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The Ability of Early Warning Scores to Predict Mortality in Covid-19 Pneumonia

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ABSTRACT

Objective: Early recognition of critical patients is crucial in emergency departments. Many scoring systems are used for it. This study aim determining the prognostic values of these scoring systems for Covid-19 patients. **Materials and Methods:** This retrospective study was performed between March 2020 -May 2020. 212 patient who have Covid-19 pneumonia were enrolled. National Early Warning Score (NEWS), Modified Early Warning Score (MEWS) and quick Sequential Organ Failure Assessment (qSOFA) scores were calculated according to patients' admission data. Receiver operating characteristic (ROC) analysis was used to determine the diagnostic values of scores and the optimum cut-off values were determined by Youden Index. **Results:** Twenty-three (10.84%) of 212 patients died and 34 (16%) were admitted to ICU. The AUC values of MEWS, NEWS, and qSOFA for predicting mortality in < 65 years old were 0.852 (95% confidence interval 0.708-0.997), 0.882 (0.741-1.000) and 0.879 (0.768-0.990) and ≥65 years old 0.854(0.720-0.987), 0.931(0.853-1.000), 0.776(0.609-0.944) respectively. For ICU admission AUC values of MEWS, NEWS and qSOFA in <65 years old followed as; 0.882(0.783-0.981), 0.914(0.817-1.000), 0.868(0.764-0.973) and 0.845(0.725-0.965), 0.926(0.854-0.998), 0.815(0.676-0.954) in ≥ 65 years old. MEWS and qSOFA optimal cut-off values for mortality were ≥2 with 90.0% sensitivity 74.7% specificity and ≥1 with 90.9% sensitivity 78.1% specificity for <65 years, NEWS optimal cut-off is ≥6 with 91.7% sensitivity and 76.7% specificity for ≥ 65 years. **Conclusion:** These scores have good predictive value for mortality and ICU admission, but NEWS is better especially in ≥ 65 years old patient with Covid-19 pneumonia.

Keywords: Prediction, Covid-19, Pneumonia, Mortality.

Erken Uyarı Skorlarının Covid-19 Pnömonisinde Ölüm Oranlarını Öngörme Yeteneği

ÖZ

Amaç: Acil servislerde kritik hastaların erken tanınması önemlidir. Bunun için birçok puanlama sistemi kullanılmaktadır. Bu çalışma, bu sistemlerin Covid-19 pnömonisinde prognostik değerlerini incelemiştir. **Gereç ve Yöntem:** Bu retrospektif çalışma Mart 2020- Mayıs 2020 tarihleri arasında yapıldı. Çalışmaya Covid-19 pnömonisi olan 212 hasta dahil edildi. Hastaların National Early Warning Score (NEWS), Modifiye Early Warning Score (MEWS) ve quick sequential organ failure assesment (qSOFA) puanları hesaplandı. Tanısal değerlerinin belirlenmesinde ROC analizi kullanıldı. Optimum eşik değerleri Youden İndeksi ile belirlendi. **Bulgular:** Toplam 212 hastanın 23'ü (%10.84) öldü, 34'ü (%16) yoğun bakıma alındı. MEWS, NEWS ve qSOFA'nın 65 yaş altı ölüm oranını öngörmeye yönelik eğri altında kalan alanları sırasıyla 0.852 (%95 güven aralığı 0.708-0.997), 0.882 (0.741-1.000) ve 0.879 (0.768-0.990) ve 65 yaş üstü hastalarda ise sırasıyla 0.854 (güven aralığı 0.720-0.987), 0.931(0.853-1.000), 0.776(0.609-0.944) idi. MEWS, NEWS ve qSOFA'nın yoğun bakım yatışını öngörme değerleri 65 yaş altı için sırasıyla 0.882(0.783-0.981), 0.914(0.817-1.000), 0.868(0.764-0.973) iken 65 yaş üstü hastalar için 0.845(0.725-0.965), 0.926(0.854-0.998), 0.815(0.676-0.954) idi. Ölüm oranı için optimal eşik değerleri 65 yaş altında; MEWS ≥2 (%90 duyarlılık, %74.7 özgüllük), qSOFA ≥1 (%90.9 duyarlılık, %78.1 özgüllük) iken 65 yaş üstü hastalarda NEWS ≥6 (%91.7 duyarlılık, %76.7 özgüllük) bulundu. **Sonuç:** Bu skorlar ölüm ve yoğun bakım yatış oranını öngörmede değerli bulunmuştur, ancak NEWS skorunun özellikle 65 yaş üstü Covid-19 pnömonisi olan hastalarda daha iyi bir gösterge olduğu görülmüştür.

Anahtar Kelimeler: Tahmin, Covid-19, Pnömoni, Ölüm Oranı.

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INTRODUCTION

Since the first coronavirus case was detected in Wuhan in December 2019, this new and rapidly spreading infection has become a global health problem (Yang et. al., 2020). Today, the number of cases has reached over 300 million and the number of deaths over 5 million (World Health Organization [WHO], 2022). This novel coronavirus named as COVID 19 that causes mild to moderate respiratory illness (Chen et al., 2020). Symptoms are usually fever, cough, tiredness, sore throat, headache, loss of taste or smell, dyspnea, chest pain. Clinical presentation is compatible with viral pneumonia and older people who have comorbidities are more likely to develop serious conditions (Chen et al., 2020; World Health Organization [WHO], 2021; Yang et al., 2020).

With the increasing the number of cases and deaths, especially critical cases should be early recognized by the health care provider in the emergency department. In this context, it is important to determine critical patients who need close care in these overcrowded settings. Many scoring systems based on patients' vital parameters are used to identify critical patients in emergency department (Liu et al., 2020; Yap et al., 2019). One of the most common scoring system is National Early Warning Score (NEWS) and it is based on patients respiratory rate (RR), SpO2 %, oxygen need, temperature (°C), systolic blood pressure (SBP) mmHg, hearth rate (HR) and level of consciousness using AVPU system (A=Alert, V=responds to voice, P=responds to pain, U=unresponsive) (Smith et al., 2013). To date, the NEWS score has been used for infectious and non-infectious conditions to determine critically ill patients, mortality and intensive care admissions (Brabrand & Henriksen, 2018; Liu et al., 2020; Yap et al., 2019). Another scoring system is Modified Early Warning System (MEWS). This scoring system has five parameters that include SBP, HR, RR, temperature and AVPU score and has been found to be useful for pneumonia (Jo et al., 2016; Scubbe et al., 2001). Quick Sequential Organ Failure Assessment (qSOFA) is another illness severity assessment score that especially used in sepsis (Evans et al., 2021). This score has three criteria, SBP (<100 mmHg), tachypnea (>22 /min) and Glasgow Coma Scale (GKS <15). In many studies qSOFA is used and compared with other scoring systems in patients with pneumonia, one of the leading causes of sepsis, to determine intensive care unit admission and mortality and found eligible to use for infectious conditions (Evans et al., 2021; George et al., 2019; Jiang et al., 2018; Liu et al., 2020; Tokioka et al., 2018; Yap et al., 2019; Zhang et al., 2020).

Although these rapid scoring systems seems to be a good predictor for mortality and intensive care unit (ICU) admission for infectious diseases, it is still unclear for patients with COVID 19 pneumonia. Calculating these scoring systems is quick and easy at the emergency department. We aim to asses and compare these rapid scoring systems' prognostic value (MEWS, NEWS and qSOFA) and to determine the optimal cut-off values for patients with COVID 19 pneumonia.

MATERIALS AND METHODS

Study type

This retrospective and observational study was carried out between 15 March 2020 and 15 May 2020 at emergency department of a tertiary hospital in Istanbul.

Study group

Patients >18 years old and have first diagnosed COVID 19 pneumonia with positive Real Time-Polymerase Chain Reaction (RT-PCR) test at admission and got no prior treatment were included in our study. Exclusion criteria is as follows; <18 years old, pregnancy, negative RT PCR test and missing data.

Procedures

Real Time-PCR test with nasopharyngeal swab was performed in our hospital's microbiology laboratory. Patients with radiological findings of pneumonia were considered as pneumonia (Bernheim et al., 2020). Patients with shock findings requiring vasopressor, need for invasive or non-invasive mechanical ventilation and worsening of consciousness were admitted to the intensive care unit. The all data of the patients were obtained from the hospital database and "www.mdcalc.com" website was used to calculate the NEWS, MEWS and qSOFA scores. The primary outcome is predicting in hospital mortality and ICU admission rate, secondary outcome is comparison of the prognostic values of scores and determinate the optimal cut off values.

Statistical analysis

For the statistical analysis of data, IBM SPSS version 20 (Armonk, NY: IBM Corp.) package program was used. Descriptive statistics of continuous variables were presented as mean ± standard deviation or median (minimum-maximum) value. Numbers and percentages were used for summarizing the categorical variables. Depending on the frequency of the data, Chi-square test or Fisher Exact test was used for analysis of categorical variables. The compliance of continuous variables to normal distribution in the study groups was tested with the Shapiro-Wilk test. Group comparison of normally distributed variables was compared with the independent samples t test, and variables that did not show normal distribution were compared with the Mann Whitney U test. ROC analysis was used to determine the diagnostic values of MEWS, NEWS, and qSOFA scores to indicate ICU admission and mortality rates. Curves and area under the curve (AUC), sensitivity and specificity values were presented. Youden index was used to determine the optimum cut-off values of the scores. A value of $p<0.05$ was considered statistically significant in all analyzes.

Ethical considerations

The study was approved by the local Ethical Committee of Şişli Hamidiye Etfal Training and Research Hospital (approval number and date:2989-22.09.2020).

RESULTS

Total 212 patients who have pneumonia and positive RT-PCR test were enrolled the study. The flow-chart of the study is shown in Figure 1. The mean age was 55.41±15.22 (range: 19-89) and 114 of the patients were male (53.77%), 98 were female (46.22%). The number of patients who died and admitted to ICU were 23 (10.84%) and 34 (16.03%) respectively.

Mortality

The mean age was 64.43±13.17 and higher in the mortality group (p=0.003). While 17 (14.91%) of the male patients died, 6 (6.12%) of the female patients died (p=0.040). Hearth rate mean was 101.0 ± 13.34 in mortality group and 84.23±12.42 was in alive group (p < 0.001). Respiratory rate median was 28.0 (12.0-44.0) in mortality group and 16.0(12.0-48.0) in alive group (p<0.001). All scores were higher in the mortality group (p<0.001), spO2 mean was 91.0% (65.0-98.0) and it was low according to the alive group (p<0.001) (Table 1). While the rate of coronary artery disease in the mortality group was 26.08% (n=6), it was 10.58 % (n=20) in the alive group (p=0.032). Dyspnea rates were 60.86% (n=14) in the mortality group and 19.57% (n=37) in the alive group (p<0.001).

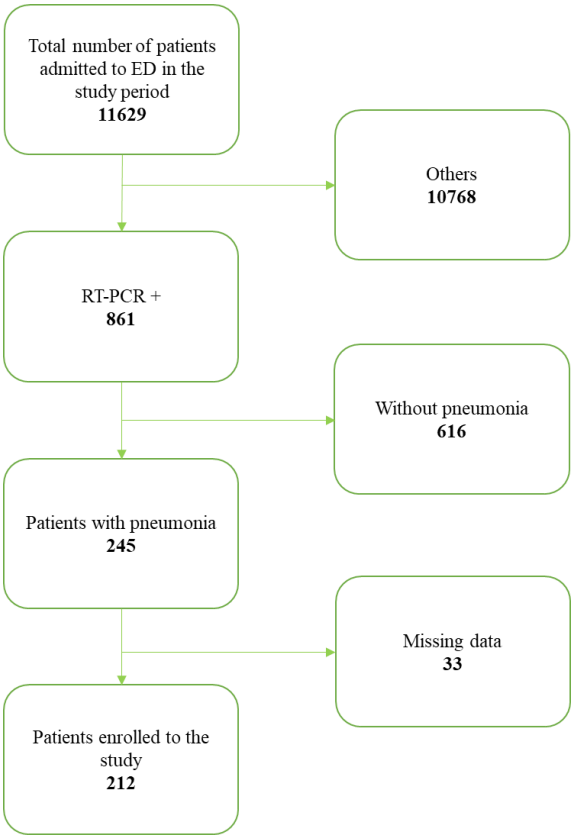

Figure 1. The flow chart of the study. ED: emergency department, RT-PCR: real time polymerase chain reaction.

Table 1. Vital parameters and total scores of alive and mortality groups.

Parameters	Status		p
	Alive	Mortality	
Age	54.32±15.14	64.43±13.17	0.003*
SBP mmHg	120.0(90.0-183.0)	127.0(75.0-165.0)	0.474
DBP mmHg	80.0(53.0-119.0)	75.0(53.0-89.0)	0.063
Temperature °C	36.8(35.8-39.5)	37.0(36.0-38.7)	0.072
SpO_2 %	97.0(82.0-100.0)	91.0(65.0-98.0)	<0.001
Heart rate bpm	84.23±12.40	101.0±13.33	<0.001*
RR bpm	16.0(12.0-48.0)	28.0(12.0-44.0)	<0.001
Stay of hospital (day)	7.0(1.0-60.0)	13.0(2.0-53.0)	0.005
MEWS	1.0(0.0-7.0)	4.0(0.0-7.0)	<0.001
NEWS	1.0(0.0-13.0)	10.0(0.0-16.0)	<0.001
qSOFA	0.0(0.0-2.0)	1.0(0.0-3.0)	<0.001

Results were presented as mean ± standard deviation or median (minimum-maximum). *Independent samples t test was performed, otherwise Mann Whitney U test was used. SBP= Systolic Blood Pressure, DBP= Diastolic Blood Pressure, RR= Respiratory rate, MEWS= Modified Early Warning Score, NEWS= National Early Warning Score, qSOFA= quick sequential organ failure assessment.

Admission to ICU

The mean age was 63.38±12.52 in ICU admission group and 53.89±15.21 was in non-ICU (p=0.001). Diastolic blood pressure mean was 80.0 (60.0-119.0) mmHg in non-ICU group and 71.5 (53.0-90.0) in ICU group (p=0.014). Oxygen saturation mean was 97.0% (88.0-100.0) in non-ICU, 90.5% (65.0-98.0) in ICU group (p <0.001). Body temperature was higher in ICU group [for non-ICU 36.8 °C (35.8-39.5), for ICU 37.1 °C (36.0-38.8)] (p <0.001). Hearth rate and respiratory rate were higher in the ICU group, [96.0 (68.0-125.0), 28.0 (12.0-48.0) respectively] (p <0.001). While MEWS' median was 3.5 (0.0-7.0) in ICU group, 1.0 (0.0-5.0) was in non-ICU patients (p <0.001). The NEWS' median was 10.0 (0.0-16.0) for ICU admission group and 1.0 (0.0-10.0) for non-ICU

group (p<0.001). And there was also statistical difference for median qSOFA scores between ICU and non-ICU group [1.0 (0.0-3.0) for ICU, 0.0 (0.0-2.0) for non-ICU] (p <0.001) (Table 2). Considering other factors that affecting the mortality of patients in ICU group and non-ICU, the rate of coronary artery disease was 23.52% (n=8) in the ICU group, and 10.11% (n=18) in the non-ICU group (p<0.029). Dyspnea rates were 52.94% (n=18) in the ICU group, 18.53% (n=33) in the non-ICU group, respectively (p<0.001).

Table 2. Vital parameters and total scores for non-ICU and ICU.

Parameters	Status		p
	Non-ICU	ICU	
Age	53.89±15.21	63.38±12.52	0.001*
SBP mmHg	120.0(90.0-180.0)	132.0(75.0-183.0)	0.106
DBP mmHg	80.0(60.0-119.0)	71.50(53.0-90.0)	0.014
Temperature °C	36.80(35.80-39.50)	37.10(36.0-38.80)	0.005
sPO_2 %	97.0(88.0-100.0)	90.50(65.0-98.0)	<0.001
Heart rate bpm	84.0(50.0-124.0)	96.0(68.0-125.0)	<0.001*
RR bpm	16.0(12.0-30.0)	28.0(12.0-48.0)	<0.001
MEWS	1.0(0.0-5.0)	3.50(0.0-7.0)	<0.001
NEWS	1.0(0.0-10.0)	10.0(0.0-16.0)	<0.001
qSOFA	0.0(0.0-2.0)	1.0(0.0-3.0)	<0.001

Results were presented as mean ± standard deviation or median (minimum-maximum). *Independent samples t test was performed, otherwise Mann Whitney U test was used. SBP= Systolic Blood Pressure, DBP= Diastolic Blood Pressure, RR= Respiratory rate, MEWS= Modified Early Warning Score, NEWS= National Early Warning Score, qSOFA= quick sequential organ failure assessment, ICU= Intensive Care Unit.

Diagnostic accuracy

The overall analysis of MEWS, NEWS and qSOFA scores according to ICU admission, mortality, <65 and ≥ 65 years old have been shown in Table 3. The diagnostic accuracy of NEWS, MEWS and qSOFA was calculated and optimal cut-off value determined by using Youden Index. The ROC analysis of scores shown in Figure 2. For <65 years old patient MEWS ≥ 2 showed the best accuracy to predict mortality and AUC 0.852 (95% CI=0.708-0.997), sensitivity 90.9%, specificity 74.7% respectively.

Table 3. The overall analysis of MEWS, NEWS and qSOFA scores.

		Age	AUC(95% CI)
Mortality	**MEWS**	<65	0.852(0.708-0.997)
		≥65	0.854(0.720-0.987)
	NEWS	<65	**0.882(0.741-1.000)**
		≥65	**0.931(0.853-1.000)**
	qSOFA	<65	0.879(0.768-0.990)
		≥65	0.776(0.609-0.944)
ICU admission	**MEWS**	<65	0.882(0.783-0.981)
		≥65	0.845(0.725-0.965)
	NEWS	<65	**0.914(0.817-1.000)**
		≥65	**0.926(0.854-0.998)**
	qSOFA	<65	0.868(0.764-0.973)
		≥65	0.815(0.676-0.954)

MEWS= Modified Early Warning Score, NEWS= National Early Warning Score, qSOFA= quick sequential organ failure assessment, AUC= Area Under the Curve, CI= Confidence Interval, ICU= Intensive Care Unit

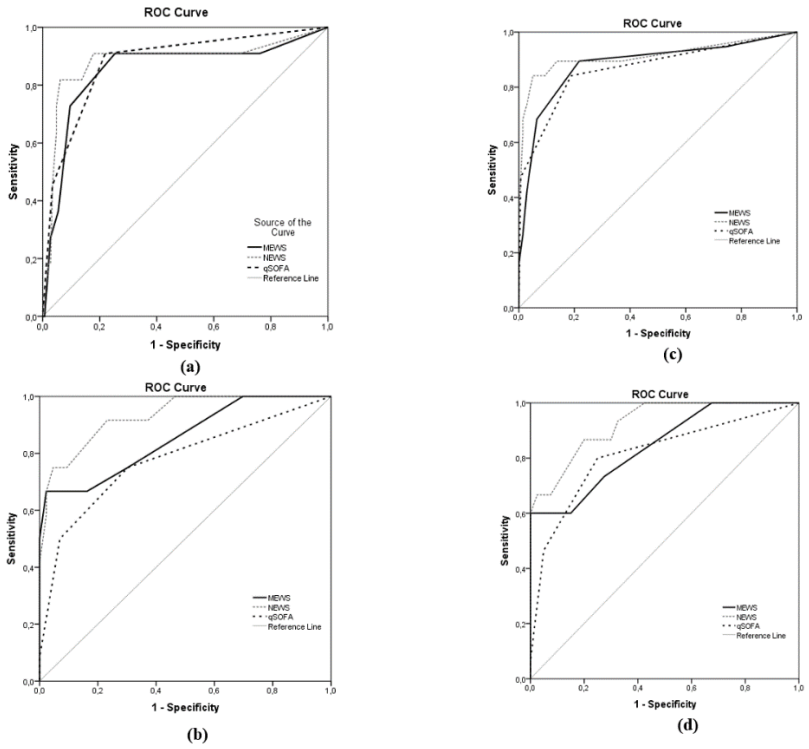

Figure 2. ROC of NEWS, MEWS and qSOFA prediction mortality and ICU admission. (a) ROC of NEWS, MEWS and qSOFA to predict mortality for <65 years old (b) ROC of NEWS, MEWS and qSOFA to predict mortality for >65 years old (c) ROC of NEWS, MEWS and qSOFA to predict ICU admission for <65 years old (d) ROC of NEWS, MEWS and qSOFA to predict ICU admission for >65 years old.

For >65 years old optimal cut-off value for MEWS to predict mortality is ≥4 with AUC 0.854(95% CI= 0.720-0.987), sensitivity 66.7% and specificity 97.7%. NEWS optimal cut-off to predict mortality for <65 years old is ≥7, >65 years old is ≥6 and AUC, sensitivity, specificity follow as; [0.882 (95% CI=0.741-1.0) 81.8%, 93.8%], [0.926 (95% CI=0.854-0.998), 91.7%, 76.7%] respectively.

Table 4. The diagnostic accuracy of the MEWS, NEWS and qSOFA <65 and ≥65 years old patients and optimal cut-off values.

		Age	AUC (95% CI)	Cut-off point*	Sensitivity (%)	Specificity (%)
Mortality	MEWS	<65	0.852(0.708-0.997)	≥2	90.9	74.7
		≥65	0.854(0.720-0.987)	≥4	66.7	97.7
	NEWS	<65	0.882(0.741-1.0)	≥7	81.8	93.8
		≥65	0.926(0.854-0.998)	≥6	91.7	76.7
	qSOFA	<65	0.879(0.768-0.990)	≥1	90.9	78.1
		≥65	0.776(0.609-0.944)	≥1	75	69.8
ICU admission	MEWS	<65	0.882(0.783-0.981)	≥2	89.5	78.3
		≥65	0.845(0.725-0.965)	≥4	60	100
	NEWS	<65	0.914(0.817-1.0)	≥6	84.2	94.9
		≥65	0.926(0.854-1.0)	≥6	86.7	80
	qSOFA	<65	0.868(0.764-0.973)	≥1	84.2	81.2
		≥65	0.815(0.676-0.954)	≥1	80	75

MEWS= Modified Early Warning Score, NEWS= National Early Warning Score, qSOFA= quick sequential organ failure assessment AUC= Area Under the Curve, CI= Confidence Interval, ICU= Intensive Care Unit.

For qSOFA both <65 and ≥65 years old cut-off point determined as ≥1 and < 65 years old AUC, sensitivity, specificity 0.879 (95% CI=0.768-0.990), 90.9%, 78.1% and ≥ 65 years old 0.776 (95% CI=0.609-0.944), 75.0%, 69.8% respectively. Considering the power of scores to determine the ICU admission for <65 years old patient, optimal cut-off values, sensitivity, specificity follow as; MEWS ≥2 [AUC 0.882 (95% CI=0.783-0.981), 89.5%, 78.3%], NEWS ≥6 [AUC 0.914 (95% CI=0.817-1.0), 84.2%, 94.6%], qSOFA ≥1 [AUC 0.868 (95% CI=0.764-0.973), 84.2%, 81.2%] respectively. For ≥ 65 years old patient the optimal cut-off values, AUC, sensitivity, specificity to admission ICU follow as; MEWS ≥4 [AUC 0.845 (95% CI=0.725-0.965), 60.0%, 100.0%], NEWS ≥6 [0.926 (95% CI=0.854-1.0), 86.7%, 80%], qSOFA ≥1 [AUC 0.815 (95% CI= 0.676-0.954), 80.0%, 75.0%]. The accuracy of the NEWS ≥6 is better to determine ICU admission for >65 years old patient. All optimal cut-off values, AUC, sensitivity, specificity shown in Table 4.

DISCUSSION

The Covid-19 pandemic continues to be a health problem worldwide and many risk factors related to this disease are reported. Especially coronary artery disease, older age, diabetes, chronic respiratory disease, hypertension are the most common risk factors for mortality in Covid-19 patients (Bernheim et al., 2020; Chatterjee et al., 2020; Covino et al., 2020; Yang et al., 2020;). In our study, coronary artery disease, older age were significant risk factors for mortality and ICU admission. Also, several findings like dyspnea, tachypnea, lower spO2 rates, associated with mortality and ICU admission have been reported in previous studies. Hai Hu and colleagues showed that dyspnea, respiratory rate and lower sPO2 rates were associated with mortality (Jordan et al., 2020). Covino and his colleagues showed also there were higher respiratory rate and lower sPO2 in patient with mortality and ICU admission (Covino et al., 2020). In our study, respiratory rate, low oxygen saturation, increased heart rate and increased body temperature were associated with mortality and intensive care unit admission. While there was no significant difference in SBP and DBP between alive and death group, there was difference in DBP between ICU and non-ICU group. Some previous studies on Covid-19 showed that systolic blood pressure is a risk factor for mortality (Jordan et al., 2020; Yang et al., 2020). However, In the study of Covino et al. there were no statistical difference in SBP or DBP between mortality or ICU admission. In this context, it can be considered that not only SBP also DBP is a parameter that indicates the deterioration of patients at the ED admission.

Considering the overall analysis of the scores; although all three scoring systems predict mortality and ICU admission, the NEWS appears to be more distinctive with a larger AUC area in both < 65 and ≥ 65 years old subgroups. Several studies showed the NEWS accuracy in infectious condition like pneumonia (Brabrand & Henriksen, 2018; Hu, Yao & Qiu, 2020; Liu et al., 2020; Smith et al., 2013; Yap et al., 2019). In Vincent et al.' study conducted with 773477 patients, it was found that the NEWS score is more discriminative than MEWS, qSOFA and SIRS, especially in infectious patients (Liu et al, 2020). In a recently published study by Saberian et al. comparing NEWS, qSOFA and PRESEP scores in Covid-19, the NEWS score was found to be more accurate in predicting both intensive care admission and mortality (Churpek et al., 2017). The NEWS score stands out compared to other scores, especially in lung infections such as Covid-19 pneumonia, because it includes parameters such as oxygen saturation and supplementary oxygen demand. The optimal cut-off points of these scores were determined for patients under 65 years of age and above by using Youden index. Knowing the optimal cut-off points is important in determining which patient will deteriorate in this overcrowding setting. In Covino et all.' study NEWS > 4 has 81.0% sensitivity and 70.9% specificity with AUC 0.829 for mortality in 48 hours and NEWS >5 has 57.7% sensitivity, 61.0% specificity with AUC 0.768 for 7 days mortality, and also they showed that NEWS is better to predict ICU admission according to other scores such as MEWS, NEWS2, qSOFA, TRIAGE, REMS (Chatterjee et al., 2020). Also, Saberian et al. showed that NEWS > 6 has good NPV for mortality and NEWS >2 has the best sensitivity and NPV for ICU admission (Churpek, 2017). However, in our study there are some differences between cut-off points for <65 years and >65 years old subgroups. While the best accuracy to predicting mortality in <65 years old patients is NEWS ≥7, <65 years old is NEWS ≥6. For ICU admission the cut-off values same and was ≥6 for each age group. Cut-off point for mortality is lower in elder group so that the age factor may be considerable additionally the other NEWS' parameters. In another study comparing MEWS and REMS scores in Covid-19 pneumonia showed that MEWS has acceptable AUC (<65 years 0.603 95% CI=0.462-0.732 and >65 years old 0.708 95% CI= 0.562-0.828 respectively) to predict mortality for <65 years old and ≥ 65 years old patient, the optimal cut-off value was same and >1 for each group (Jordan et al., 2020). In our study we found better accuracy for MEWS especially in < 65 years old group and the optimal cut-off value was ≥2 for both mortality and ICU admission with 90.0% and 89.5% sensitivity respectively. In this context MEWS prediction performance is better in younger than 65 years old patient with Covid-19 pneumonia. Quick sequential organ failure assessment (qSOFA) score is used for early identification of patients at high risk of death due to sepsis and qSOFA ≥2 is associated with high mortality rates (Evans et al., 2021). Previous studies showed that pneumonia scoring systems, such

as CURB-65, pneumonia severity index (PSI) are not superior the qSOFA (George et al., 2019; Tokioka et al., 2018; Zhang et al., 2020). However, there are studies showing that the qSOFA score has lower accuracy compared to early warning scores such as NEWS, MEWS (Hu et al., 2020; Holten et al., 2020; Liu et al., 2020; Saberian et al., 2020; Yap et al., 2019). Wang et all reported that qSOFA optimal cut-off value is 1.5 with AUC 0.886 (95% CI=0.804–0.969), 73% sensitivity and 95% specificity (Wang et al., 2020). Especially under 65 years old qSOFA ≥1 has higher specificity but lower sensitivity for each mortality and ICU admission. Although in the sepsis-3 study, it was reported that the mortality rate of patients with a qSOFA ≥2, for patients with Covid-19 pneumonia with a score ≥1 should be care earlier.

There are some limitations of this study. First, this study was performed as single center, retrospective and was conducted with a limited number of cases due to the difficulty in accessing medical records and some cases were excluded because of missing data. Further studies may conduct with large population and multicenter. Second limitation of the study is; only hospitalized patients were enrolled the study and we could only assess in hospital mortality, so there is no information after discharge and re-admission to another hospital or dead. Thirdly, only the parameters at the time of first admission to the emergency department were recorded, repeated measurements were not calculated. Also, we didn't measure radiological involvement, it may be important to combine early warning scores with radiological findings.

CONCLUSION

These early warning scores are easy and useful tools to detect critical patients in emergency department. All these three scores have good predictive value for Covid-19 pneumonia. However, The NEWS score is superior to MEWS and qSOFA scores for patient both under 65 and over 65 years old. Although the ability of these scores are good, with the further studies, performance of the scores can be increased especially combining with age and comorbidities.

Conflict of Interest

The author declares no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

Author Contributions

Plan, design: YEA; **Material, methods and data collection:** YEA, HT; **Data analysis and comments:** YEA; **Writing and corrections:** HT.

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