The Ability of Early Warning Scores to Predict in Hospital Mortality and ICU Admission for Patients with Covid 19 Pneumonia in the Emergency Department

Abstract

Introduction: Early recognition of critical patients in crowded environments such as emergency departments is required in Covid 19 pandemic and many early recognition scoring systems are used. In this study, we aimed to determine the prognostic values of these scoring systems.

Material and method: This retrospective study was performed between March 2020 -May 2020 and 212 patient who have Covid 19 pneumonia were enrolled the study. National Early Warning Score (NEWS), Modified Early Warning Score (MEWS) and quick Sequential Organ Failure Assessment (qSOFA) scores were calculated at the time of admission to the emergency department. Demographic data, mortality, intensive care unit (ICU) admission rates and the prognostic values of the scores were calculated. Receiver operating characteristic (ROC) analysis was used to determine the diagnostic values of scores and the optimum cut-off values were determined by using Youden Index.

Results: 23 (10.8%) 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. While < 65 years old; MEWS and qSOFA's optimal cut-off values for mortality were ≥2 with %90.0 sensitivity %74.7 specificity and ≥1 with %90.0 sensitivity %74.7 specificity, for ≥ 65 years NEWS optimal cut-off is ≥6 with 91.7% sensitivity and 76.7% specificity.

Conclusion: All these three scores have good predictive value for mortality and ICU admission, but NEWS is better than MEWS and qSOFA especially in ≥ 65 years old patient with Covid 19 pneumonia.

Keywords: Early warning scores, NEWS, MEWS, qSOFA, Covid 19, pneumonia

What's already known about this topic?

Early detection of critical patients and optimal use of the healthcare systems is crucial in pandemic. Early warning scores for many diseases have been developed and applied until today. The prognostic values of these scoring systems have been previously demonstrated in many infectious diseases, including pneumonia. They were compared with pneumonia severity scores, especially in community-acquired pneumonia. But for Covid 19 pneumonia there is not enough studies to show prognostic values of these scoring systems.

What does this article add?

This study will benefit patients with Covid 19 pneumonia who can get worse quickly in the hospital and the use of this rapid and easy scoring systems will assist healthcare professionals in identifying patients with early deterioration. In this study, we found that the scores have a substantial diagnostic accuracy for Covid 19 pneumonia. We think that these scores especially NEWS can be used for patient with Covid 19 pneumonia with high prognostic value.

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[1].Today, the number of cases has reached over 95 million and the number of deaths over 2 million[2]. This novel coronavirus named as COVID 19 that causes mild to moderate respiratory illness and some of the patients may have life threatening situations[3].Symptoms are usually fever, dry cough, tiredness, pain, sore throat, headache, loss of taste or smell, difficulty breathing or shortness of breath, chest pain or pressure, loss of speech or movement. Clinical presentation is compatible with viral pneumonia and older people who have cardiovascular disease, diabetes, chronic respiratory disease, and cancer are more likely to develop serious conditions[1,3,4].

With the increasing the number of cases and deaths, effective triage and efficient use of already limited health resources were needed. Especially critical cases with severe symptoms should be early recognized and evaluated 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[5,6]. One of the most common scoring system is National Early Warning Score (NEWS) and it is based on patients respiratory rate, SpO_2 %, oxygen need, temperature (°C), systolic blood pressure (mmHg), hearth rate and level of consciousness using AVPU system (A= Alert, V=responds to voice, P=responds to pain, U=unresponsive)[7]. To date, the NEWS score has been used for infectious and non-infectious conditions to determine critically ill patients, mortality and intensive care admissions [5,6,8]. Another scoring system is Modified Early Warning System (MEWS). This scoring system has five parameters that include systolic blood pressure, heart

rate, respiratory rate, temperature and AVPU score[9] and has been found to be useful for pneumonia[10]. Recently sepsis criteria have been changed and new definition for sepsis has been named as quick Sequential Organ Failure Assessment (qSOFA)[11]. These new criteria are systolic blood pressure (<100 mmHg), tachypnea (>22 /min) and state of consciousness according to 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[5,6,11,12,13,14,15].

Although these rapid scoring systems seems to be a good predictor for mortality and ICU admission for infectious diseases, it is still unclear for patients with COVID 19 pneumonia. We aim to asses and compare these rapid scoring systems' prognostic value (MEWS, NEWS and qSOFA) according to their ability to predict in hospital mortality and ICU admission rate in patients with COVID 19 pneumonia.

Method

Study Design, Setting and Population

This retrospective and observational study was carried out between 15 March 2020 and 15 May 2020 in Istanbul Sarıyer Hamidiye Etfal Training and Research Hospital Emergency Department, which has approximately 100.000 patient admissions annually. In our hospital, patients with suspected COVID 19 infection are evaluated in a specially reserved section in the emergency department. Patients with suspected Covid 19 infection are managed according to the "Republic of Turkey Ministry of Health Covid 19 Diagnosis and Treatment Guideline". Suspected case definition according to this guideline is as follows; at least one of the signs and symptoms of fever, cough, shortness of breath, sore throat, headache, muscle aches, loss of taste and smell or diarrhea and close contact with a confirmed COVID-19 case within 14 days prior to the onset of symptoms. According to these definitions, advanced evaluations such as Real Time-Polymerase Chain Reaction (RT-PCR), radiological imaging and blood test are performed for suspicious cases.

Patients >18 years old and have COVID 19 pneumonia with positive RT-PCR test were included in our study. Exclusion criteria is as follows; <18 years old, pregnancy, negative RT

PCR test and missing data. RT PCR test with nasopharyngeal swab was performed in our hospital's microbiology laboratory. According to Covid 19 pneumonia computed tomography findings previously described in lecture, one of the findings of ground glass opacity, consolidation, linear opacity, crazy paving pattern and infiltration was accepted as pneumonia[16]. According to our hospital ICU admission criteria; 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 at the time of admission to the emergency department or during the service follow-up.

Data collection and measurements

The demographic data of the patients, complaints of admission to the emergency room, RT-PCR test results, initial vital parameters, radiological results, intensive care admissions and mortality rates were collected from the hospital database. NEWS, MEWS and qSOFA scores of the patients were calculated accordingly. “www.mdcalc.com” website was used to calculate the scores and then the results were recorded to the study form. Details of these scores are shown in tables 1a-c.

Outcomes

The primary outcome of this study is predicting 30-day mortality and ICU admission rate for patients with COVID 19 pneumonia. Secondary outcome is comparison of the prognostic values of scoring systems and determination of optimal cut off values for the patients.

Ethical Approval

Our study was approved by the local ethics committee of Şişli Hamidiye Etfal Training and Research Hospital and was conducted in accordance with the Helsinki declaration.

Data 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.

Table 1a. Modified Early Warning Score (MEWS)

	3	2	1	0	1	2	3
Systolic Blood Pressure mmHg	<70	71-80	81-100	101-199		>199	
Heart rate/min		<40	41-50	51-100	101-110	11-129	>129
Respiratory rate/min		<9		9-14	15-20	21-29	>29
Temperature °C		<35		35-38,4		>38,4	
AVPU score				A	V	P	U

A: Alert, V: responds to voice, P: responds to pain, U: unresponsive

Table 1b. National Early Warning Score (NEWS)

	3	2	1	0	1	2	3
Respiratory rate /min	<8		9-11	12-20		21-24	>25
SpO_2 %	91	92-93	94-95	>96			
Supplementary O_2		Yes		No			
Temperature °C	<35.5		35.1-36	36.1-38	38.1-39	>39.1	
Systolic Blood Pressure mmHg	<90	91-100	101-110	111-219			>220
Heart rate /min	<40		41-50	51-90	91-110	111-130	>131
Level of consciousness				A			V, P, U

Table 1c. qSOFA

Parameters	Score
Altered mental status (GCS <15)	1
Respiratory rate >22/min	1
Systolic Blood Pressure <100 mmHg	1

Results

Total number of patients admitted to the ED in study period was 11629 and 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 55.4 ± 15.2 (range: 19-89) and 114 of the patients were male (53.8%), 98 of them were female (46.2%). The number of patients who died and admitted to ICU were 23 (10.8%) and 34 (16.0%) respectively.

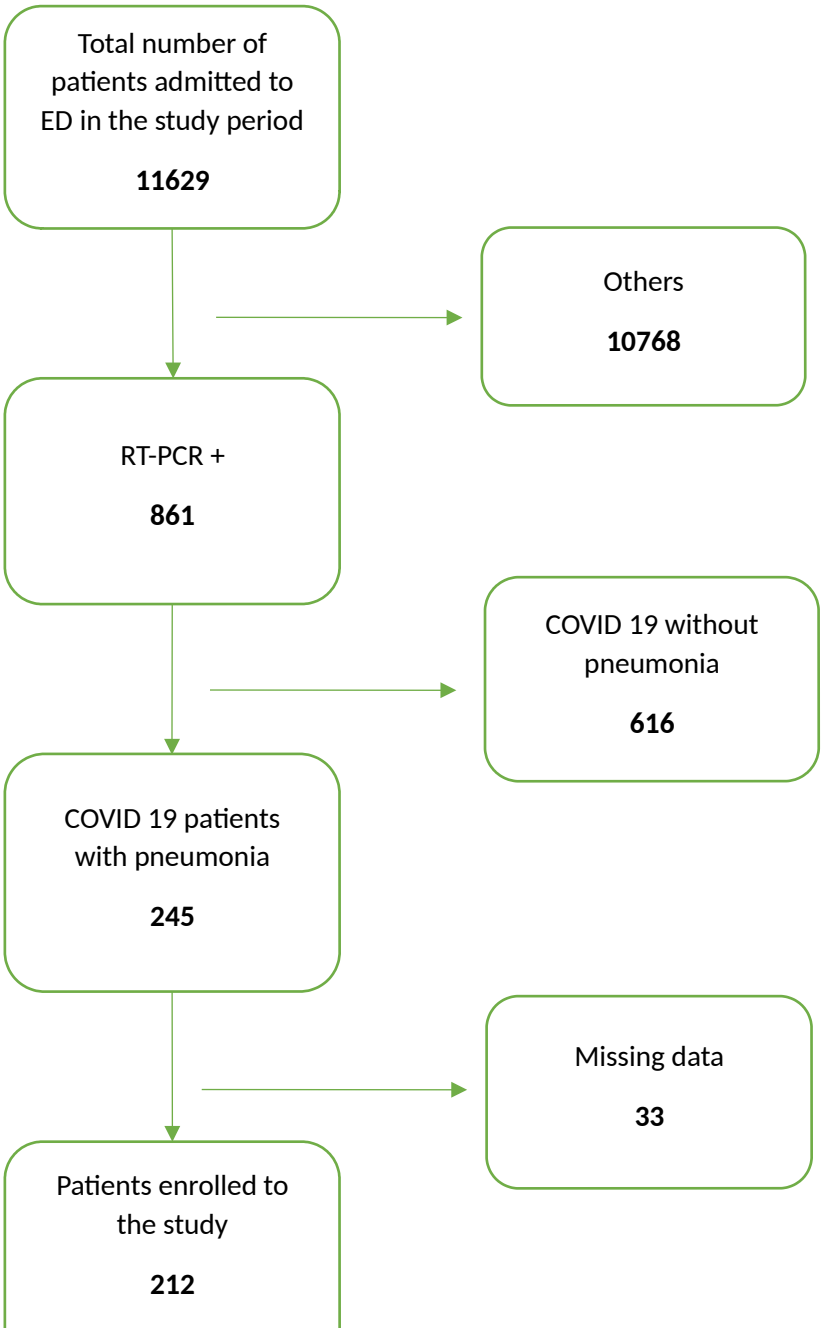

Figure 1. The Flow chart of the study. ED: Emergency Department, RT-PCR: Real Time Polymerase Chain Reaction

Mortality

The mean age was 64.4±13.2 and higher in the mortality group (p=0.003). While male patient mortality rate was 14.9 %, female patient's mortality rate was 6.1% (p=0.040). Hearth rate and respiratory rate in mortality group was higher than alive group. hearth rate mean was 101.0±13.3 in death group and 84.2±12.4 was in alive group (p<0.001). Respiratory rate mean was 28.0(12.0-44.0) in death group and 16.0(12.0-48.0) in alive group (p<0.001). All scores (NEWS, MEWS, qSOFA) were higher in the mortality group (p<0.001), spO_2 mean was 91.0% (65.0-98.0) and it was low according to the alive group (p<0.001) (Table 2). Mortality rates were statistically high in patients with coronary artery disease (p=0.032), dyspnea (p<0.001), tachypnea (p<0.001), sarcoidosis (p=0.032) and hypotension (p=0.032) (Table 3).

Table 2. Vital parameters and total scores of Alive and Death groups

Parameters	Status		p
	ALIVE	DEATH	
Age	54.3±15.1	64.4±13.2	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	84.2±12.4	101.0±13.3	<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

Table 3. Comparison of symptoms and comorbidities for alive and death group

All patients n (%)	**Alive** 189(89.2%)	**Death** 23(10.8%)	**Total** 212(100%)
	n (%)	**n (%)**	
Sex			**p value**
female	92 (48.6%)	6 (26.0%)	0.040
male	97 (51.4%)	17 (74.0%)	
Comorbidities			
HT	63(33.3%)	8(34.7%)	0.889
DM	39(20.6%)	5(21.7%)	0.999*
KAD	20(10.5%)	6(26.0%)	**0.032***
Hypothyroidy	17(9.0%)	0(0.0%)	0.227*
Malignancy	11(5.8%)	0(0.0%)	0.613*
COPD	10(5.3%)	1(4.3%)	0.999*
Asthma	7(3.7%)	2(8.7%)	0.253*
Heart failure	3(1.6%)	2(8.7%)	0.092*
Gastric bypass surgery	2(1.0%)	0(0.0%)	0.999*
CKD	1(0.5%)	0(0.0%)	0.999*
Epilepsy	1(0.5%)	0(0.0%)	0.999*
Dvt	1(0.5%)	1(4,3%)	0.108*
Af	1(0.5%)	0(0.0%)	0.999*
Vsd	1(0.5%)	0(0,0%)	0.999*
CeVD	1(0.5%)	1(4.3%)	0.206*
ITP	1(0.5%)	0(0,0%)	0.999*
sarcoidosis	1(0.5%)	2(8.7%)	**0.032***
Symptoms			
Cough	123(65.1%)	7(30.4%)	**0.001**
Fever	78(41.2%)	7(30.4%)	0.317
weakness	60(31.7%)	5(21.7%)	0.473*
dyspnea	37(19.5%)	14(60.8%)	**<0.001**
myalgia	25(13.2%)	3(13.0%)	0.999*
sore throat	21(11.1%)	3(13.0%)	0.731*
headache	15(7.9%)	1(4.3%)	0.999*
diarrhea	11(5.8%)	1(4.3%)	0.999*
Abdominal pain	8(4.2%)	1(4.3%)	0.999*

Results were presented as count and percentage. *Fisher's exact test was performed. Otherwise Chi-square test was used

CKD: chronic kidney disease, Dvt: deep vein thrombosis, Af: atrial fibrillation, Vsd: ventricular septal defect, DM: diabetes mellitus, HT: hypertension, COPD: chronic obstructive pulmonary disease, CeVD: cerebrovascular disease, KAD: coronary artery disease.

Admission to ICU

The mean age was 63.4±12.5 in ICU admission group and 53.9±15.2 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 ℃ (35.8-39.5), for ICU 37.1 ℃ (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 4. Considering other factors that affecting the mortality of patients in ICU group and non-ICU, 8 of total 34 patient who admitted to ICU have coronary artery disease (30.8 %). The ICU admission rate in patients who have dyspnea and tachypnea was higher than non-ICU patients (p<0.001). While 27 of 34 (57.4%) patients have tachypnea, 18 (52.9%) patients have dyspnea in ICU group. Table 5.

Table 4. Vital parameters and total scores of non-ICU and ICU patient

Parameters	**Status**		**p**
	Non-ICU	**ICU**	
Age	53.9±15.2	63.4±12.5	**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)	71.5(53.0-90.0)	0.014
Temperature ℃	36.8(35.8-39.5)	37.1(36.0-38.8)	0.005
sPO_2 %	97.0(88.0-100.0)	90.5(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)	3.5(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

Table 5. Comparison of symptoms and comorbidities for non-ICU and ICU groups

All patients	**Non-ICU**	**ICU**	**Total**
n (%)	178(84.0%)	34(16.0%)	212(100%)
	n (%)	**n (%)**	
Sex			**p value**
female	87(48.9%)	11(32.3%)	0.077
male	91(51.1%)	23(67.7%)	
Comorbidities			
HT	56(31.5%)	15(44.1%)	0.152
DM	36(20.2%)	8(23.5%)	0.663
KAD	18(10.1%)	8(23.5%)	**0.029**
Hypothyroidy	16(9.0%)	1(2.9%)	0.320*
COPD	10(5.6%)	1(2.9%)	0.999*
Malignancy	10(5.6%)	1(2.9%)	0.999*
Asthma	7(3.9%)	2(5.9%)	0.639*
Heart failure	3(1.7%)	2(5.9%)	0.183*
Gastric bypass surgery	2(1.1%)	0(0,0%)	0.999*
Af	1(0.6%)	0(0.0%)	0.999*
Vsd	1(0.6%)	0(0.0%)	0.999*
CeVD	1(0.6%)	1(2.9%)	0.296*
ITP	1(0.6%)	0(0,0%)	0.999*
sarcoidosis	1(0.6%)	2(5.9%)	0.068*
CKD	0(0.0%)	1(2.9%)	0.160*
Epilepsy	0(0.0%)	1(2.9%)	0.160*
Dvt	0(0.0%)	1(2.9%)	0.160*
Symptoms			
Cough	113(63.5%)	17(50.0%)	0.139
Fever	71(39.9%)	14(41.2%)	0.888
weakness	54(30.3%)	11(32.3%)	0.815
dyspnea	33(18.5%)	18(52.9%)	**<0.001**
myalgia	23(12.9%)	5(14.7%)	0.784*
sore throat	20(11.2%)	4(11.8%)	0.999*
headache	14(7.8%)	2(5.9%)	0.999*
diarrhea	10(5.6%)	2(5.9%)	0.999*
Abdominal pain	8(4.5%)	1(2.9%)	0.999*

Results were presented as count and percentage. *Fisher's exact test was performed. Otherwise Chi-square test was used

CKD: chronic kidney disease, Dvt: deep vein thrombosis, Af: atrial fibrillation, Vsd: ventricular septal defect, DM: diabetes mellitus, HT: hypertension, COPD: chronic obstructive pulmonary disease, CeVD: cerebrovascular disease, KAD: coronary artery disease

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 6. For the prediction mortality in younger than 65 years old patients, MEWS, NEWS, qSOFAs' AUC were 0.852 (95% CI= 0.708-0.997), 0.882 (95% CI=0.741-1.000), 0.879 (95% CI=0.768-0.990) and ≥65 years old patient AUC were 0.854 (95% CI=0.720-0.987), 0.931 (95% CI=0.853-1.000), 0.776 (95% CI=0.609-0.944) respectively. For the ICU admission MEWS, NEWS, qSOFAs' AUC were 0.882 (95% CI=0.783-0.981), 0.914 (95% CI=0.817-1.000), 0.868 (95% CI=0.764-0.973) in < 65 years old group and 0.845 (95% CI=0.725-0.965), 0.926 (95% CI=0.854-0.998), 0.868 (95% CI=0.854-0.998) in ≥65 years old group. Both in predicting mortality and ICU admission NEWS score is better in all subgroups.

Table 6. The overall analysis of MEWS, NEWS and qSOFA scores to prediction of mortality and ICU admission according to the subgroups.

		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)

The diagnostic accuracy of NEWS, MEWS and qSOFA was calculated to prediction mortality, ICU admission for <65 years and >65 years old patient 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 0.85 (95% CI = 0.71-1.0), sensitivity 90.9, specificity 74.7 respectively. For >65 years old optimal

cut-off value for MEWS to predict mortality is ≥4 with AUC 0.85(95% CI= 0.72-0.99), sensitivity 66.7% and specificity 97.7%. While NEWS optimal cut-off to predict mortality for <65 years old is ≥7, >65 years old is ≥6 and AUC, sensitivity, specificity follow as; [0.88 (95% CI=0.74-1.0) 81.8, 93.8], [0.93 (95% CI=0.85-1.0), 91.7, 76.7] respectively. For qSOFA both <65 and >65 years old cut-off point determined as ≥1 and < 65 years old AUC, sensitivity, specificity 0.88 (95% CI=0.77-1.0), 90.9, 78.1 and > 65 years old 0.78 (95% CI=0.61-0.94), 75.0, 69.8 respectively. NEWS seems to be better accuracy to determine mortality for > 65 years old patients. 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 0.88 (95% CI=0.78-0.98), 89.5, 78.3], NEWS ≥6 [AUC 0.92 (95% CI=0.82-1.0), 84.2, 94.6], qSOFA ≥1 [AUC 0.87 (95% CI=0.76-0.97), 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 0.85 (95% CI=0.73-0.97), 60, 100], NEWS ≥6 [0.93 (95% CI=0.85-1.0), 86.7, 80], qSOFA ≥1 [AUC 0.82 (95% CI= 0.68-0.95), 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 7.

Table 7. The diagnostic accuracy of the MEWS, NEWS and qSOFA for mortality and ICU admission <65 years and > 65 years old patients and optimal cut-off values

		Age	AUC (95% CI)	Cut-off point*	Sensitivity (%)	Specificity (%)
Mortality	MEWS	<65	0.85(0.71-1.0)	≥2	90.9	74.7
		≥65	0.85(0.72-0.99)	≥4	66.7	97.7
	NEWS	<65	0.88(0.74-1.0)	≥7	81.8	93.8
		≥65	0.93(0.85-1.0)	≥6	91.7	76.7
	qSOFA	<65	0.88(0.77-1.0)	≥1	90.9	78.1
		≥65	0.78(0.61-0.94)	≥1	75	69.8
ICU admission	MEWS	<65	0.88(0.78-0.98)	≥2	89.5	78.3
		≥65	0.85(0.73-0.97)	≥4	60	100
	NEWS	<65	0.92(0.82-1.0)	≥6	84.2	94.9
		≥65	0.93(0.85-1.0)	≥6	86.7	80
	qSOFA	<65	0.87(0.76-0.97)	≥1	84.2	81.2
		≥65	0.82(0.68-0.95)	≥1	80	75

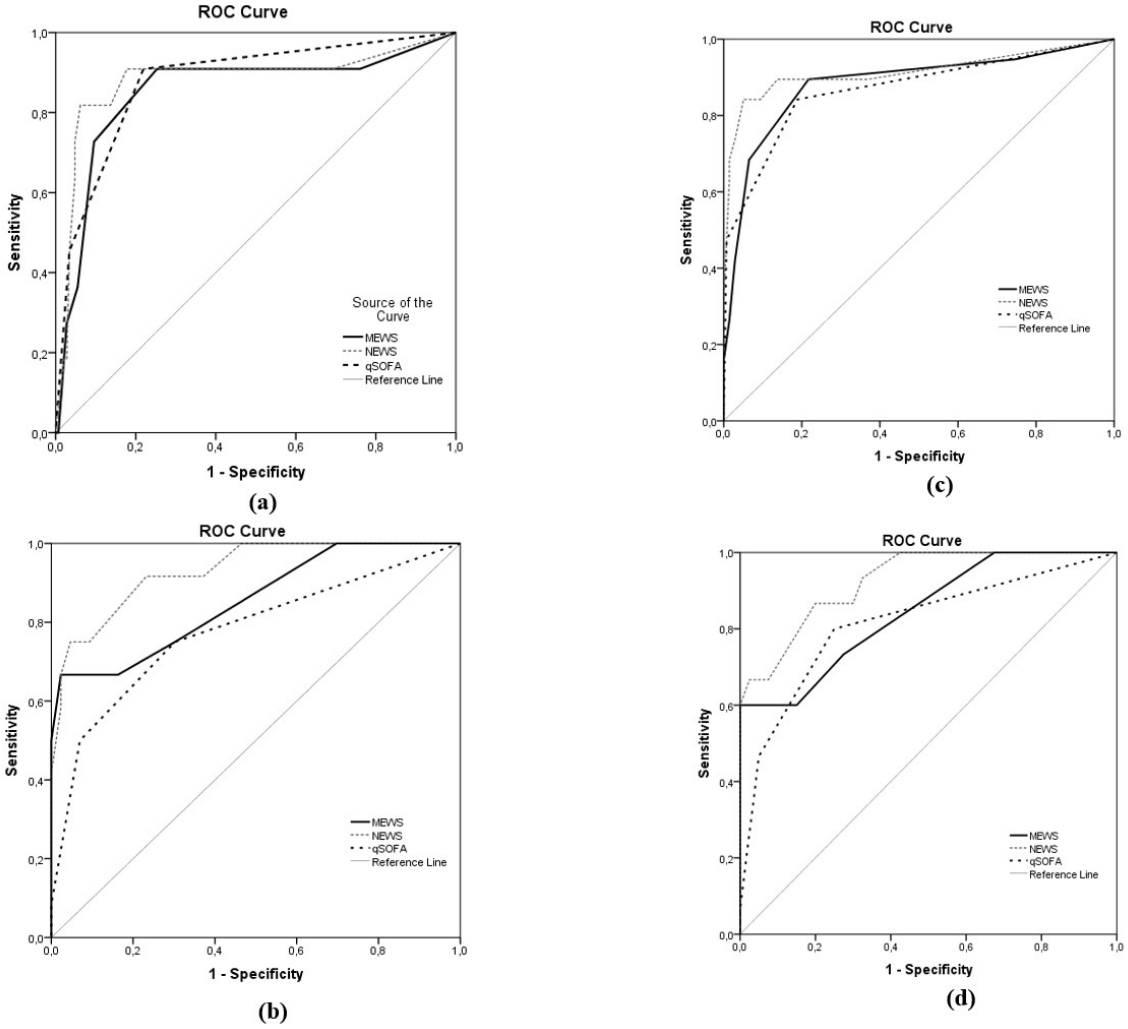

Figure 2. ROC of NEWS, MEWS and qSOFA prediction mortality and ICU admission. **(a)** ROC of NEWS, MEWS and qSOFA to predict mortality for <65 years old **(b)** ROC of NEWS, MEWS and qSOFA to predict mortality for >65 years old **(c)** ROC of NEWS, MEWS and qSOFA to predict ICU admission for <65 years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

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[1,16,17,18]. In our study, coronary artery disease, older age were

significant risk factors for mortality and ICU admission. Also, several findings like dyspnea, tachypnea, lower spO_2 rates, associated with mortality and ICU admission have been reported in previous studies. Hai Hu and colleagues showed that dyspnea, respiratory rate and lower sPO_2 rates were associated with mortality[19]. Covino and his colleagues showed also there were higher respiratory rate and lower sPO_2 in patient with mortality and ICU admission[17]. In our study, we found that, in addition to respiratory rate and 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[1,19]. 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 or especially in pneumonia[5,6,7,8,20]. In Vincent et all.' study conducted with 773477 patients, it was found that the NEWS score' discriminative power was better than MEWS, qSOFA and SIRS, especially in infectious patients[5]. 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[21]. 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.

In our study, 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% 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[17]. 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[21]. 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[19]. 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% 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[11]. Previous studies showed that pneumonia scoring systems, such as CURB-65, pneumonia severity index (PSI) are not superior the qSOFA[13,14,15]. However, there are studies showing that the qSOFA score has lower accuracy compared to early warning scores such as NEWS, MEWS[5,6,20,22]. 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[24]. In our study we showed that 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 computed tomography involvement, it may be important to combine early warning scores with radiological findings.

In conclusion, these early warning scores are easy and useful tools to detect patients with high mortality rates in emergency department. All these three scores have good predictive value for mortality and ICU admission in patients with Covid 19 pneumonia. However, The NEWS score's ability to predict mortality and intensive care is superior to MEWS and qSOFA scores for patient both under 65 and over 65 years old.

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Conflict of Interest

There is no conflict of interest in this study.

Author contributions

Yunus Emre ARIK: corresponding author, designed the study, collected the data, authored and reviewed the paper, prepared figures and tables, approved the final draft.

Hatice TOPÇU: collected the data, analyzed the data, reviewed drafts and approved the final draft

Mustafa ALTINAY: collected the data, prepared figures and tables, reviewed drafts and approved the final draft

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