an increasing amount of patient scoring systems have been used worldwide to assess the severity of the illness to predict the chances of hospitalization, ICU admission, and in-hospital mortality of ED patients [4]. The Modified Early Warning Score (MEWS), the Vital Pac Early Warning Score, the Rapid Emergency Medicine Score, the

electronic Cardiac Arrest Risk Triage (eCART) score, the newly designed National Early Warning Score (NEWS) are commonly used [5-8].

The National Early Warning Score (NEWS) and The National Early Warning Score 2 (NEWS2) were designed by the Royal College of Physicians to detect deteriorating patients in hospital wards, specifically those at increased risk of ICU admission, cardiac arrest, or death within 24 hours [9-11]. The NEWS was initially used to predict illness severity and deterioration in the hospital [9]. The NEWS enables the early identification and diagnosis of patient deterioration, timely action of the hospital's rapid response teams (RRTs), and consistent assessment of illness severity; it also provides useful baseline data to evaluate a patient's clinical progress [10]. Moreover, the NEWS is useful to standardize the assessment of acute illness and support urgency and competency of the clinical response and used to re-organize hospital services. The implementation of NEWS was associated with a significant improvement in patients' outcomes in hospital wards, increases in the frequency of vital signs measurements, and an increase in the number of medical reviews following clinical instability [12]. Recently, a study demonstrated that the NEWS is also a valuable tool for coronavirus disease 2019 (COVID-19) patients and recommended by the World Health Organization (WHO) during the COVID-19 pandemic [13]. NEWS2 support clinical judgment and provide a standardized communication tool that could be practically feasible in a short time scale, and in the context of strained resources and operational pressure faced by hospitals during the emergency phase of the COVID-19 pandemic outbreak.

Previous studies have concentrated on the relationship between the NEWS, mortality, and the prognostic value of using the NEWS with inflammatory blood markers or the Sequential Organ Function Assessment score [14]. Recent trends in NEWS studies [2,3] should focus on a simple, economic, and fast scanning tool to identify critically ill patients quickly and admit them to the ICU to improve the outcomes [4]. However, to the best of our knowledge, few numbers of cross-sectional studies were performed to determine the association between NEWS score and ICU admissions of ED patients. In this study, we aimed to conduct a secondary cross-sectional study using non-randomized cluster sampling and cross-sectional study and the data from a multinational observational cohort study conducted at three tertiary care hospitals by a public DATADRYAD database to clarify the relation of NEWS score and ICU admissions of ED patients and which may provide a basis for future planning the random grouping, experimental control, and prospective study of NEWS.

Material and Methods

Collection of data and score assignment

This study was a secondary analysis of data from a multinational observational cohort study conducted at three tertiary care hospitals in Aarau (Switzerland), Paris (France), and Clearwater (Florida, USA), from March 2013 to October 2014. The DATADRYAD database was used to obtain the data. We cited the DRYAD data package following protocols released in the DATADRYAD [15]. All adult internal medicine patients seeking emergency care at one of the participating hospitals were included in the study, while surgical and pediatric patients were excluded. The protocol and details regarding the study design have been published previously [16,17]. The patients in the original study were 1303, however, 25 patients were eliminated because of the research indicators missing. The final sample size was 1278, the details of the selection of the patients showed in Figure 1. When patients were admitted to the ED, a triage nurse in ED recorded their age, sex, vital signs, main clinical symptoms and complaints, and socio-demographic characteristics and following regular laboratory tests, MR-proADM, and Procalcitonin (PCT) determination and leftover blood samples for further analyses. The NEWS method was calculated as shown in the original study15 based on six parameters: respiratory rate, oxygen saturation, temperature, blood pressure, heart rate, and level of consciousness. As suggested by the Royal College of Physicians, Patients were classified into three NEWS categories: low (0-4points), moderate (5-6 points), high (≥7 points) risk. Additionally, as supplemental oxygen data were not available, the results of this study correspond to the NEWS-potentially minus 2 points, and detailed demographic data are shown in Table 1.

Figure 1.

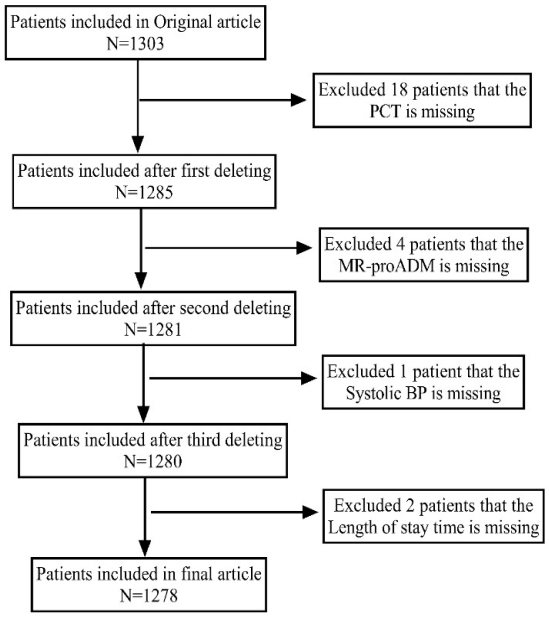

Figure 1: Flowchart of the patients selection.

Physiological Parameters	3	2	1	0	1	2	3
Temperature(℃)	<35.0		35.1–36.0	36.1–38.0	38.1–39.0	>39.0	
Heart rate (bpm)	<41		41–50	51–90	91–110	111–130	>130
Systolic blood pressure(mm/Hg)	<91	91–100	101–110	111–219			>219
Respiratory rate(bpm)	<9		9–11	12–20		21–24	>25
Oxygen saturation(%)	<92	92–93	94–95	>96			
Oxygen supplement		YES		NO			
Level of consciousness				A			V,P,U
Notes: A: Alert; V: verbal; P: pain; U: unresponsive; bpm: beats or breaths per minute							

Table 1: The National Early Warning Score (NEWS) calculation.

Statistical Analysis

Continuous variables were expressed as mean ±SD (for normally distributed outcomes) or median (IQR) (for non-normally distributed outcomes), and categorical variables were presented as frequencies and percentages. First, the relationship between the NEWS (or other variables) and ICU admission was assessed using multivariable logistic regression models. Non-adjusted, minimally adjusted, and multivariate-adjusted models were employed. In another separate analysis, the NEWS was included as a continuous and categorical variable. Unadjusted and adjusted odds ratios (ORs) with 95% confidence intervals (CIs) were calculated. We employed R programming and Empower Stats software18 to conduct the analyses, and the significance level was set at $p< 0.05$.

Results

The characteristics of selected patients

In this study, we included 1,303 patients in the original database, and out of which 25 patients with missing data were excluded. Finally 1,278 patients were analyzed, of whom 168 (13.15%) were admitted to the ICU, and 1,110 (86.85%) were not. The general information of the patients is shown in Table 2.

Characteristics	Total	NON-ICU	ICU	P-value	P-value*
		Admission	Admission		
N	1278	1110	168		
Gender n(%)				0.02	
Male	646 (50.55%)	547 (49.28%)	99 (58.93%)		
Female	632 (49.45%)	563(50.72%)	69 (41.07%)		
Age, years, Mean(SD)	65±18	64±18	67±17	0.087	0.083
Respiration rate, bpm, Mean(SD)	20±5	20±5	21±8	<0.01	0.016
SPO2, percent, Mean(SD)	96 ±4	97 ±3	95±7	<0.01	0.008
SBP, mmHg, Mean(SD)	141 ±30	142 ±30	137±33	0.038	0.025
DBP, mmHg, Mean(SD)	79±18	79±17	78±20	<0.01	0.058
Heart rate, bpm, Mean(SD)	86 ±21	85 ±20	91±27	0.007	0.004
Temperature, ℃, Mean(SD)	37±1	37±1	37±1	0.002	0.048

MR-pro ADM, nmol/L,	0.87 (0.62-1.48)	0.84 (0.21, 22.25)	1.37 (0.39,14.71)	<0.002	<0.01
median (IQR)					
PCT, μg/L, median (IQR)	0.08 (0.06-0.14)	0.08 (0.03,55.37)	0.11 (0.03,46.78)	<0.01	<0.01
Mental status, n(%)				0.124	-
Responsive	1235 (96.64%)	1076 (96.94%)	159 (94.64%)		
Unresponsive	43 (3.36%)	34(3.06%)	9 (5.36%)		
NEWS, median (IQR)	1.00 (0.00-16.00)	1.00 (0.00,16.00)	3.00 (0.00,10.00)	<0.01	<0.01
Notes: SD: standard deviation; IQR: interquartile range; bpm: beats or breaths per minute; mmHg :millimeters of mercury,SPO2: percutaneous oxygen saturation; SBP: systolic blood pressure; DBP: diastolic blood pressure; MR-pro ADM: midregional proadrenomedullin; PCT: procalcitonin, p-value: t-test, p-value*: u-test					

Table 2: Characteristics of the patients.

Univariate and multivariate analysis of influence factor in ICU admission

Demographic characteristics including gender, age, respiratory rate, saturation of peripheral oxygen(SPO2), systolic blood pressure(SBP), diastolic blood pressure(DBP), heart rate, temperature, MR-proADM, Procalcitonin (PCT), mental status, and NEWS. Univariate analysis showed gender,respiratory rate, SPO2, SBP, heart rate, temperature, MR-proADM, PCT, and NEWS to be possible risk factors for ICU admission ($p<0.05$). Multivariate analysis showed that gender and NEWS were the two factors associated with ICU admission ($p<0.05$). However, no statistical differences were observed with the other variables (Table 3).

Variable	Univariate	Multivariate
	β (95%CI) P-value	β (95%CI) P-value
Gender, n(%)		
Male	Ref	Ref
Female	0.68 (0.49, 0.94) 0.0203	0.67 (0.48, 0.95) 0.0250
Age	1.01 (1.00, 1.02) 0.0879	
Respiration rate ,bpm, mean±SD	1.04 (1.01, 1.07) 0.0029	1.00 (0.97, 1.03) 0.9321
SPO2, percent, mean±SD	0.92 (0.89, 0.95) <0.01	0.98 (0.94, 1.02) 0.2642
SBP, mmHg, mean±SD	0.99 (0.99, 1.00) 0.0386	1.00 (1.00, 1.01) 0.6619
DBP, mmHg, mean±SD	0.99 (0.99, 1.00) 0.2787	
Heart rate ,bpm, mean±SD	1.01 (1.01, 1.02) 0.0009	1.00 (0.99, 1.01) 0.5723
Temperate,℃, mean±SD	1.42 (1.14, 1.77) 0.0018	1.24 (0.99, 1.55) 0.0574
MR-proADM, nmol/L, median (IQR)	1.33 (1.21, 1.46) <0.01	
PCT,μg/L, median (IQR)	1.08 (1.03, 1.13) 0.0014	1.02 (0.97, 1.07) 0.4854
Mental status, n(%)		
Responsive	Ref	
Unresponsive	1.79 (0.84, 3.81) 0.1293	
NEWS , median (IQR)	1.25 (1.17, 1.34) <0.01	1.17 (1.05, 1.29) 0.0030

Table 3: Univariate and multivariate analysis of factors in ICU-Admission.

Multivariable logistic regression model to determine the relation between NEWS score and ICU admission in ED patients

The results of multivariable logistic regression are shown in Table 4. In the non-adjusted model, the OR was 1.25, and the 95% CI was 1.17-1.34. A unit increase in the NEWS could be interpreted as leading to a 25% increase in the incidence of ICU admission. Patients were classified into three NEWS categories: low (0-4points), moderate (5-6 points), high (≥7 points)risk and calculated the p-value for the trend. There was an increased risk for the prevalence of ICU admission as the cutoff point for the NEWS was elevated (p<0.001). Participants who had a higher NEWS experienced an elevated risk of ICU admission (OR= 3.28, 95% CI: 2.06-5.22). Intuitively, supplemental oxygen data have an extraordinary effect on the overall NEWS scores. To explore the effect of supplemental oxygen data on the overall NEWS scores, we had performed an additional adjusted regression model to determine the differences between NEWS scores without supplemental oxygen as non-adjusted model 1 and the NEWS-potentially add 2 points with supplemental oxygen as an adjusted model. In Table 5, the results show that OR (95% CI): 1.25 (1.17, 1.34) in Non-adjusted Model 1, and respectively 1.25(1.17, 1.33). Therefore, we concluded that supplemental oxygen or not in ED patients might not affect OR values in the relationship between ICU admission and NEWS score.

Variable	Non-adjusted Mode l	Adjust Model I	Adjust Model II
	OR (95%CI) p-value	OR (95%CI) p-value	OR (95%CI) p-value
NEWS	1.25 (1.17, 1.34) <0.01	1.25 (1.17, 1.33) <0.01	1.16 (1.03, 1.31) 0.0158
NEWS classifications			
T0(≤4)	1	1	1
T1(5-6)	1.34 (0.80, 2.22) <0.01	1.33(0.80, 2.21) <0.01	1.06 (0.61, 1.83) <0.01
T2(≥7)	3.28 (2.06, 5.22) <0.01	3.18 (1.99, 5.08) <0.01	1.79 (0.97, 3.30) <0.01
P for trend	<0.01	<0.01	<0.05
Notes: NEWS: National Early Warning Score; ICU admission: intensive care unit admission; CI: confidence interval; OR, odds ratio; Model I adjusted for age, sex; Model II adjusted for age, gender, respiratory rate, SPO2, heart rate, temperature, MR-proADM, PCT, mental status, SBP and DBP			

Table 4: The relation between the NEWS and ICU admission in a multiple regression model.

Variable	Non-adjusted Mode l	Adjust Model I	Adjust Model II
	OR (95%CI) p-value	OR (95%CI) p-value	OR (95%CI) p-value
NEWS	1.25 (1.17, 1.34) <0.01	1.25 (1.17, 1.33) <0.01	1.16 (1.04, 1.30) 0.0101
NEWS three classifications			
T0(≤4)	1	1	1
T1(5-6)	1.83 (1.22, 2.76) <0.01	1.77 (1.18, 2.68) <0.01	1.52 (1.03, 2.40) <0.01
T2(≥7)	4.42 (2.96, 6.58) <0.01	4.36 (2.92, 6.53) <0.01	3.03 (1.63, 5.65) <0.01
P for trend	<0.01	<0.01	<0.01
Notes: NEWS: National Early Warning Score; ICU admission: intensive care unit admission; CI: confidence interval; OR, odds ratio; Model I adjusted for age, sex; Model II adjusted for age, gender, respiratory rate, SPO2, heart rate, temperature, MR-proADM, PCT, mental status, SBP and DBP			

Table 5: The relationship between the NEWS with or without oxygen supplement and ICU admission in a multiple regression model.

Discussion

Early detection of clinically unstable emergency department patients is the cornerstone in improving the patient, If you do not find in time, and delays in the ED patients associate with unplanned admissions or readmissions to ICU, cardiac arrests, and even unexpected

deaths. This study aimed to clarify the relationship between the NEWS and ICU admission in patients in the ED in the setting of cross-sectional analysis. The major finding of our study lies that the NEWS was independently associated with ICU admission in patients in the ED. The multiple regression analysis performed in the current research indicated that the NEWS noticeably influenced ICU admission, and the result is consistent with that of some other studies. One of the results from retrospective cohort studies data with the hospitalized population showed that the NEWS is more accurate at predicting 10-day and 30-day mortality than the qSOFA and Systemic Inflammatory Response Syndrome (SIRS) in patients admitted to the ED with suspected sepsis [14]. In addition, the NEWS can effectively predict the risk of admission in ICU of sepsis patients [19]. A tertiary hospital in South China including 383 patients clearly showed that the area under the receiver operating characteristic (ROC) curve of the MEWS for in-hospital mortality prediction was 0.83 (95% CI: 0.786–0.881). This study used a prospective study design and provided a new cut-off point for the MEWS using the ROC curve to increase sensitivity in predicting in-hospital mortality and ICU admission [5]. Alhmoud's study [20], concluded the same, as it was found through this study that pre-hospital NEWS was associated with death or critical care unit escalation within 48 hours of hospital admission, the NEWS could be used with ED patients to evaluate whether the patients require hospital treatment or rapid transport.

Most interestingly, controversy exists about the NEWS. Some scholars have concluded that the NEWS has poor predictive powers for 28-day mortality in patients who activate the medical emergency team (MET). A new scoring system is needed to compare the diagnosis and prognosis of patients who activate the METs [2]. Aprospective cohort (SNOOPII study) also did not support the use of the NEWS to predict the in-hospital mortality risk of sepsis in medical wards [3]. One study including 85,322 patients (42,402 patients pre-NEWS and 42,920 patients post-NEWS implementation) found that the first outcome of ICU admission rate or death rate did not change after the NEWS implementation [21]. Asystematic review showed that the methodology and quality of validation studies of the NEWS are insufficient to recommend its use in all diseases and all clinical settings despite the good performance of the NEWS in some subgroups. There is an urgent need for consistent studies following consensus guidelines for the NEWS [22].

Many attempts have been made to increase the sensitivity and specificity of the NEWS for predicting mortality and ICU admission. Chiu [22], conducted a study on a large sample (13,631 individuals) of patients discharged from the ICU after risk-stratified cardiac surgery in four centers and added some vital signs to generate a logistic version of the NEWS, which he found did better at determining deaths due to cardiac surgeries, cardiac arrest, or unplanned readmission to intensive care. Logistic scores also provided an assessment tool for predicting risk factors, in which the original NEWS AUC scored 0.779 (0.771–0.786) vs. 0.754 (0.746–0.761), $p < 0.001$ for 24 hours and 6 hours, respectively. However, the logistic scores for these time periods were 0.841 (0.829–0.853) vs. 0.813 (0.800–0.825), $p< 0.001$, respectively. Andreas Eckart's15research showed that the NEWS is helpful in risk stratification of ED patients and can be further improved by the addition of inflammatory blood markers. The Japanese investigators used the NEWS and the Classification and Regression Tree (CART) machine learning method to analyze the predictive weight of parameters for the outcomes and found that the NEWS was highly associated with 30-day mortality and ICU admission after RRT/MET calls [23]. Another study suggest that combination the NEWS with the triage system increase the capacity to separate those patients with conditions that had the potential to worsen, despite previously being classified otherwise [24,25].

In Table 5, we concluded that supplemental oxygen or not in ED patients might not affect OR values in the relationship between ICU admission and NEWS score. The reason for this may lies in the setting of that oxygen supplement in patients with low NEWS scores (severe case) do not affect the key scoring items of the NEWS system, whereas oxygen intake in patients with high scores (mild case) do not determine overall NEWS scores including the decrement of respiration rate, SPO2, SBP, DBP as a categories variable. We could conclude supplemental oxygen is not an independent variable to determine the ED patients' ICU admission, but overall NEWS score is independent variable.

To the best of our knowledge, we firstly clarified that NEWS score is a rapid, simple, and accurate screening tool to determine the ED patient's ICU admission by a cross-sectional study which data integrated from three large, independent, multicenter of clinical research. The NEWS or rapid response systems, which are assigned to clinical measurements and used to distinguish patients who need clinical review or resuscitation, are increasingly and commonly used in United Kingdom hospitals and primary health care settings [25]. Many studies have shown that the NEWS combined with inflammatory blood markers, the triage system, or the CART machine learning method improved sensitivity and specificity for predicting in-hospital mortality and ICU admission. However, some scholars advise that future studies be undertaken to validate this conclusion.

Limitation

This study is a cross-sectional study but not a complete cohort study. The method in this study was non-randomized cluster sampling and cross-sectional study and the data from a multinational observational cohort study. Therefore, the extrapolation of the conclusion of NEWS score as a screening tool to determine the ED patient's ICU admission in all settings

should be carefully adopted. In addition, we could not obtain the exact data on oxygen therapy in the observational cohort study. In the process of data processing, we reduced the overall NEWS score by 2 points in the data processing, resulting in a low score of the NEWS. Therefore, there may be some deviation. Oxygen therapy might not affect OR values in the relationship between ICU admission and NEWS score. In view of this, the random grouping, experimental control, and prospective study will be the future planned work.

Conclusion

The current research clarified that the NEWS is independently associated with ICU admission in patients in ED.A unit increase in the NEWS could be interpreted as leading to a 25% increase in the incidence of ICU admission. The study provides evidence and methods for future research on the NEWS in ED patients.

Data availability statement

The datasets presented in this study can be accessed via the DRYAD data repository at http://datadryad.org/ with the doi:10.5061/dryad.d22q6vh.

Ethics statement

 Ethical approval was issued by the Ethics Committee of The First People's Hospital of Changde City (2018-035-09).

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Contribution

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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