

The Role of Simple Blood Tests and a Modified Chest X-Ray Scoring System in Assessing the Severity Disease and Mortality Risk in COVID-19 Patients in a Secondary Hospital, Indonesia

Soedarsono Soedarsono¹, Deri Yunita², Emma Ayu Lirani³, Robitha Kartika Sari³, Yoga Indrawan Pratama³, Afifah Listiati³, Bambang Supriyanto⁴

¹Sub-Pulmonology Department of Internal Medicine, Faculty of Medicine, Hang Tuah University, Surabaya, East Java, Indonesia; ²Medical and Health Service Management, Petrokimia Gresik Hospital, Gresik, East Java, Indonesia; ³Emergency Installation, Petrokimia Gresik Hospital, Gresik, East Java, Indonesia; ⁴Department of Radiology, Faculty of Medicine, Universitas Airlangga, Surabaya, East Java, Indonesia

Correspondence: Soedarsono Soedarsono, Email ssoedarsono@gmail.com

Background: Coronavirus disease 2019 (COVID-19) has resulted in millions of mortality cases and significant incremental costs to the healthcare system. Examination of CRP and D-dimer were considered to have higher costs, and the use of simple hematological parameters such as lymphocyte, neutrophil, and white blood cell (WBC) which have more affordable costs would be cost-saving. Radiological imaging complements clinical evaluation and laboratory parameters for managing COVID-19 patients. Therefore, categorizing patients into severe or non-severe becomes more defined, allowing for earlier interventions and decisions of hospital admission or being referred to a tertiary hospital.

Purpose: To evaluate the variables correlated with poor outcomes in COVID-19 patients.

Patients and Methods: This was a retrospective study on COVID-19 patients in a secondary referral hospital in treating COVID-19 in Indonesia. Demographic, clinical data, laboratory parameters, CXR (analyzed using a modified scoring system), and prognosis were collected through electronic nursing and medical records.

Results: This study included 476 hospitalized COVID-19 patients. Severe patients were commonly found with older age (median of 57 vs 40), dyspnea (percentage of 85.2% vs 20.5%), higher CXR score (median of 7 vs 5), higher levels of neutrophil (median of 79.9 vs 68.3), and lower lymphocyte levels (median of 13.4 vs 22.7), compared to non-severe patients. These variables were known to increase the odds of severe disease. Older age (median of 57 vs 48), SpO₂ <94% room air (percentage of 87.4% vs 31.5%), higher CXR score (median of 8 vs 5), and higher respiratory rate (median of 25 vs 20) were found higher in death patients and were known to increase the odds of death outcome.

Conclusion: The simple blood tests (neutrophil and lymphocyte) and modified CXR scoring system are useful in risk stratification for severe disease and mortality in COVID-19 patients to decide the earlier interventions and treatment.

Keywords: modified chest x-ray, prognosis of COVID-19, secondary hospital, simple blood tests

Introduction

A current global pandemic of coronavirus disease 2019 (COVID-19) caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) has spread rapidly and become a public health challenge all over the world.¹ As of 30 January 2022, over 370 million confirmed cases and over 5.6 million deaths have been reported globally.² The current COVID-19 pandemic is a complex challenge that has stretched health services globally, including Indonesia is currently experiencing a surge of cases of COVID-19. Thousands of deaths rapidly caused by this disease have put the national health system under pressure.^{3,4} Evidence of variables correlated with poor outcomes could assist medical staff in triaging patients when allocating limited health-care resources, especially in a secondary hospital.⁵

The rapid increasing patients with COVID-19 seeking admission to the emergency installation (cause lack of available resources). With the limited evidence of associated variables which can help determine the severity of the disease progression in COVID-19 patients, prioritizing hospital admission of non-critical patients was an arduous task. The criteria for hospital admission included the clinical symptoms of COVID-19, the presence of respiratory symptoms, and the level of blood oxygenation.⁶ During the examination, these subjective clinical symptoms can be interpreted more confidently with the use of biological markers (biomarkers). These provide objective values throughout the progression of the disease.⁷

Laboratory biomarkers to forecast the severity of COVID-19 are essential in a pandemic because resource allocation must be carefully planned, especially in the context of respiratory support readiness.⁸ Increased CRP and D-dimer correlated with poor outcomes, including severe COVID-19 and mortality.^{8–10} However, as has been known that COVID-19 has already resulted in significant incremental costs to the healthcare system.¹¹ The examination of CRP and D-dimer were considered to have higher costs, and the use of simple hematological parameters such as lymphocyte, neutrophil, and white blood cell (WBC) which have more affordable costs would be cost-saving and become a routine test for every hospitalized patient. As has been reported in the previous study that lower lymphocyte counts and higher levels of WBC count at admission were significantly correlated with death in COVID-19 patients.^{12,13}

Chest radiography has limited sensitivity and specificity for the identification of patients with SARS-CoV-2 infection but can help identify patients with the disease. The severity of lung involvement at chest radiography in SARS-CoV-2 infection is closely correlated with many key outcomes for patients, including intensive care unit (ICU) admission and death. Several scoring systems for assessing the severity of lung involvement in SARS-CoV-2 infection have been described in the literature. The most widely used and studied systems include Brixia and radiographic assessment of lung edema (RALE/modified RALE).¹⁴ However, the lack of availability of digital imaging of chest X-ray (CXR) in the secondary hospital is a challenge. CXR may not be as sensitive as CT, but it still plays a major role in developing countries that lack more sophisticated modalities. Henceforth, a modified scoring system has been adopted from Brixia and RALE scoring systems demonstrated by Setiawati et al is very useful.¹⁵

Effective biomarkers would be helpful for screening, clinical management, and prevention of serious complications.¹⁶ Radiological imaging complements clinical evaluation and laboratory parameters for managing COVID-19 patients.¹⁷ Therefore, categorizing patients into severe or non-severe becomes more defined, allowing for earlier interventions and decisions of hospital admission. Although CRP and D-dimer have been reported to correlate with poor outcome, the higher costs of CRP and D-dimer examination has resulted in significant pressure on the healthcare system.^{8–11} This study was conducted to evaluate the variables correlated with poor outcomes (severity and mortality of COVID-19) to find the simple variables which are more cost-effective to determine the risk stratification for severe disease and outcome of death in COVID-19 patients.

Materials and Methods

Study Design and Ethical Statement

This was a retrospective study in patients with confirmed COVID-19 in Petrokimia Gresik Hospital, a secondary referral hospital for treating COVID-19 from March 2020 to October 2021. This study was approved by the ethics committee with ethical clearance number 49/EC/KEPK/FKUA/2022. This study was conducted in accordance with the Declaration of Helsinki. All participants included had given their written informed consent to participate in this study during admission. In cases of decreased consciousness and severe illness, written informed consent was represented by next of kin.

Data Collection and Study Definition

Demographic, clinical data, laboratory parameters, chest X-ray (CXR), and prognosis (outcome) were collected through electronic nursing and medical records using a standardized data collection form. Inclusion criteria included confirmed COVID-19 with age ≥ 18 years old. Exclusion criteria included patients with incomplete medical record data. Confirmed cases were defined as consistent with clinical manifestations, and microbiological evidence for SARS-CoV-2 by real-time

reverse transcription-polymerase chain reaction (RT-PCR) assay. The severity of COVID-19 was defined as severe ($\text{SpO}_2 < 94\%$ on room air) and non-severe ($\text{SpO}_2 \geq 94\%$ on room air). The laboratory parameters we evaluate included C-reactive protein (CRP), white blood cell (WBC), D-dimer, neutrophil, lymphocyte, aspartate aminotransferase (AST), and alanine aminotransferase (ALT). CXR score used the modified CXR scoring system by Setiawati et al with the maximum score for the Modified Chest X-ray scoring system being 12. The final scores were then classified further into mild (score 1–4), moderate (score 5–8) and severe (score 9–12).¹⁵

Data Analysis

Results of continuous data were analyzed for Tests of Normality with Kolmogorov–Smirnov Tests. Continuous data were expressed as median (minimum–maximum) and compared by the Mann–Whitney test. Categorical variables were expressed as numbers (percentages) and compared by Chi-square tests or Fisher’s exact test. Logistic regression analysis was used to explore the risk factors associated with severity and mortality. Logistic regression between all variables with and without CRP, D-dimer, and AST/ALT were compared. This was to evaluate the results when CRP, D-dimer, and AST/ALT were not examined to reduce the costs. Statistical analyses were performed using SPSS (v.21.0 by IBM Corporation, New York, United States), and a P -value < 0.05 was considered statistically significant.

Results

Characteristics of Study Subjects

This study included 476 hospitalized patients with confirmed COVID-19. The median age was 52 years, ranging from 19 to 81 years. The severe group was significantly older than non-severe group, with a median age of 57 years (24–81 years) vs 40 years (19–79 years), $P < 0.001$. Co-morbidities were also found higher in severe group than non-severe group, including diabetes mellitus (36.9% vs 18.3%, $P < 0.001$), hypertension (37.4% vs 14.3%, $P < 0.001$), cardiovascular disease (21.7% vs 7%, $P < 0.001$), and renal disease (6.4% vs 2.6%, $P = 0.039$).

COVID-19 Patients According to the Severity Disease

Compared to the non-severe group, the severe group was more common to report dyspnea or shortness of breath, fever, cough, nausea, fatigue, and loss of appetite with $P < 0.001$, 0.001, < 0.001 , 0.005, < 0.001 , and < 0.001 , respectively. CXR score in the severe group was also found higher, compared to the non-severe group with a median score of 7 (1–12) vs 5 (1–11), $P < 0.001$. The classified final score of CXR into the severe category also accounted higher in the severe group than the non-severe group with 36% vs 8.8%, $P < 0.001$. Results of laboratory tests also showed numerous differences between the severe group and non-severe group, including CRP, D-dimer, WBC, neutrophil, lymphocyte, AST, and ALT. These results are presented in [Table 1](#).

COVID-19 Patients According to Treatment Outcome

The mortality rate in this study was 95/476 (20%). Patients with the outcome of death were found to have older age, compared to discharge patients, with a median age of 57 years vs 48 years, $P < 0.001$. Patients with the outcome of death were also more likely to have co-morbidities of diabetes mellitus, hypertension, and cardiovascular disease. According to the severity of CXR, severe lung lesion in the death group has a higher percentage than discharge group (44.2% vs 14.4%, $P < 0.001$). Compared to discharge patients, patients with the outcome of death have a lower level of lymphocytes and higher levels of CRP, D-dimer, WBC, neutrophil, and AST ([Table 2](#)).

Logistic Regression Analysis for Severe Disease and Mortality

Results of logistic regression analysis ([Table 3](#)) revealed that although CRP, D-dimer, and AST/ALT were not performed, parameters of neutrophil and lymphocyte could be used to evaluate the risk for severe disease. Older age (OR 1.06, 95% CI 1.04–1.09), dyspnea (OR 12.82, 95% CI 7.24–22.69), higher CXR score (OR 1.18, 95% CI 1.06–1.33), higher levels of neutrophil (OR 1.18, 95% CI 1.08–1.29), and lower lymphocyte levels (OR 1.17, 95% CI 1.06–1.29) were significantly positively correlated with severe disease in patients with COVID-19.

Table 1 Characteristics of COVID-19 Patients According to the Severity Disease

Variable	Severe (n = 203)	Non Severe (n = 273)	P-value
Age (years) (Median (min-max))	57 (24–81)	40 (19–79)	<0.001
Sex			0.519
Men	122 (60.1%)	172 (63%)	
Women	81 (39.9%)	101 (37%)	
Co-morbid			
Diabetes mellitus	75 (36.9%)	50 (18.3%)	<0.001
Hypertension	76 (37.4%)	39 (14.3%)	<0.001
Asthma	5 (2.5%)	3 (1.1%)	0.252
Tuberculosis	5 (2.5%)	2 (0.7%)	0.121
Cardiovascular disease	44 (21.7%)	19 (7%)	<0.001
Liver disease	6 (3%)	7 (2.6%)	0.795
Renal disease	13 (6.4%)	7 (2.6%)	0.039
HIV	1 (0.5%)	1 (0.4%)	1.000
Sign and symptoms			
Dyspnea	173 (85.2%)	56 (20.5%)	<0.001
Fever	135 (66.5%)	140 (51.3%)	0.001
Cough	165 (81.3%)	170 (62.3%)	<0.001
Congestion or runny nose	61 (30%)	72 (26.4%)	0.377
Sore throat	24 (11.8%)	37 (13.6%)	0.576
Nausea	87 (42.9%)	83 (30.4%)	0.005
Vomit	37 (18.2%)	38 (13.9%)	0.202
Headache	49 (24.1%)	80 (29.3%)	0.210
Fatigue	113 (55.7%)	82 (30%)	<0.001
Loss of appetite	110 (54.2%)	70 (25.6%)	<0.001
Diarrhea	16 (7.9%)	15 (5.5%)	0.297
Loss of smell (anosmia)	38 (18.7%)	61 (22.3%)	0.335
Loss of taste (ageusia)	25 (12.3%)	29 (10.6%)	0.565
CXR score (Median (min-max))	7 (1–12)	5 (1–11)	<0.001
Severity CXR			<0.001
Severe	73 (36%)	24 (8.8%)	
Moderate	99 (48.8%)	114 (41.8%)	
Mild	31 (15.3%)	135 (49.5%)	

(Continued)

Table 1 (Continued).

Variable	Severe (n = 203)	Non Severe (n = 273)	P-value
Laboratory findings (Median (min-max))			
C-reactive protein	52.7 (1.2–321.7)	18.3 (0.15–249)	<0.001
D-dimer	790 (0.1–9370)	0.75 (0.03–5137)	<0.001
WBC	7.8 (3.1–41.8)	6.5 (1.9–48.3)	<0.001
Neutrophil	79.9 (20.1–95.7)	68.3 (24.9–93.9)	<0.001
Lymphocyte	13.4 (1.2–75.4)	22.7 (0.1–49.4)	<0.001
AST	60 (15–567)	35 (10–1248)	<0.001
ALT	42 (8–555)	33 (4–727)	<0.001

Abbreviations: ALT, alanine aminotransferase; AST, aspartate aminotransferase; CXR, chest x-ray; HIV, human immunodeficiency virus; WBC, white blood cell.

In terms of CRP, D-dimer, and AST/ALT were not performed, variables correlated with the outcome of death in COVID-19 patients were older age (OR 1.03, 95% CI 1.01–1.06), SpO₂ <94% room air (OR 3.04, 95% CI 1.38–6.69), higher CXR score (OR 1.14, 95% CI 1.02–1.27), and higher respiratory rate (OR 1.11, 95% CI 1.05–1.18). This is presented in Table 4.

Discussion

Patients with SARS-CoV-2 infection can experience a range of clinical manifestations, from no symptoms to critical illness.¹⁸ Efficient diagnosis and information on the prognosis of the disease are needed to mitigate the burden on the healthcare system as well as to provide the best possible care for patients.⁵ The availability of variables correlated with severe disease and mortality would be beneficial, not only to triage patients but also to monitor hospitalized patients.⁶

In this current study, older age increased the risk for severe disease (OR 1.06, 95% CI 1.04–1.09) and outcome of death (OR 1.03, 95% CI 1.01–1.06), according to Tables 3 and 4. Another hospital-based retrospective cohort study by Surendra et al also reported that the risk of death was associated with higher age, while a systematic review with the meta-analysis by Starke et al reported that the risk for severe COVID-19 (hospitalization) and case mortality increased along with increasing age. There was no evidence of a specific age threshold at which the risk accelerates considerably. The confidence of evidence was high for mortality and hospitalization.^{19,20} Sex was not correlated both with severe disease and outcome of death in our study. Du et al also reported no correlation between sex and mortality, while Surendra et al reported that male sex is the risk factor for death outcome.^{19,21}

Dyspnea, fever, cough, fatigue, and loss of appetite were more commonly reported in patients with severe disease and the outcome of death (Tables 1 and 2). A previous study also reported higher rates of upper respiratory symptoms, dyspnea, muscle pain, and gastrointestinal symptoms in mortality cases of COVID-19.²² Common clinical features include major symptoms such as fever, cough, dyspnea, and minor symptoms such as altered sense of smell and taste, gastrointestinal symptoms, and cutaneous manifestations.²³ Result of regression analysis revealed that dyspnea was the only symptom that correlated with severe disease (12.82, 95% CI 7.24–22.69) (Table 3). Booth et al also reported dyspnea as the risk of severe outcomes (OR 8.68, 95% CI 8.25–9.11).²³

In our emergency installation, measurement of SpO₂ and respiratory rate was one of the basic tests to categorize patients into severe or non-severe. Besides, simple blood tests and CXR results were also used to make earlier interventions and decisions on COVID-19 management. Information on demographic, clinical symptoms and co-morbidities were used for early assessment. This current study showed that vital measures included SpO₂ <94% room

Table 2 Characteristics of COVID-19 Patients According to the Final Outcome

Variable	Death (n = 95)	Discharge (n = 381)	P-value
Age (Median (min-max))	57 (30–81)	48 (19–79)	<0.001
Sex			0.755
Men	60 (63.2%)	234 (61.4%)	
Women	35 (36.8%)	147 (38.6%)	
Co-morbid			
Diabetes mellitus	40 (42.1%)	85 (22.3%)	<0.001
Hypertension	39 (41.1%)	76 (19.9%)	<0.001
Asthma	0 (0%)	8 (2.1%)	0.367
Tuberculosis	1 (1.1%)	6 (1.6%)	1.000
Cardiovascular disease	23 (24.2%)	40 (10.5%)	<0.001
Liver disease	4 (4.2%)	9 (2.4%)	0.302
Renal disease	7 (7.4%)	13 (3.4%)	0.092
HIV	0 (0%)	2 (0.5%)	1.000
Sign and symptoms			
Dyspnea	83 (87.4%)	146 (38.3%)	<0.001
Fever	64 (67.4%)	211 (55.4%)	0.034
Cough	76 (80%)	259 (68%)	0.024
Congestion or runny nose	36 (37.9%)	97 (25.5%)	0.021
Sore throat	8 (8.4%)	53 (13.9%)	0.173
Nausea	34 (35.8%)	136 (35.7%)	1.000
Vomit	17 (17.9%)	58 (15.2%)	0.523
Headache	21 (22.1%)	108 (28.3%)	0.221
Fatigue	55 (57.9%)	140 (36.7%)	<0.001
Loss of appetite	55 (57.9%)	125 (32.8%)	<0.001
Diarrhea	9 (9.5%)	22 (5.8%)	0.191
Loss of smell (anosmia)	18 (18.9%)	81 (21.3%)	0.619
Loss of taste (ageusia)	13 (13.7%)	41 (10.8%)	0.422
SpO₂ <94% room air	83 (87.4%)	120 (31.5%)	<0.001
Respiratory rate (Median (min-max))	25 (15–60)	20 (15–40)	<0.001
CXR score (Median (min-max))	8 (2–12)	5 (1–12)	<0.001

(Continued)

Table 2 (Continued).

Variable	Death (n = 95)	Discharge (n = 381)	P-value
Severity CXR			<0.001
Severe	42 (44.2%)	55 (14.4%)	
Moderate	40 (42.1%)	173 (45.4%)	
Mild	13 (13.7%)	153 (40.2%)	
Laboratory findings (Median (min-max))			
C-reactive protein	53.2 (9.3–321.7)	38.1 (0.15–201.5)	<0.001
D-dimer	1120 (0.1–9370)	3.29 (0.03–5192)	<0.001
WBC	8.3 (3.3–41.8)	6.6 (1.9–48.3)	<0.001
Neutrophil	80.9 (42.3–95.7)	72.5 (20.1–95.2)	<0.001
Lymphocyte	12.6 (1.2–55.7)	20.4 (0.1–75.4)	<0.001
AST	67 (17–1248)	39 (10–501)	<0.001
ALT	38 (8–727)	36 (4–495)	0.110

Abbreviations: ALT, alanine aminotransferase; AST, aspartate aminotransferase; CXR, chest x-ray; HIV, human immunodeficiency virus; WBC, white blood cell.

Table 3 Logistic Regression Analysis for Severe Disease

Variables	OR	95% CI
Included all variables		
Older age	1.06	1.03–1.08
Dyspnea	10.61	5.94–18.92
CXR score	1.16	1.04–1.31
Lymphocyte	1.17	1.06–1.30
D-dimer	1.00	1.00–1.01
Neutrophil	1.18	1.08–1.29
CRP, D-dimer, and AST/ALT were not performed		
Older age	1.06	1.04–1.09
Dyspnea	12.82	7.24–22.69
CXR score	1.18	1.06–1.33
Neutrophil	1.18	1.08–1.29
Lymphocyte	1.17	1.06–1.29

Abbreviations: ALT, alanine aminotransferase; AST, aspartate aminotransferase; CRP, c-reactive protein; CXR, chest x-ray; CI 95%, confidence interval 95%; OR, odds ratio.

air (OR 3.04, 95% CI 1.38–6.69) and higher respiratory rate (OR 1.11, 95% CI 1.05–1.18) were correlated with the outcome of death. Previous studies in COVID-19 patients also reported respiratory rate and SpO₂ as the risk for poor outcome.^{22,23}

Table 4 Logistic Regression Analysis for Outcome of Death

Variables	OR	95% CI
Included all variables		
Older age	1.03	1.00–1.06
SpO ₂ <94% room air	3.55	1.61–7.83
Respiratory rate	1.10	1.03–1.17
CRP	1.01	1.00–1.02
D-dimer	1.00	1.00–1.00
AST (SGOT)	1.00	1.00–1.06
CRP, D-dimer, and AST/ALT were not performed		
Older age	1.03	1.01–1.06
SpO ₂ <94% room air	3.04	1.38–6.69
CXR score	1.14	1.02–1.27
Respiratory rate	1.11	1.05–1.18

Abbreviations: ALT, alanine aminotransferase; AST, aspartate aminotransferase; CRP, c-reactive protein; CXR, chest x-ray; CI 95%, confidence interval 95%; OR, odds ratio.

Many studies reported diabetes, chronic kidney disease, and hypertension as risk factors for mortality in COVID-19 patients.^{19,24,25} However, although diabetes mellitus, hypertension, and cardiovascular disease were more common significantly in patients with severe disease and outcome of death, those co-morbidities were not correlated with increased risk of severe disease and outcome of death in our study. The management of COVID-19 patients with co-morbidity using appropriate medical care is an imperative step towards their survival.²⁶ Implementation of adequate protection and interventions for COVID-19 patients in general and in particular having co-morbidities may significantly reduce the risk of mortality associated with COVID-19.²⁷ Previous study in South Korea found that patients with non-allergic asthma had a greater risk of SARS-CoV-2 test positivity and worse clinical outcomes of COVID-19 than patients with allergic asthma.²⁸ However, asthma in severe patients and non-severe patients was not significantly different in our study. In the routine examination in our hospital, patients with asthma are not distinguished between allergic asthma and non-allergic asthma in our hospital. Therefore, it is not written in the medical record.

Laboratory markers have been proposed for risk stratification.⁸ Regression analysis in our study showed that a higher level of D-dimer (OR 1.00, 95% CI 1.00–1.01) was correlated with risk for severe disease. While in terms of CRP, D-dimer, and AST/ALT were not performed, identified variables correlated with risk for the severe disease were older age, dyspnea, higher CXR score and higher levels of neutrophils, and lower lymphocyte levels (Table 3). This result suggested that the examination of neutrophils and lymphocytes could also be used in risk stratification for severe disease. Identified biomarkers included hematological (lymphocyte count, neutrophil count, neutrophil-lymphocyte ratio), inflammatory C-reactive protein (CRP), and biochemical (D-dimer, aspartate aminotransferase) have been identified as correlated with poor outcome, including severe COVID-19 and mortality.^{8–10,16}

Characteristics of hyper inflammation which consist of elevated serum CRP and D-dimer were also found in critically ill patients.⁸ D-dimer is commonly elevated in patients with COVID-19. D-dimer levels correlate with disease severity and are a reliable prognostic marker for in-hospital mortality in patients admitted for COVID-19.¹⁰ In logistic regression analysis for the outcome of death, CRP (OR 1.01, 95% CI 1.00–1.02), D-dimer (OR 1.00, 95% CI 1.00–1.00), and AST (OR 1.00, 95% CI 1.00–1.06) were correlated with increased odds of mortality (Table 4). In terms of CRP, D-dimer, and AST/ALT were not performed, older age, SpO₂ <94% room air, higher CXR score, and higher respiratory rate were correlated with increased odds of mortality in our study (Table 4).

Radiological examination is reported to play an important role in the diagnosis of COVID-19.¹⁵ Imaging has been also considered to complement clinical evaluation and laboratory parameters in the management of patients already diagnosed with COVID-19.²⁹ The use of a modified CXR scoring system in our study showed that higher CXR score was correlated with increased odds for severe disease in our study (OR 1.16, 95% CI 1.04–1.31) and odds for outcome of death (OR 1.14, 95% CI 1.02–1.27), as presented in Table 4. A previous study reported that this modified score system is significantly correlated with the clinical severity of the disease, although its correlation coefficient was lower than the Brixia score and RALE score.¹⁵ CXR findings are very good predictors for assessing the course of COVID-19 disease and they could be used for long-term consequences monitoring.³⁰ CXR scoring system using RALE score was correlated with risk for mortality (OR 6.82, 95% CI 2.07–22.44).³¹ This modified scoring system can help determine the severity of the disease progression in COVID-19 patients, especially in areas with shortages of facilities and specialists.¹⁵

According to the finding of this study, we concluded that to determine the risk stratification for poor outcomes, the examination of CRP and D-dimer can be replaced with simple blood tests (including neutrophil and lymphocyte examination) which were more cost-effective. The modified CXR scoring system could also be used to make it easier while reading the results, especially in the secondary hospital with the lack of availability of digital imaging of CXR. The limitations of this study: the examination of procalcitonin as a marker of inflammation caused by bacterial co-infection was not performed in all patients, especially in non-severe COVID-19 patients. While in some other studies, it was reported that procalcitonin could be used as a predictor for severity or mortality.

Conclusion

Older age, dyspnea, higher CXR score, higher levels of neutrophil, and lower lymphocyte levels were variables correlated with severe disease in patients with COVID-19. Variables correlated with the outcome of death in COVID-19 patients were older age, SpO₂ <94% room air, higher CXR score, and higher respiratory rate. We suggested that the simple blood tests (including neutrophil and lymphocyte examination) and modified CXR scoring system are useful in risk stratification for severe disease and mortality in COVID-19 patients, and can be used as a parameter in referring patients to the hospitals with better facilities.

Abbreviations

ALT, alanine aminotransferase; AST, aspartate aminotransferase; ED, emergency department; COVID-19, coronavirus disease-2019; CRP, c-reactive protein; CXR, chest x-ray; ICU, intensive care unit; OR, odds ratio; CI, confidence interval; RALE, radiographic assessment of lung edema; RT-PCR, real-time reverse transcription-polymerase chain reaction; SARS-CoV-2, severe acute respiratory syndrome coronavirus-2; WBC, white blood cell.

Disclosure

The authors report no conflicts of interest in this work.

References

1. World Health Organization. WHO Director-General's opening remarks at the media briefing on COVID-19-11 March 2020. 2020. Available from: <https://www.who.int/director-general/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19---11-march-2020>. Accessed June 22, 2022.
2. World Health Organization. COVID-19 weekly epidemiological update. World Health Organization. 2022;1–23. Available from: <https://www.who.int/publications/m/item/covid-19-weekly-epidemiological-update>. Accessed June 22, 2022.
3. Hafiz M, Icksan AG, Harlivasar AD, et al. Association between clinical, laboratory findings and chest CT in COVID-19 in a secondary hospital in Jakarta, Indonesia. *Germes*. 2021;11:32–38. doi:10.18683/germes.2021.1238
4. Briggs T, Project G, Navaratnam A, et al. *Clinical Practice Guide for Improving the Management of Adult COVID-19 Patients in Secondary Care*. NHS; 2020.
5. Wynants L, Van Calster B, Collins GS, et al. Prediction models for diagnosis and prognosis of covid-19: systematic review and critical appraisal. *BMJ*. 2020;369. doi:10.1136/bmj.m1328
6. Garrafa E, Vezzoli M, Ravanelli M, et al. Early prediction of in-hospital death of covid-19 patients: a machine-learning model based on age, blood analyses, and chest x-ray score. *Elife*. 2021;10:1–20. doi:10.7554/eLife.70640
7. Kernali M, Khalsa RK, Pillai K, et al. The role of biomarkers in diagnosis of COVID-19 – a systematic review. *Life Sci*. 2020;254:117788. doi:10.1016/j.lfs.2020.117788

8. Huang I, Pranata R, Lim MA, et al. C-reactive protein, procalcitonin, D-dimer, and ferritin in severe coronavirus disease-2019: a meta-analysis. *Ther Adv Respir Dis*. 2020;14:1753466620937175. doi:10.1177/1753466620937175
9. Wang D, Li R, Wang J, et al. Correlation analysis between disease severity and clinical and biochemical characteristics of 143 cases of COVID-19 in Wuhan, China: a descriptive study. *BMC Infect Dis*. 2020;20:1–9. doi:10.1186/s12879-020-05242-w
10. Yao Y, Cao J, Wang Q, et al. D-dimer as a biomarker for disease severity and mortality in COVID-19 patients: a case control study. *J Intensive Care*. 2020;8:1–11. doi:10.1186/s40560-020-00466-z
11. Coe E, Enomoto K, Finn P, et al. Understanding the hidden costs of COVID-19's potential impact on US healthcare; 2020:14. Available from: <https://www.mckinsey.com/industries/healthcare-systems-and-services/our-insights/understanding-The-hidden-costs-of-covid-19s-potential-impact-on-us-healthcare#>. Accessed June 22, 2022.
12. Zhang HJ, Qi GQ, Gu X, et al. Lymphocyte blood levels that remain low can predict the death of patients with COVID-19. *Medicine*. 2021;100:e26503. doi:10.1097/MD.00000000000026503
13. Zhu B, Feng X, Jiang C, et al. Correlation between white blood cell count at admission and mortality in COVID-19 patients: a retrospective study. *BMC Infect Dis*. 2021;21:1–5. doi:10.1186/s12879-021-06277-3
14. Au-Yong I, Higashi Y, Giannotti E, et al. Erratum: chest radiograph scoring alone or combined with other risk scores for predicting outcomes in covid-19: a UK study. *Radiology*. 2021;301:E444. doi:10.1148/radiol.2021219021
15. Setiawati R, Widyoningroem A, Handarini T, et al. Modified chest X-ray scoring system in evaluating severity of COVID-19 patient in Dr. Soetomo general hospital Surabaya, Indonesia. *Int J Gen Med*. 2021;14:2407–2412. doi:10.2147/IJGM.S310577
16. Ponti G, Maccaferri M, Ruini C, et al. Biomarkers associated with COVID-19 disease progression. *Crit Rev Clin Lab Sci*. 2020;57:389–399. doi:10.1080/10408363.2020.1770685
17. Abougazia A, Alnuaimi A, Mahran A, et al. Chest X-ray findings in COVID-19 patients presenting to primary care during the peak of the first wave of the pandemic in Qatar: their association with clinical and laboratory findings. *Pulm Med*. 2021;2021:1–8. doi:10.1155/2021/4496488
18. National Institutes of Health. Treatment Guidelines Panel. Coronavirus disease 2019 (COVID-19). National Institutes of Health; 2022:1–243. Available from: <https://www.covid19treatmentguidelines.nih.gov/>. Accessed June 22, 2022.
19. Surendra H, Elyazar IR, Djaafara BA, et al. Clinical characteristics and mortality associated with COVID-19 in Jakarta, Indonesia: a hospital-based retrospective cohort study. *Lancet Reg Heal*. 2021;9:100108.
20. Starke KR, Reissig D, Petereit-Haack G, et al. The isolated effect of age on the risk of COVID-19 severe outcomes: a systematic review with meta-analysis. *BMJ Glob Heal*. 2021;6:1–12.
21. Du RH, Liang LR, Yang CQ, et al. Predictors of mortality for patients with COVID-19 pneumonia caused by SARS-CoV-2: a prospective cohort study. *Eur Respir J*. 2020;55:2000524. doi:10.1183/13993003.00524-2020
22. Azarkar G, Osmani F. Clinical characteristics and risk factors for mortality in COVID-19 inpatients in Birjand, Iran: a single-center retrospective study. *Eur J Med Res*. 2021;26:1–8. doi:10.1186/s40001-021-00553-3
23. Booth A, Reed AB, Ponzo S, et al. Population risk factors for severe disease and mortality in COVID-19: a global systematic review and meta-analysis. *PLoS One*. 2021;16:1–30. doi:10.1371/journal.pone.0247461
24. Osibogun A, Balogun M, Abayomi A, et al. Outcomes of COVID-19 patients with comorbidities in southwest Nigeria. *PLoS One*. 2021;16:1–12. doi:10.1371/journal.pone.0248281
25. Panagiotou OA, Kosar CM, White EM, et al. Risk factors associated with all-cause 30-day mortality in nursing home residents with COVID-19. *JAMA Intern Med*. 2021;181:439–448. doi:10.1001/jamainternmed.2020.7968
26. Ejaz H, Alsrhani A, Zafar A, et al. COVID-19 and comorbidities: deleterious impact on infected patients. *J Infect Public Health*. 2020;13:1833–1839. doi:10.1016/j.jiph.2020.07.014
27. Biswas M, Rahaman S, Biswas TK, et al. Association of sex, age, and comorbidities with mortality in COVID-19 patients: a systematic review and meta-analysis. *Intervirology*. 2021;64:36–47. doi:10.1159/000512592
28. Yang JM, Koh HY, Moon SY, et al. Allergic disorders and susceptibility to and severity of COVID-19: a nationwide cohort study. *J Allergy Clin Immunol*. 2020;146(4):790–798. doi:10.1016/j.jaci.2020.08.008
29. Akl EA, Blazic I, Yaacoub S, et al. Use of chest imaging in the diagnosis and management of COVID-19: a WHO rapid advice guide. *Radiology*. 2021;298:E63–E69. doi:10.1148/radiol.2020203173
30. Yasin R, Gouda W. Chest X-ray findings monitoring COVID-19 disease course and severity. *Egypt J Radiol Nucl Med*. 2020;51(1). doi:10.1186/s43055-020-00296-x
31. Sensusiati AD, Amin M, Nasronudin N, et al. Age, neutrophil-lymphocyte ratio, and radiographic assessment of the quantity of lung edema (RALE) score to predict in-hospital mortality in COVID-19 patients: a retrospective study. *F1000Research*. 2021;9:1–13. doi:10.12688/f1000research.26723.2

International Journal of General Medicine

Dovepress

Publish your work in this journal

The International Journal of General Medicine is an international, peer-reviewed open-access journal that focuses on general and internal medicine, pathogenesis, epidemiology, diagnosis, monitoring and treatment protocols. The journal is characterized by the rapid reporting of reviews, original research and clinical studies across all disease areas. The manuscript management system is completely online and includes a very quick and fair peer-review system, which is all easy to use. Visit <http://www.dovepress.com/testimonials.php> to read real quotes from published authors.

Submit your manuscript here: <https://www.dovepress.com/international-journal-of-general-medicine-journal>