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Original Contribution

Comparison of Prognostic Scores for Patients with COVID-19 Presenting with Dyspnea in the Emergency Department

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□ **Abstract—Background: Easy-to-use bedside risk assessment is crucial for patients with COVID-19 in the overcrowded emergency department (ED). Objective: The aim of this study was to explore the prognostic ability of ratio of percutaneous oxygen saturation (SpO_2) to fraction of inspired oxygen (FiO_2) (S/F); ratio of SpO_2/FiO_2 to respiratory rate (ROX); National Early Warning Score (NEWS); quick Sequential Organ Failure Assessment (qSOFA); and confusion, respiratory rate, blood pressure, and age ≥ 65 years (CRB-65) in patients with COVID-19 presenting with dyspnea to the ED. Methods: In this retrospective observational study, clinical and demographic details of patients with COVID-19 were obtained at ED admission. S/F, ROX, NEWS, CRB-65, and qSOFA scores were calculated at the time of ED arrival. Accuracy of these five indices to predict the need for invasive mechanical ventilation (IMV) within 48 h, intensive care unit (ICU) admission, and early (7-day) mortality were determined using receiver operating characteristic curves. Results: A total of 375 patients were included in this study. Fifty patients (13.3%) required IMV within 48 h and 58 patients (15.5%) were transferred to the ICU. Seven-day mortality was 6.7% and 28-day mortality was 18.1%. Among all five scores determined from patient data on ED admission, ROX, S/F, and NEWS presented greater discriminatory performance than CRB-65 and qSOFA in predicting IMV within 48 h, ICU admission, and early mortality. Conclusions: Emergency physicians can effectively use S/F, ROX, and NEWS scores for rapid risk stratification of patients with COVID-19 infection. Moreover, from the perspective of simplicity and ease of calculation, we recommend the use of the S/F ratio. © 2023 Elsevier Inc. All rights reserved.**

□ **Keywords—COVID-19; SpO_2/FiO_2; ROX; NEWS; qSOFA; CRB-65; emergency department**

Introduction

In December 2022, with the termination of China's "zero-COVID" policy, an epidemic of COVID-19 broke out rapidly. Data indicated that > 85% of Chinese people were infected with COVID-19 during this period of the Omicron variant epidemic (1). The rapid and widespread epidemic seriously overloaded the already crowded emergency departments (EDs). Although this epidemic wave ended in January 2023, additional waves of infection and death may soon follow (2).

COVID-19 mainly involves the respiratory system, and its manifestations range from mild pneumonia to severe acute respiratory distress syndrome. Hypoxia and dyspnea are the main clinical manifestations in patients with COVID-19 who present to the ED. Patients with moderate or even severe COVID-19 may present well at ED admission but tend to deteriorate promptly. Therefore, rapid identification and triage of high-risk patients with

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COVID-19 in the ED are critical to the rational use of medical resources and saving patients' lives.

Different risk-stratification scores for patients with COVID-19 have been explored, such as ratio of percutaneous oxygen saturation (SpO_2) to fraction of inspired oxygen (FiO_2) (S/F); ratio of SpO_2/FiO_2 to respiratory rate (ROX); confusion, respiratory rate, blood pressure, and age $\geq$ 65 years (CRB-65); National Early Warning Score (NEWS); and quick Sequential Organ Failure Assessment (qSOFA), which are readily available bedside scores and can be calculated with simple and noninvasive parameters. Generally, the S/F and ROX indices are used as indicators to predict the failure of high-flow nasal oxygen (3,4). However, their use has been extended to other clinical situations, such as COVID-19 (5,6). CRB–65, an international decision support tool for identifying patients with community-acquired pneumonia, also offers good discriminatory value for predicting COVID-19 mortality (7). The NEWS, developed by the U.K. National Health Service, together with the qSOFA, has been suggested as a candidate for predicting the prognosis of severe COVID-19 with limited medical resources (7,8).

Although S/F, ROX, CRB–65, NEWS, and qSOFA scores can be used to assess the prognosis of patients with COVID-19, few studies have reported which parameter is more appropriate for patients with COVID-19 presenting to the ED. Therefore, in this study, we aimed to evaluate the prediction performance of current score rules in estimating early (48 h) invasive mechanical ventilation (IMV) requirement, intensive care unit (ICU) admission, and early (7–day) mortality among patients with COVID-19 presenting with dyspnea to the ED.

Materials and Methods

Study Design

We conducted a retrospective observational study to evaluate patients with dyspnea caused by SARS-CoV-2 infection who were admitted to the ED of Zhuhai People's Hospital, an urban tertiary hospital. Data were collected from December 14, 2022 to January 22, 2023, which was the first wave of the COVID-19 outbreak after the termination of China's zero-COVID policy. This study was approved by the Research Ethics Commission of Zhuhai People's Hospital. The ethics committee waived the requirement for informed consent due to the retrospective design of this study.

Participants

This study included patients with dyspnea confirmed to be infected with SARS-CoV-2 in the ED. *Dyspnea* was defined as "a subjective experience of respiratory discomfort, consisting of sensations of varying intensity, that includes the physician's perception of shortness of breath and the patient's response to that perception" and was noted on the patient's chart on arrival in the ED. A positive reverse transcription polymerase chain reaction (RT-PCR) result from an oral or nasopharyngeal swab was considered SARS-CoV-2 infection. The exclusion criteria included patients with SARS-CoV-2 without dyspnea, patients $<$ 18 years, pregnant patients, patients who were transferred from other hospitals, patients who were intubated before they arrived at the ED, and patients for whom it was impossible to collect parameters to calculate the analyzed indices.

Definitions

S/F was the percutaneous SpO_2/FiO_2. When patients received oxygen via nasal cannula, the FiO_2 was calculated by multiplying the flow rate of oxygen by 4 and adding 20. When patients received oxygen via simple oxygen masks, the FiO_2 corresponding to an oxygen flow rate of 5 L/min was 0.45; for a flow rate of 6 L/min, the FiO_2 was 0.5; for a flow rate of 7 L/min, the FiO_2 was 0.55; and for a flow rate of 8 L/min, the FiO_2 was 0.6. When oxygen therapy was administered with an oxygen reservoir bag, the FiO_2 corresponding to an oxygen flow rate of 6 L/min was 0.6; for a flow rate of 7 L/min, the FiO_2 was 0.7; and for a flow rate $\geq$ 8 L/min, the FiO_2 was 0.8 (9). The ROX index is defined as the ratio of SpO_2/FiO_2 to respiratory rate (RR) (10). The qSOFA scale is an integral of three parameters: RR $\geq$ 22 breaths/min, Glasgow Coma Scale (GCS) score $<$ 15, and systolic blood pressure (SBP) $\leq$ 100 mm Hg. Each parameter is 1 point, with a full score of 3 points (11). The NEWS (0–20 points) consists of heart rate (HR), RR, body temperature, SBP, state of consciousness, SpO_2, and need for oxygen supplementation; each parameter is assigned a score of 0–3 points (12). CRB-65 (0–4 points) measures confusion, RR $\geq$ 30 breaths/min, SBP $<$ 90 mm Hg or diastolic blood pressure (DBP) $\leq$ 60 mm Hg, and age $\geq$ 65 years (13).

Data Collection

We collected data on demographic characteristics; medical history; GCS scores; and vital signs, including SpO_2, FiO_2, RR, SBP, DBP, HR, and temperature, from the triage chart recorded by the emergency registered nurse at the time of initial patient contact. Scores were calculated for each patient on arrival at the ED based on five prognostic scoring rules, including S/F, ROX, CRB–65, NEWS, and qSOFA. RT-PCR test positivity, tracheal intubation and mechanical ventilation time, ICU admission date, and death date were obtained from the electronic

medical records. Hospital follow-up for inpatients was up to 120 days (cohort patients with the longest hospital stays).

Outcomes

When to start IMV and whether to transfer the patients to the ICU were determined by the attending physicians according to the Chinese COVID-19 clinical practice guidelines (14). The primary outcome of our study was IMV use within 48 h after ED admission. The secondary outcomes were ICU admission and 7-day mortality.

Statistical Analysis

Continuous variables are expressed as median and interquartile range (IQR) because the variables were not normally distributed (normal distribution was assessed by the Shapiro-Wilk test). We used the Mann-Whitney U test to compare continuous variables. Categorical variables are expressed as numbers and percentages and were compared using χ^2 tests (applying correction by continuity if necessary). We performed receiver operating characteristic (ROC) curve analysis to calculate the area under the ROC curve (AUROC) of the prediction models. The Youden index was used to determine the optimal cutoff point. We used VassarStats (http://vassarstats.net/index.html) to calculate sensitivity and specificity. Delong's test was used to compare ROC curves. Patients with missing data were excluded from the individual calculations. Statistical analysis was conducted using SPSS statistical package, version 26.0. A p value < 0.05 was considered significant for all statistical tests.

Results

Patient Characteristics

From December 14, 2022 to January 22, 2023, 454 patients with COVID-19 with respiratory distress arrived at the ED. Three hundred seventy-five patients with sufficient first assessment data to calculate ROX, qSOFA, CRB-65, S/F, and NEWS scores were included in our study. Of these, 223 were male (59.5%) and 152 were female (40.5%); median age was 76 years (IQR 21 years). The most common comorbidity was hypertension (53.9%), followed by chronic cardiac diseases (27.7%) and diabetes mellitus (25.9%). All of the included patients were infected with SARS-CoV-2 for the first time. Thirty-four patients (9.1%) had completed a primary COVID-19 vaccine series only, 56 patients (14.9%) had completed a primary series plus one booster dose, 136 patients (36.3%) had completed a primary series plus two booster doses, and 149 patients (39.7%) were unvaccinated. Overall, 50 patients (13.3%) needed IMV within 48 h, and 58 patients (15.5%) were admitted to the ICU. The 7-day mortality rate was 6.7% and the 28-day mortality rate was 18.1%. Age, male sex, cancer complications, admission vital signs (excluding temperature), laboratory parameters (including urea, creatinine, D-dimer and C-reactive protein), and score systems differed significantly between the IMV and non-IMV groups. Patient characteristics and the association of various parameters with early IMV requirement are summarized in Table 1.

Main Outcomes

For predicting early IMV, ROX demonstrated an AUROC of 0.82 (95% CI 0.75–0.89), S/F was 0.81 (95% CI 0.74–0.88), NEWS was 0.81 (95% CI 0.73–0.89), qSOFA was 0.74 (95% CI 0.66–0.82), and CRB-65 was 0.74 (95% CI 0.65–0.83). ROX was significantly better than qSOFA and CRB-65 and comparable with NEWS and S/F. The ROX cutoff set to 8.76 points displayed a sensitivity of 60% and a specificity of 95% in identifying the requirement for IMV. An S/F < 260 had a sensitivity of 60% and a specificity of 92%. A NEWS ≥ 9 showed a sensitivity of 66% and a specificity of 85%. A CRB-65 score ≥ 2 and qSOFA score ≥ 2 had sensitivities of 58% and 40% and specificities of 91% and 94%, respectively (Figure 1 and Table 2).

The AUROC of S/F for predicting ICU admission was 0.83 (95% CI 0.76–0.90), which was comparable with those of NEWS (0.82; 95% CI 0.76–0.88) and ROX (0.83; 95% CI 0.76–0.89), and was significantly better than those of qSOFA (0.72; 95% CI 0.64–0.79) and CRB-65 (0.62; 95% CI 0.53–0.72). The sensitivity and specificity for the S/F with a cutoff of 282.8 were 72% and 87%, respectively. A ROX score < 15.7 had a sensitivity of 84% and a specificity of 66%. A NEWS ≥ 7 displayed a sensitivity of 79% and a specificity of 75%. A CRB-65 score ≥ 2 and qSOFA score ≥ 1 had sensitivities of 41% and 84% and specificities of 89% and 48%, respectively (Figure 1 and Table 2).

The AUROCs of S/F (0.86; 95% CI 0.79–0.92), ROX (0.83; 95% CI, 0.75–0.91) and NEWS (0.82; 95% CI 0.73–0.91) showed no significant differences on comparison for early mortality and were significantly higher than the qSOFA (0.75; 95% CI 0.65–0.85) and CRB-65 (0.74; 95% CI 0.62–0.86) AUROCs. The sensitivity in identifying early mortality for a qSOFA score ≥ 1 was 88%, followed by an S/F ≥ 295.3 (80%), ROX score ≥ 8.59 (64%), CRB-65 score ≥ 2 (60%), and NEWS ≥ 10 (60%). The specificity in identifying early mortality for a ROX score ≥ 8.59 was 92%, followed by NEWS ≥ 10 (89%), CRB-65 score ≥ 2 (88%), S/F ≥ 295.3 (78%), and qSOFA score ≥ 1 (46%) (Figure 1 and Table 2).

Table 1. Baseline Characteristics Based on Invasive Mechanical Ventilation Requirement within 48 Hours

Characteristic	Total	IMV	Non-IMV	*p* Value
Patients with data, n (%)	375 (100)	50 (13.3)	325 (86.7)	NA
Age, years, median (IQR)	76 (21)	79 (17)	74 (20)	0.03
Male, n (%)	223 (59.5)	38 (76)	185 (56.9)	0.01
Comorbidities, n (%)				
Chronic cardiac disease	104 (27.7)	13 (26)	91 (28)	0.77
Chronic pulmonary disease	44 (11.7)	6 (12)	38 (11.7)	0.95
Chronic kidney disease	28 (7.5)	5 (10)	23 (7.1)	0.66
Diabetes mellitus	97 (25.9)	13 (26)	84 (25.8)	0.98
Chronic hypertension	202 (53.9)	26 (52)	176 (54.2)	0.78
Cerebrovascular disease	81 (21.6)	14 (28)	67 (20.6)	0.24
Cancer	30 (8)	9 (18)	21 (6.5)	0.01
Vital signs				
Temperature, °C, median (IQR)	37 (1.4)	37.4 (1.3)	37 (1.2)	0.21
SpO_2, %, median (IQR)	97 (5)	89 (16)	97 (3)	< 0.01
FiO_2, %, median (IQR)	21 (11)	36 (22)	21 (11)	< 0.01
RR, breaths/min, median (IQR)	21 (5)	28 (10)	21 (4)	< 0.01
HR, beats/min, median (IQR)	98 (29)	108 (37)	96 (28)	< 0.01
SBP, mm Hg, median (IQR)	140 (36)	128 (50)	141 (35)	0.02
DBP, mm Hg, median (IQR)	80 (22)	70 (23)	81 (21)	< 0.01
GCS < 15, n (%)	48 (12.8)	22 (44)	26 (8)	< 0.01
Laboratory parameters, median (IQR)				
Lymph, $\times 10^9$/L	0.8 (0.7)	0.7 (1.4)	0.8 (0.7)	0.9
Platelet, $\times 10^9$/L	176 (81)	183 (140)	175 (77)	0.6
Urea, mmol/L	7.1 (6.4)	10.4 (10.1)	6.9 (5.1)	< 0.01
Creatinine, μmol/L	83.5 (54.6)	108.3 (114)	82.1 (46.3)	0.01
d-dimer, mg/L	1.0 (2.1)	2.4 (3.1)	0.8 (1.8)	< 0.01
CRP, mg/L	32.3 (76.7)	97.6 (191)	24.7 (64.9)	< 0.01
Score systems, n (%)				
S/F $\geq$ 260	319 (85.1)	20 (40)	299 (92)	< 0.01
ROX $\geq$ 8.76	330 (88)	20 (40)	310 (95.4)	< 0.01
CRB–65 $\geq$ 2	59 (15.7)	29 (58)	30 (9.2)	< 0.01
NEWS $\geq$ 9	81 (21.6)	33 (66)	48 (14.8)	< 0.01
qSOFA $\geq$ 2	40 (10.7)	20 (40)	20 (6.2)	< 0.01

CRB–65 = confusion, respiratory rate, blood pressure, and age $\geq$ 65 years; CRP = C-reactive protein; DBP = diastolic blood pressure; FiO_2 = fraction of inspired oxygen; GCS = Glasgow Coma Scale; HR = heart rate; IMV = invasive mechanical ventilation; IQR, interquartile range; NA = not applicable; NEWS = National Early Warning Score; qSOFA = quick Sequential Organ Failure Assessment; ROX = ratio of SpO_2/FiO_2 to respiratory rate; RR = respiratory rate; SBP = systolic blood pressure; S/F = ratio of SpO_2/FiO_2; SpO_2 = percutaneous oxygen saturation.

Discussion

Predicting the outcome of SARS-CoV-2 infection based on current assays is quite difficult due to the presence of multiple confounding factors. Since the termination of China's zero-COVID policy, no validated scores have been proposed to precisely predict the poor outcome of patients with COVID-19 presenting to the ED.

A valuable score for ED should be noninvasive, readily available at the bedside, and able to detect patients who may deteriorate rapidly and require a higher intensity of care. Therefore, in this study, we externally validated and

Table 2. Comparison of Different Clinical Score Systems for Predicting Early Invasive Mechanical Ventilation Requirement, Intensive Care Unit Admission, and Early Mortality

Variable	AUROC (95% CI)	*p* Value	Cutoff value	Sensitivity (95% CI)	Specificity (95% CI)
Early IMV					
S/F	0.81 (0.74–0.88)	0.66	260	0.60 (0.45–0.73)	0.92 (0.88–0.95)
ROX	0.82 (0.75–0.89)	Ref	8.76	0.60 (0.45–0.73)	0.95 (0.92–0.97)
CRB–65	0.74 (0.65–0.83)	0.02	2	0.58 (0.43–0.72)	0.91 (0.87–0.94)
NEWS	0.81 (0.73–0.89)	0.39	9	0.66 (0.51–0.78)	0.85 (0.81–0.89)
qSOFA	0.74 (0.66–0.82)	< 0.01	2	0.40 (0.27–0.55)	0.94 (0.91–0.96)
ICU admission					
S/F	0.83 (0.76–0.90)	Ref	282.8	0.72 (0.59–0.83)	0.87 (0.83–0.90)
ROX	0.83 (0.76–0.89)	0.83	15.7	0.84 (0.72–0.92)	0.66 (0.61–0.71)
CRB–65	0.62 (0.53–0.72)	< 0.01	2	0.41 (0.29–0.55)	0.89 (0.85–0.92)
NEWS	0.82 (0.76–0.88)	0.76	7	0.79 (0.66–0.88)	0.75 (0.70–0.79)
qSOFA	0.72 (0.64–0.79)	< 0.01	1	0.84 (0.72–0.92)	0.48 (0.43–0.54)
Early mortality					
S/F	0.86 (0.79–0.92)	Ref	295.3	0.80 (0.59–0.92)	0.78 (0.73–0.82)
ROX	0.83 (0.75–0.91)	0.16	8.59	0.64 (0.43–0.81)	0.92 (0.89–0.95)
CRB–65	0.74 (0.62–0.86)	0.04	2	0.60 (0.39–0.78)	0.88 (0.84–0.91)
NEWS	0.82 (0.73–0.91)	0.23	10	0.60 (0.39–0.78)	0.89 (0.85–0.92)
qSOFA	0.75 (0.65–0.85)	< 0.01	1	0.88 (0.68–0.97)	0.46 (0.41–0.51)

AUROC = area under the receiver operating characteristic curve; CRB–65 = confusion, respiratory rate, blood pressure and age ≥ 65 years; ICU = intensive care unit; NEWS = National Early Warning Score; qSOFA = quick Sequential Organ Failure Assessment; Ref = reference; ROX = ratio of percutaneous oxygen saturation/fraction of inspired oxygen to respiratory rate; S/F = ratio of percutaneous oxygen saturation to fraction of inspired oxygen.

compared five noninvasive prognostic scores on three profiling outcomes: early IMV requirement, ICU admission, and early mortality among 375 patients with COVID-19 presenting with dyspnea to the ED.

In this study, the early IMV rate among our included patients was 13.3%, a percentage in accordance with that in a previous study (13%) (15). The ICU admission rate was 15.5%, higher than that in a previous study in a Geneva ED (10.2%) (16). The 7-day mortality was 6.7%, lower than the 9.5% mortality rate found in a multicenter retrospective cohort study (17). Moreover, we also found that no scoring system had both high sensitivity and specificity for predicting early IMV, ICU admission, or early mortality on ED arrival. However, in terms of the AUROC, NEWS, ROX, and S/F were comparable and were more accurate than qSOFA and CRB-65.

The qSOFA score, specifically used for risk stratification of patients with sepsis, and the CRB-65 rule, used to predict mortality from bacterial pneumonia, had low prognostic value in predicting early IMV requirement, ICU admission, and early mortality among patients with COVID-19 arriving at the ED, findings that were consistent with those of previous studies (18,19). This low predictive value seems biologically plausible because COVID-19 infection rarely leads to hemodynamic impairments, whereas respiratory distress and severe hypoxia due to viral infection are the leading causes of patient death. Thus, clinical models that perform well for patients with sepsis or bacterial pneumonia may be of limited value for patients with COVID-19.

The NEWS score, which consists of seven parameters (i.e., HR, RR, body temperature, SBP, state of consciousness, SpO_2 and need for oxygen supplementation), was implemented in 2012 by the NEWS Development and Implementation Group on behalf of the Royal College of Physicians (12). The NEWS is widely used for the assessment of, and response to, sepsis, and has also been proposed as a candidate prognostic predictor for COVID-19 (7). Moreover, in our study, NEWS performed better in terms of ICU admission, early IMV requirement and early mortality compared with qSOFA, another prognostic predictor of sepsis, in agreement with previous studies (20,21). Unlike sepsis, which usually exhibits multiple organ failure, COVID-19 is usually characterized by respiratory failure, and in the NEWS, three of the seven parameters are linked to the severity of respiratory failure, so in terms of the predictive value of COVID-19, NEWS performs better than qSOFA (22,23).

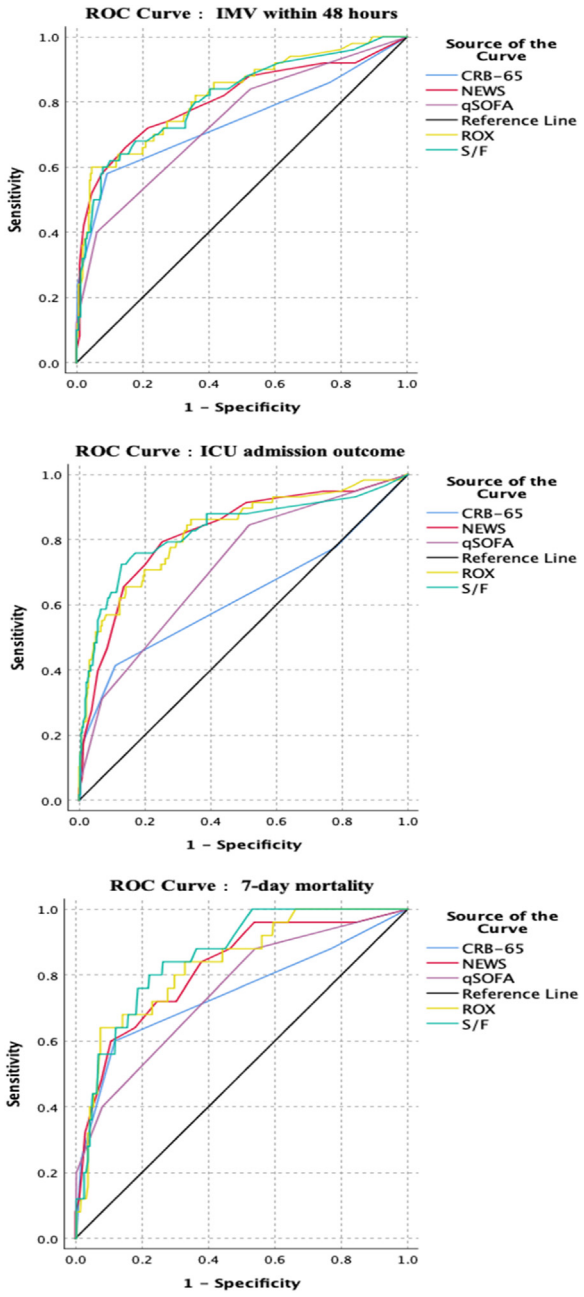

Figure 1. Receiver operating characteristic (ROC) curves comparing the ability of confusion, respiratory rate, blood pressure, and age ≥ 65 years (CRB-65), ratio of percutaneous oxygen saturation/fraction of inspired oxygen to respiratory rate (ROX), National Early Warning Score (NEWS), quick Sequential Organ Failure Assessment (qSOFA), and percutaneous oxygen saturation/fraction of inspired oxygen (S/F) score to predict early invasive mechanical ventilation (IMV) requirement, intensive care unit (ICU) admission, and early mortality.

The ROX index is the ratio of SpO_2/FiO_2 to RR, and it was initially designed to predict the success of high-flow nasal oxygen in patients with severe pneumonia (3). There have been many studies on using the ROX index to predict high-flow nasal cannula (HFNC) failure in patients with COVID-19, but few have used the ROX index for patients with COVID-19 undergoing non-HFNC treatment in EDs (24,25). The ROX index with a cutoff value of 5.99 detected by Vega et al. was lower than our value of 8.76, which may be due to the higher FiO_2 and flow levels used during HFNC treatment (26). In an ED setting similar to that in our study, Zaboli et al. assessed the ROX index in evaluating patients with COVID-19 at high evolutionary risk and found that the AUROC value for the risk of intubation was 0.727 (95% CI 0.634–0.821) (27). A study conducted by Arora et al. in an Indian hospital showed that ROX had good performance in determining 14-day mortality, with an AUROC of 0.91 (95% CI 0.88–0.94) (28). In addition, a study of 2122 patients with COVID-19 conducted by Martin et al. demonstrated a good discriminatory performance of the ROX index (AUROC 0.79; 95% CI 0.76–0.83) in predicting ICU admission (16). Consistent with these studies, ROX also performed well in predicting early IMV requirement, ICU admission, and early mortality in our study among patients with COVID-19 in the ED, with AUROCs of 0.82, 0.83, and 0.83, respectively. Therefore, our study found that the ROX index can be an effective tool for the early identification of high-risk patients with COVID-19 who present to the ED.

S/F, a noninvasive index, has an advantage in identifying the course of patients in EDs (6). Studies have also discovered a strong linear correlation between the S/F ratio and partial pressure of oxygen to FiO_2 ratio in patients with COVID-19, and these have been proven valuable in determining the mortality risk of patients with COVID-19 (6,29). Moreover, studies from Korea and China have found that S/F can be used as a prognostic marker for COVID-19 (30,31). Despite its lower sensitivity (0.60; 95% CI 0.45–0.73) in predicting the requirement for early IMV in our study conducted in the ED, S/F has the benefit of not requiring arterial blood collection and can be measured dynamically. In addition, in terms of the AUROC, given the "noninferiority" of S/F compared with NEWS and ROX, and its ease of calculation, we believe this score is the optimal tool for determining the prognosis of patients with COVID-19 in the ED.

Limitations

Our study had several limitations. First, this study had a retrospective design and was based on data from a single hospital, severely weakening its statistical power. Second, due to insufficient data, we excluded a relatively high proportion of patients (almost one-fifth), which may have biased the results, and future studies with large samples are still needed to validate our findings. Third, owing to the substantial fluctuation of SpO_2 measurements in various clinical situations, the S/F and ROX scores have

inherent limitations. For example, SpO_2 values may appear spuriously low in patients with shock with weak pulses, patients with severe anemia, or in patients with poorly cleaned fingers/nails during hypoxia (32). Finally, our study was conducted among patients with COVID-19 with symptoms of dyspnea during the Omicron epidemic, so our findings may not apply to patients infected with other COVID-19 variant strains.

Conclusions

The S/F, ROX, CRB–65, NEWS, and qSOFA score systems did not have both high sensitivity and specificity for predicting early IMV requirement, ICU admission, and early mortality among patients with COVID-19 with dyspnea at the time of ED arrival. However, in terms of the AUROC, NEWS, ROX, and S/F were comparable and were more accurate than qSOFA and CRB-65. From the viewpoint of simplicity and ease of calculation, we recommend using the S/F ratio.

Declaration of Competing Interest

The authors have no conflict of interest to declare with the subject matter or materials discussed in the manuscript.

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