EM - ORIGINAL

The predictive value of modified risk scores in patients with acute exacerbation of COPD: a retrospective cohort study

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Abstract

This study aims to evaluate the performance of CREWS (Chronic Respiratory Early Warning Score), S-NEWS (Salford-National Early Warning Score), qNEWS (Quick National Early Warning Score), NEWS (National Early Warning Score), and qSOFA (Quick Sequential Organ Failure Assessment) scores in predicting mortality, intensive care unit (ICU) admission and the need for mechanical ventilation (MV) of patients presented with acute exacerbations of chronic obstructive pulmonary disease (AECOPD). This retrospective cohort study was conducted in the emergency department of a tertiary hospital between January 1 and December 31, 2019. The patients with AECOPD and aged ≥ 18 were included. Patients who were transferred from another center and whose data could not be reached were excluded. Demographic information, comorbid diseases, variables of the scores, laboratory results, and outcomes were recorded. A total of 575 consecutive patients were included. The 30-day mortality, ICU admission, and MV need rate were 5.7% ($n = 33$), 9.6% ($n = 55$), and 13.7% ($n = 79$), respectively. Each score had moderate-to-excellent performance in predicting MV need and ICU admission, while their performance in predicting mortality was poor. CREWS is the most successful score in predicting 30-day mortality (AUC 0.695), ICU admission (AUC 0.841), and MV need (AUC 0.924). ICU admission, age, and creatinine levels were associated with mortality ($p < 0.05$). All scores have better performance in predicting ICU admission and MV need than mortality. ICU admission, age, and creatinine levels may be the predictors of mortality among AECOPD patients.

Keywords Acute exacerbation · Chronic obstructive pulmonary disease · Early warning score · Chronic respiratory disease · Emergency

Introduction

Chronic obstructive pulmonary disease (COPD) is one of the top three causes of death worldwide, and 90% of deaths occur in low- and middle-income countries [1]. It is the fourth most common cause of mortality in Turkey [2]. Many people around the world live with the risk of morbidity and mortality caused by this disease. Its incidence is increasing year by year due to continued exposure to risk factors and prolongation of lifespan [1]. Its impact on health expenditures is also increasing [3, 4].

Acute exacerbations of chronic obstructive pulmonary disease (AECOPD) are defined as acute worsening of respiratory symptoms that require additional treatment [1]. Acute exacerbations are directly associated with mortality in COPD patients [5]. Besides, AECOPD has a negative effect on the quality of life, admission and readmission rates, and disease progression [1, 2, 6]. For these reasons, appropriate management of acute exacerbations is recommended by national and international organizations [1, 2].

The majority of the AECOPD patients were presented to the emergency departments (EDs), and most of them were discharged after appropriate treatment [2]. Deciding on admission or discharge of AECOPD patients is challenging for emergency physicians. Studies in the literature, which included patients with chronic respiratory disease, were frequently conducted in moderate and severe patients admitted to the ward and/or intensive care units. Studies including the patients with mild AECOPD who were discharged from the ED after appropriate treatment are limited.

The use of early warning scores in follow-up is recommended for the early detection of critically ill patients and

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the prediction of clinical deterioration [7–10]. However, the AECOPD has a different treatment target threshold from other diseases [1]. Modified forms of existing scores are recommended to predict clinical deterioration and mortality in patients with chronic respiratory disease [11, 12]. However, the studies evaluating modified forms of the existing scores among AECOPD patients are limited.

This study aims to evaluate the performance of CREWS (Chronic Respiratory Early Warning Score), S-NEWS (Salford-National Early Warning Score), qNEWS (Quick National Early Warning Score), NEWS (National Early Warning Score), and qSOFA (Quick Sequential Organ Failure Assessment) scores in predicting mortality, intensive care unit (ICU) admission and the need for mechanical ventilation (MV) of patients presented to the ED with AECOPD.

Materials and methods

Study design

This retrospective cohort study was conducted in the ED of a tertiary training and research hospital between January 1 and December 31, 2019, after local ethics committee approval (Approval Id: 2021/257). The study hospital is located in Istanbul, which is the most populous city in Turkey, and approximately 350,000 patients present to the ED annually. It serves as a primary percutaneous coronary intervention and thrombolytic center for acute coronary syndrome and stroke patients and a level 3 trauma center for trauma patients.

This study was conducted in accordance with the Strengthening the Reporting of Observational Studies (STROBE) guidelines for cohort studies.

Patient selection and groups

The patients aged 18 years and older and who presented to the ED with AECOPD were included in the study. All the patients had clinically and spirometrically confirmed COPD. The diagnosis of AECOPD was defined as an acute worsening of clinical symptoms requiring additional treatment. Patients diagnosed with AECOPD between study dates were re-evaluated by the researchers. The international and national organizations' diagnosis criteria were followed for the selection of the patients [1, 2]. Patients who did not meet the diagnostic criteria for AECOPD were excluded from the study. Patients transferred from another healthcare center and who had missing medical records were excluded from the study. In recurrent presentations of the same patient, the first presentation was included.

Patients presented between the years 2020 and 2021 were not included in the study due to the possibility that the COVID-19 virus may affect outcomes. The first confirmed case of COVID-19 in our country was detected in the 2 week of March 2020.

Patients were divided into groups according to their mortality within 30 days, ICU admission, and the need for mechanical ventilation (MV). The need for MV was defined as patients who underwent non-invasive mechanical ventilation (NIMV) and/or invasive mechanical ventilation (IMV) during the follow-up in the ED. Decisions for discharge, ward or ICU admission, and MV application of the patients were in line with the indications suggested by international organizations [1].

The mechanical ventilation indications were as follows: Non-invasive mechanical ventilation indications

- Persistent hypoxemia despite supplemental oxygen therapy
- Severe dyspnea with the signs of accessory muscle use
- Respiratory acidosis

Invasive mechanical ventilation indications

- Respiratory and/or cardiac arrest
- Hemodynamic instability does not respond to intravenous fluids and/or inotropic agents
- Unable to tolerate NIMV
- Severe hypoxemia does not respond to NIMV
- Do not maintain airway security
- Persistent vomiting and/or aspiration

The indications for ICU admission were as follows:

- Severe dyspnea that does not respond adequately to initial medical treatment
- Persistent or worsening hypoxemia
- Life-threatening acute respiratory failure
- Changes in consciousness
- Need for invasive mechanical ventilation support
- Hemodynamic instability that needs inotropic agents

A registered triage nurse assessed the patients on ED arrival and recorded the vital signs in the ED files. Patient data were obtained from electronic medical records and ED files. Demographic information, comorbid diseases, vital signs, levels of consciousness, laboratory results, emergency department length of stay (ED LOS), and outcomes of the patients were recorded on the study forms.

Scores were calculated according to previously defined variables and point values by the researchers retrospectively. The variables and point values of the scores are presented in Appendix 1 in supplementary file.

Early warning scores

The National Early Warning Score was developed by the Royal College of Physicians to evaluate acutely ill patients in 2012 [13]. NEWS consists of scoring seven variables from 0 to 3. NEWS has been used to detect high-risk patients and to assess the severity of many diseases in different fields [9, 10, 14–17].

CREWS and S-NEWS were created by decreasing the target values of peripheral capillary oxygen saturation, which is one of the seven variables of NEWS [11, 18]. Without supplemental oxygen, peripheral capillary oxygen saturation values below 96% were scored in NEWS, while the threshold values for CREWS and S-NEWS were determined as 90% and 88%, respectively. CREWS and S-NEWS are calculated by scoring seven variables between 0 and 3 points including respiratory rate, peripheral oxygen saturation (SpO_2), need for supplemental oxygen, body temperature, systolic blood pressure, heart rate, and level of consciousness.

qSOFA has been used to evaluate many diseases, especially sepsis, in the literature [8, 10, 19–22]. In the third international consensus definitions for sepsis and septic shock (Sepsis-3), qSOFA was recommended to rapidly identify poor outcomes of adult patients with suspected infection in out-of-hospital, emergency department, or general ward settings [23]. However, the surviving sepsis campaign recommended against using qSOFA as a single screening tool for sepsis and septic shock in 2021 [24]. Besides, studies evaluating the performance of qSOFA among AECOPD patients are limited. qSOFA is calculated by giving 1 point for each variable of respiratory rate, systolic blood pressure, and altered mental status.

Redfern et al. have developed qNEWS by reducing the variables of NEWS, similar to qSOFA [8]. qNEWS is calculated by scoring the respiratory rate, systolic blood pressure, and level of consciousness (AVPU) variables from 0 to 3.

The variables and point values used in calculating the scores are presented in Appendix 1 in supplementary file.

Outcomes

The primary outcome of this study was the performance of early warning scores in predicting 30-day mortality in AECOPD patients.

Secondary outcomes are the performance of early warning scores in predicting MV need and ICU admission and the factors affecting mortality in AECOPD patients.

Statistical analyses

The sample size was calculated using Stone et al.'s study as a reference (24,181 AECOPD patients and a 3.5% in-hospital mortality rate) previous to the study [25]. With the estimated 30-day mortality rate of 6% (power = 0.80 and alpha = 0.05), the sample size was calculated as 502 AECOPD patients. An online open-access sample size calculator was used to determine the sample size (www.clincalc.com).

Numerical variables were presented as mean ± standard deviation or median (interquartile range [IQR]) values according to the distribution of the data. Qualitative variables were presented as numbers and percentages. The distribution of the groups was determined by the Shapiro–Wilks and Kolmogorov–Smirnov tests. The numerical variables were evaluated with the Student t-test or Mann–Whitney U test. The qualitative variables were evaluated with the Chi-square test. Variables with a p value less than 0.05 and do not correlate with each other in univariate analysis were included in the multivariate analysis. Odds ratios were presented with a 95% confidence interval. The area under the receiver-operating characteristic (AUROC) curve was used to evaluate the performance of the scores. The optimum cutoff values of the scores were determined by the Youden index J point. SPSS® for Windows version 23.0 (IBM, Chicago, IL, US) program was used for statistical analysis. The statistical significance level was accepted as $p < 0.05$.

Results

A total of 634 consecutive patients were included in the study. Patients who were transferred from another center ($n = 23$) had missing medical records ($n = 13$), and did not meet the diagnosis criteria for AECOPD ($n = 23$) were excluded. Five hundred and seventy-five patients were included in the final analyses. The flow diagram of the study is shown in Fig. 1.

The median age of the patients was 69 (IQR 59–77), and 261 (45.4%) were female. The 30-day mortality of the patients was determined as 5.7% ($n = 33$). ICU admission and the need for MV were determined as 9.6% ($n = 55$) and 13.7% ($n = 79$), respectively. The baseline characteristics of the patients are shown in Table 1.

In the non-survivor group, age was higher, SpO_2 was lower, blood urea nitrogen (BUN) and creatinine levels were higher, partial carbon dioxide pressures were higher, and ED LOS was longer than in the survivor group ($p < 0.05$). The univariate analysis results of the patients are presented in Table 2. Arrival by ambulance, receiving home oxygen therapy, altered mental status, ICU admission, MV need, presence of congestive heart failure (CHF), and coronary artery disease (CAD) were associated with mortality in univariate analysis ($p < 0.05$). Gender and presence of hypertension, diabetes mellitus, active malignancy, and chronic renal disease were not associated with mortality in univariate analysis ($p > 0.05$). However, a multivariate analysis showed that ICU admission, age, and creatinine levels

Fig. 1 Flow diagram of the study
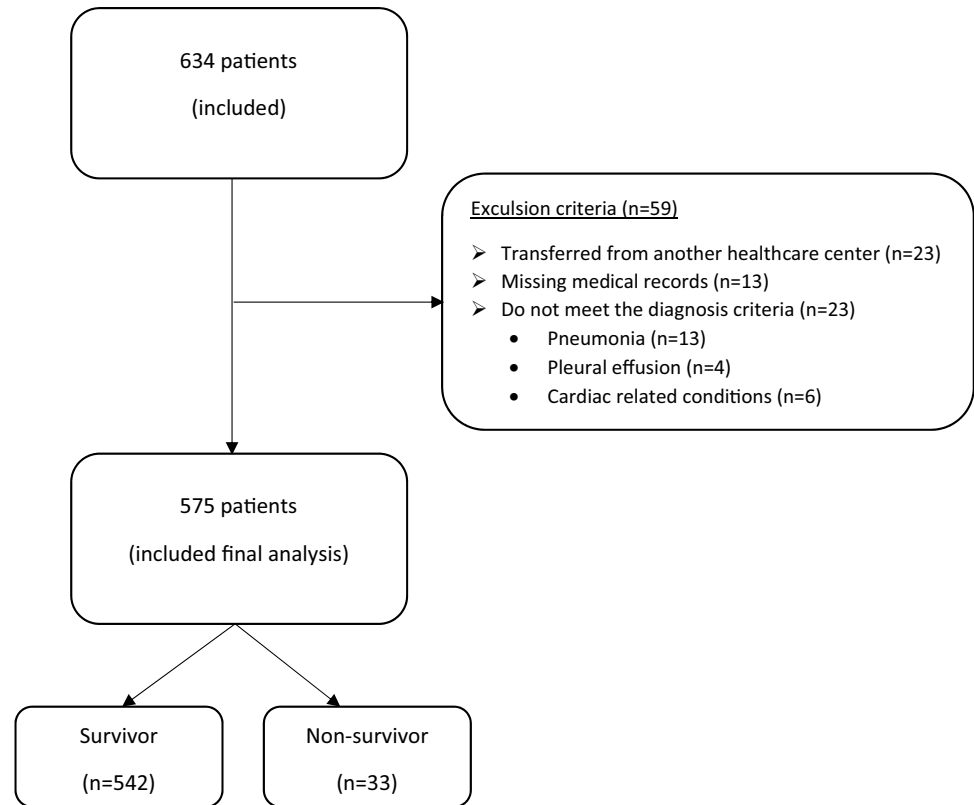
were the predictors of mortality among AECOPD patients ($p < 0.05$) (Table 3).

CREWS is the most successful score in predicting 30-day mortality (AUC 0.695), ICU admission (AUC 0.841), and MV need (AUC 0.924). CREWS and S-NEWS which is modified forms of NEWS were outperformed other scores in predicting ICU admission (AUC 0.841 (95% CI 0.809–0.870), $p < 0.001$, AUC 0.836 (95% CI 0.804–0.866), $p < 0.001$, respectively), MV need (AUC 0.924 (95% CI 0.899–0.944), $p < 0.001$; AUC 0.912 (95% CI 0.886–0.934), $p < 0.001$, respectively), and NIMV need (AUC 0.918 (95% CI 0.892–0.936), $p < 0.001$; AUC 0.905 (95% CI 0.878–0.928), $p < 0.001$, respectively). The performances of the scores in predicting IMV needs did not perform because of the lower patient counts ($n = 6$). The performances, sensitivity, specificity, likelihood ratios, and predictive values of the scores are presented in Table 4. The ROC curves of the scores for each outcome are presented in Fig. 2.

Discussion

In our study, each score had a moderate-to-excellent performance in predicting ICU admission and MV need, although their performance in predicting mortality was poor. CREWS and S-NEWS which are the modified forms of NEWS had

higher AUROC values than NEWS, qSOFA, and qNEWS for each outcome in evaluating patients with AECOPD.

Pedersen et al. reported that modified NEWS scores had lower sensitivity than NEWS for predicting 48-h mortality in patients with chronic respiratory disease [26]. Hodgson et al. evaluated the performances of CREWS and S-NEWS and stated that using lower oxygen saturation thresholds for the AECOPD patients might include high-risk patients in the low-risk group [18]. Similarly, in our study, while the overall performances of CREWS and S-NEWS were better in predicting mortality, their sensitivities were lower than NEWS (66.6% and 78.7% vs. 93.9%, respectively). The difference between the modified NEWS scores and NEWS is only on the target oxygen saturation threshold, and the sensitivity for predicting mortality was lower than NEWS. This decrease might be due to involving patients with lower SpO_2 values in low-risk groups. Thus, we cannot conclude that CREWS and S-NEWS can be used safely to predict mortality in AECOPD patients in clinical practice. The original NEWS may be useful in selecting non-critical AECOPD patients, with its high sensitivity (93.9%).

Usman et al. found that NEWS is more successful than qSOFA in evaluating in-hospital mortality in sepsis patients [10]. Redfern et al. evaluated in-hospital mortality in all hospitalizations and concluded that NEWS performed better than qSOFA and qNEWS [8]. Similarly, in our study, NEWS outperformed qSOFA and qNEWS

Table 1 Baseline characteristics of the patients

Variables	Values
Gender, women n (%)	261 (45.4)
Age, median (IQR)	69 (59–77)
Arrival, n (%)	
Ambulatory	457 (79.5)
Ambulance	118 (20.5)
Comorbid diseases, n (%)	
Chronic heart failure	84 (14.6)
Hypertension	251 (43.7)
Diabetes mellitus	103 (17.9)
Coronary artery disease	186 (32.3)
Active malignancy	23 (4.0)
Chronic renal disease	30 (5.2)
Chronic liver disease	3 (0.5)
Cerebrovascular disease	13 (2.3)
Benign prostatic hyperplasia	2 (0.3)
Rheumatoid arthritis	2 (0.3)
Hipotiroidi	6 (1.0)
Alzheimer	3 (0.5)
Parkinson	1 (0.2)
Home oxygen therapy, n (%)	78 (13.6)
MV need, n (%)	79 (13.7)
NIMV need	73 (12.7)
IMV need	6 (1.0)
Disposition, n (%)	
Discharge	506 (88.0)
Ward admission	14 (2.4)
ICU admission	55 (9.6)
30-day mortality, n (%)	33 (5.7)

IQR interquartile range, *MV* mechanical ventilation, *NIMV* non-invasive mechanical ventilation, *IMV* invasive mechanical ventilation, *ICU* intensive care unit

in predicting mortality in AECOPD patients. However, qNEWS was the second most sensitive score after NEWS, with a sensitivity of 81.8% in predicting mortality. Since qNEWS can be calculated easily with three variables, it can be an alternative option to NEWS for ED triage areas or overcrowded EDs to discriminate the non-critical AECOPD patients.

Pedersen et al. found moderate-to-good overall performance for NEWS, CREWS, and S-NEWS in predicting ICU admission in hospitalized patients with the chronic respiratory disease [26]. Küpeli and Subaşı concluded that NEWS can be used safely in predicting early clinical deterioration and readmission to the ICU in patients transferred from the ICU to the wards [7]. CREWS and S-NEWS outperformed other scores in predicting ICU admission in our study. CREWS and S-NEWS can be used safely to predict ICU admission of AECOPD patients.

Mohan et al. found that pCO_2, pO_2, and GCS were associated with MV needs in AECOPD patients [27]. Besides, they found high AUC, sensitivity, and specificity values with their constructed formula with these variables [27]. Unlike their formula, CREWS and S-NEWS do not need laboratory results and it is easy to calculate at the bedside. CREWS and S-NEWS had excellent overall performance (AUC 0.924, 0.912, respectively) in predicting MV needs in our study. CREWS and S-NEWS can assist clinicians in deciding on the admission of the AECOPD patients to the acute medical units or ICUs who need MV according to current institution conditions.

In our study, qSOFA and qNEWS had moderate-to-good overall performance to predict ICU admission and MV need. In Su et al.'s study, the overall performance of qSOFA in predicting the need for intensive respiratory support in COVID-19 patients was similar to our study, and qSOFA had lower sensitivity values than our study [28]. qSOFA may help intensivists decide on discharge from ICUs and/ or transfer to the inpatient units due to its high sensitivity in discrimination of the need for ICU admission and MV (87.2%, 92.4%, respectively). Besides, its quick and easy calculation will not impose an additional workload on healthcare workers in repetitive measurements. On the other hand, qNEWS may be useful in identifying the AECOPD patients who will need critical care with its good overall performance and high specificity (88.1% and 85.3%, respectively) in predicting the need for MV and ICU admission.

The Global Initiative for Chronic Obstructive Lung Disease (GOLD) reported a poor long-term prognosis after hospitalization for AECOPD patients in the 2021 report [1]. Advanced age, cardiovascular comorbidities, and the need for long-term oxygen therapy after discharge have associations with poor outcomes [1]. Besides, Tabak et al. found the advanced age, altered mental status, presence of congestive heart failure, increased BUN, low pH, increased pCO_2, and increased white blood cells as predictors of in-hospital mortality in AECOPD patients [29]. In our study, in line with the literature, advanced age, low SpO_2, low pH, high pCO_2, presence of congestive heart failure and coronary artery disease, receiving home oxygen therapy, altered mental status, need for MV and ICU admission were found associated with 30-day mortality in AECOPD patients in univariate analyses. However, the multivariate analyses showed that only age, ICU admission, and creatinine levels were the predictors of mortality among AECOPD patients. The AECOPD patients with advanced age, higher creatinine levels, and those admitted to the ICU are at high risk for 30-day mortality.

In our study, mild cases (88%) were discharged from the ED after appropriate treatment. Moderate and severe cases

Table 2 Univariate analysis results of the patients according to the 30-day mortality

Variables, median (IQR)	All patients ($n = 575$)	Survivor ($n = 542$)	Non-survivor ($n = 33$)	p^*
Age, years	69 (59–77)	68 (58–77)	72 (66–86.5)	0.002
SBP, mmHg	143 (125–163)	143 (125–163)	140 (109.5–163)	0.132
DBP, mmHg	81 (71–90)	81 (71–90)	80 (61–92)	0.209
HR, per min	93 (80–106)	93 (80–106)	94 (84.5–104)	0.860
RR, per min	22 (20–24)	22 (20–24)	22 (20.5–24)	0.154
SpO_2, %	91 (88–94)	92 (89–94)	87 (82.5–90.5)	<0.001
Fever, ℃	36.4 (36.2–36.7)	36.4 (36.2–36.7)	36.4 (36.7)	0.199
WBC, per mm^3	8.7 (7.1–10.3)	8.7 (7.1–10.4)	8.7 (6.5–9.8)	0.619
BUN, mg/dl	17.2 (14.0–23.8)	17.2 (13.5–22.8)	27.1 (18.4–62.1)	<0.001
Creatinine, mg/dl	0.80 (0.63–1.05)	0.79 (0.63–1.02)	1.17 (0.61–1.60)	0.005
pH	7.37 (7.34–7.40)	7.37 (7.34–7.40)	7.34 (7.25–7.39)	0.006
$PaCO_2$, mmHg	48.2 (42.7–55.9)	47.9 (42.6–55.2)	54.9 (42.7–74.3)	0.012
Bicarbonate, mmol/l	27.6 (25.0–30.2)	27.5 (25–30)	29.4 (25.3–34.9)	0.088
Lactate, mmol/l	1.7 (1.4–2.3)	1.7 (1.4–2.2)	2 (1.4–2.7)	0.061
Base excess, mmol/l	2.5 (0.5–4.6)	2.4 (0.5–4.6)	3.4 (0.2–9.0)	0.228
ED LOS, h	4.0 (2.5–7.0)	4 (2.5–7.0)	5.5 (3.5–9.2)	0.010
NEWS	7 (5–8)	7 (5–8)	7 (7–9)	<0.001
CREWS	5 (3–6)	5 (3–6)	7 (5–8)	<0.001
S-NEWS	5 (3–6)	4 (3–6)	6 (5–8)	<0.001
qNEWS	2 (0–2)	2 (0–2)	2 (2–3)	0.005
qSOFA	1 (0–1)	1 (0–1)	1 (0.5–1.0)	0.005

IQR interquartile range, *SBP* systolic blood pressure, *DBP* diastolic blood pressure, *HR* heart rate, *RR* respiratory rate, *SPO₂* peripheral oxygen saturation, *WBC* white blood cell, *BUN* blood urea nitrogen, *ED LOS* emergency department length of stay, *NEWS* National Early Warning Score, *CREWS* Chronic Respiratory Early Warning Score, *S-NEWS* Salford-National Early Warning Score, *qNEWS* Quick National Early Warning Score, *qSOFA* Quick Sequential Organ Failure Assessment Score

*Mann–Whitney *U* test

$p < 0.05$ considered significant

Table 3 Multivariate analysis results of the patients according to the 30-day mortality

	Odds ratio	95% confidence interval	p value
Age, years	1.05	1.01–1.09	0.006
Creatinine, mg/dl	2.28	1.48–3.50	<0.001
ICU admission	6.71	1.1.46–30.80	0.014
Mechanical ventilation need	1.29	0.29–5.64	0.730
SpO_2, %	0.97	0.91–1.04	0.481
$PaCO_2$, mmHg	1.0	0.96–1.03	0.984
ED LOS, h	0.96	0.88–1.04	0.323
Arrival, ambulance	1.87	0.72–4.88	0.196
Chronic heart failure	1.53	0.44–5.32	0.497
Coronary artery disease	0.75	0.23–2.37	0.625
Home oxygen therapy	0.98	0.35–2.75	0.977
Altered mental status	0.51	0.10–2.40	0.395

Hosmer and Lemeshow test: 0.725

ICU intensive care unit, *ED LOS* emergency department length of stay

Table 4 Area under the curve, sensitivity, specificity, likelihood ratios, and predictive values of the scores

	AUC	95% CI	Sensitivity	Specificity	+LR	−LR	PPV	NPV	p
Mortality									
NEWS >5	0.681	0.641–0.719	93.9	35.0	1.45	0.17	8.1	99.0	<0.001
CREWS >5	0.695	0.655–0.732	66.6	66.4	1.99	0.50	10.8	97.0	<0.001
S-NEWS >4	0.683	0.643–0.721	78.7	51.6	1.63	0.41	9.0	97.6	<0.001
qNEWS >0	0.636	0.595–0.676	81.8	37.4	1.31	0.49	7.4	97.1	0.005
qSOFA >0	0.626	0.585–0.666	75.7	41.5	1.30	0.58	7.3	96.6	0.007
ICU admission									
NEWS >7	0.807	0.773–0.839	74.5	70.5	2.53	0.36	21.1	96.3	<0.001
CREWS >6	0.841	0.809–0.870	76.3	80.9	4.01	0.29	29.8	97.0	<0.001
S-NEWS >6	0.836	0.804–0.866	70.9	84.4	4.55	0.34	32.5	96.5	<0.001
qNEWS >2	0.796	0.761–0.828	67.2	85.3	4.60	0.38	32.7	96.1	<0.001
qSOFA >0	0.728	0.690–0.764	87.2	43.4	1.54	0.29	14.0	97.0	<0.001
MV need									
NEWS >7	0.864	0.834–0.891	82.2	73.9	3.16	0.24	33.5	96.3	<0.001
CREWS >6	0.924	0.899–0.944	86.0	85.2	5.85	0.16	48.2	97.5	<0.001
S-NEWS >6	0.912	0.886–0.934	81.0	88.7	7.18	0.21	53.3	96.7	<0.001
qNEWS >2	0.834	0.801–0.864	68.3	88.1	5.75	0.36	47.8	94.6	<0.001
qSOFA >0	0.746	0.709–0.781	92.4	45.7	1.70	0.17	21.3	97.4	<0.001
NIMV need									
NEWS >7	0.853	0.822–0.881	80.8	73.9	3.11	0.26	31.4	96.3	<0.001
CREWS >6	0.918	0.892–0.936	84.9	85.2	5.77	0.18	45.9	97.5	<0.001
S-NEWS >6	0.905	0.878–0.928	79.4	88.7	7.04	0.23	50.9	96.7	<0.001
qNEWS >2	0.820	0.786–0.851	65.7	88.1	5.53	0.39	44.9	94.6	<0.001
qSOFA >0	0.726	0.687–0.762	91.7	45.7	1.69	0.18	19.9	97.4	<0.001

AUC area under the curve, *CI* confidence interval, *LR* likelihood ratio, *PPV* positive predictive value, *NPV* negative predictive value, *NEWS* National Early Warning Score, *CREWS* Chronic Respiratory Early Warning Score, *S-NEWS* Salford-National Early Warning Score, *qNEWS* Quick National Early Warning Score, *qSOFA* Quick Sequential Organ Failure Assessment Score, *ICU* intensive care unit, *MV* mechanical ventilation

$p < 0.05$ considered significant

(12%) were admitted to the wards and ICUs. The strength of our study is that, unlike other studies in the literature, mild AECOPD patients were included in our study, and a sample was chosen that could better reflect the whole population.
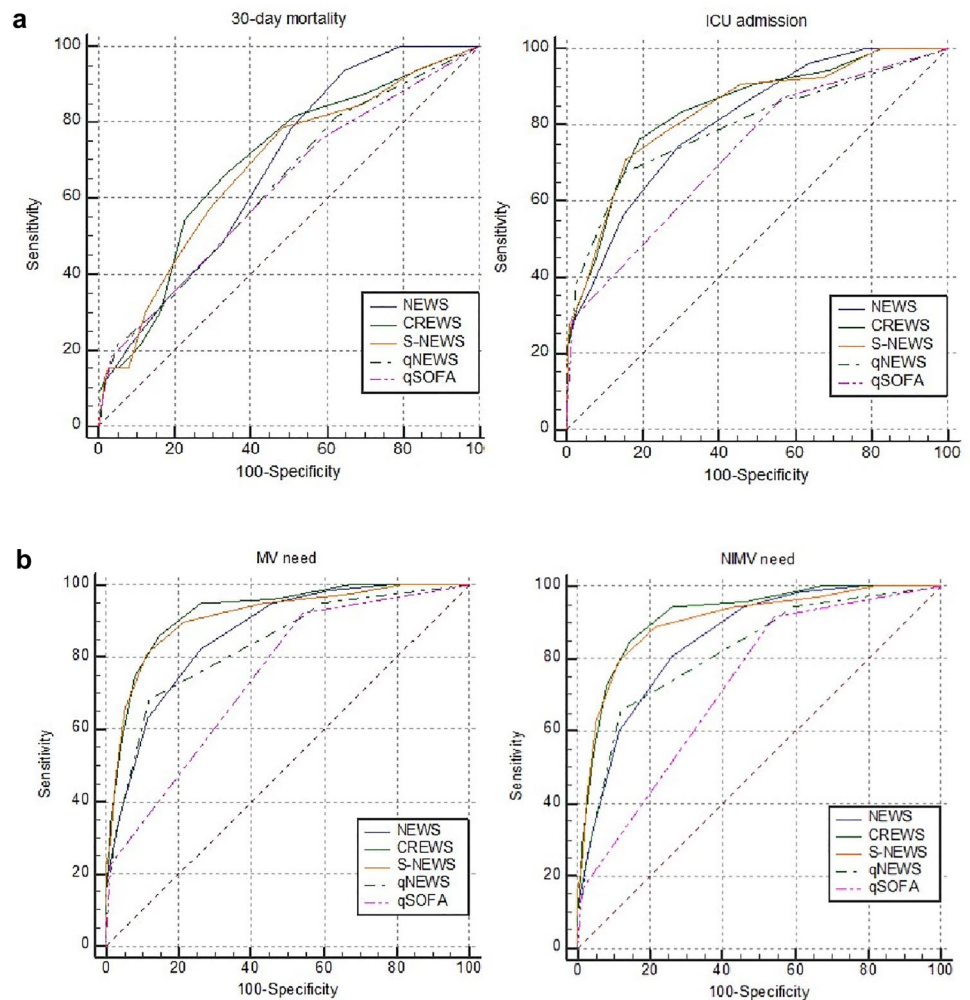
Limitations

The first limitation of our study is being a retrospective single-center study. Some data could not be reached, even if few, due to the retrospective design. Second, the cases between 2020 and 2021 could not be included in the study due to the COVID-19 pandemic that emerged at the end of 2019 and the risk of affecting the mortality and study results of this disease. Thus, the number of patients included in our study was limited only to 2019. The third limitation is the lack of etiology of the patients. The mild AECOPD patients (88%) were discharged from the ED after appropriate treatment and further etiological and/or microbiological evaluation could not be done. Thus, we could not comment on the effect of etiological factors. Another limitation of the study is that we could not present the performance of the scores for predicting IMV needs of the patients because of the lower patient counts ($n = 6$).

Conclusion

The overall performances of CREWS and S-NEWS, which are the modified forms of NEWS, were insufficient in predicting mortality. However, CREWS and S-NEWS can be used safely in predicting AECOPD patients who need ICU admission and mechanical ventilation support. qSOFA can be used for quick and easy detection of non-critical AECOPD patients with its high sensitivity for the need of MV and ICU admission. qNEWS can be used for quick and easy detection of critically ill AECOPD patients who need MV and ICU admission with its high specificity. More accurate scores are required to evaluate AECOPD patients.

Fig. 2 a ROC curves for NEWS, CREWS, S-NEWS, qNEWS, and qSOFA for detection of 30-day mortality and ICU admission. **b** ROC curves for NEWS, CREWS, S-NEWS, qNEWS, and qSOFA for detection of MV need and NIMV need. *ROC* receiver-operating characteristics, *NEWS* National Early Warning Score, *CREWS* Chronic Respiratory Early Warning Score, *S-NEWS* Salford-National Early Warning Score, *qNEWS* Quick National Early Warning Score, *qSOFA* Quick Sequential Organ Failure Assessment Score, *ICU* intensive care unit, *MV* mechanical ventilation

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