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Validation of the MuLBSTA Scale in Predicting the Mortality Risk of SARS-CoV-2 in the Iranian Population; A pilot study

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Abstract

Background: MuLBSTA is a scale designed for easy clinical assessment of the mortality risk of viral pneumonia patients.
Objectives: The overall purpose of conducting this research is to investigate the effectiveness of MuLBSTA in estimating the mortality risk of COVID-19 patients.
Methods: A cross-sectional study was performed on 99 COVID-19 patients from December 2020 to February 2021. The MuLBSTA scores of patients were calculated, and their survival and risk rates were estimated by the Kaplan-Meier method. The ROC diagram was used for the logistic model assessment to determine the best mortality prediction cut-off point. Data were analyzed in SPSS version 21 at the 0.05 significance level.
Results: Of the 99 monitored patients, 69 (69.69%) recovered, and 30 (30.31%) died during the study period. The mean MuLBSTA scores of patients who recovered and died were 10.51±3.99 and 16.53±3.02, respectively. A statistically significant positive relationship was found between MuLBSTA scores and mortality ($p<0.001$). The area under the ROC curve (AUC) of MuLBSTA in predicting mortality during hospitalization was calculated to be 0.88 (95%CI=0.82-0.95, SE=1.55).
Conclusion: MuLBSTA scores are highly correlated with the severity of COVID-19. Therefore, MuLBSTA can serve as a tool for rapid situation assessment and swift decision-making about the treatment approach and the allocation of hospital resources to COVID-19 patients.

Keywords: Clinical Decision Rules, SARS-CoV-2 ,Mortality, Viral Pneumonia

1. Background

Contagious infectious diseases can have a devastating impact on the health of the human population. The COVID-19 pandemic showed how a contagious disease can turn into a health threat on a global scale (1). The first case of the disease, later called COVID-19, was reported in late December 2019 in Wuhan City, Hubei Province, China (2-6). In February 2020, the World Health Organization (WHO) named the virus COVID-19, and the International Committee on Taxonomy of Viruses (ICTV) named it SARS-COV-2(1, 2, 4, 7, 8). COVID-19 belongs to the same family as Severe Acute Respiratory Syndrome (SARS) and Middle East Respiratory Syndrome (MERS) (5). This virus affected over 4 million people and caused 300,000 fatalities by early 2020 (9).

The high transmission rate of COVID-19 should be attributed to its easy transmission through asymptomatic carriers or people with mild symptoms (3, 10). Thanks to this high transmission rate, COVID-19 spread rapidly in all countries, causing a global epidemic with implications ranging from mild to severe respiratory problems to death (2, 11). Recent estimates revealed that fifteen percent of people with COVID-19 showed a severe form of this viral pneumonia, and 5 to 10% will require intensive care. The mortality rate among this section of the population is 3 to 5% (11). Several factors, including age, history of smoking, history of diabetes and leukocytosis have been identified as important determinants of the course of this disease (2, 3, 7, 12). To diagnose this disease, it is first necessary to ask whether the person has come into contact with a COVID-19-positive or suspected individual and then perform a CT scan of the lung, looking for multifocal spots in its peripheral and posterior parts. Finally, the diagnosis can be confirmed by a PCR assay (7). According to WHO, a diagnosis without a positive PCR test cannot be considered definite. It should be noted that PCR assays are subject to error, especially if the sample is small or the test is performed in the first five days of exposure (2, 7).

Viral infections can manifest as acute respiratory distress syndrome (ARDS) or bacterial super-infections. Cytokines and chemokines can be potential markers for these diseases, as severe infections tend to cause a spike in serum levels (13).

While there are a variety of measures, such as CRB-65 and CURB-65, for the clinical prediction of community-acquired pneumonia, there is still no

widely accepted rule for scoring the severity of viral pneumonia. MuLBSTA is a mortality risk prediction scale designed for easy clinical assessment of the mortality risk of patients with viral pneumonia. It has been shown that MuLBSTA has good predictive power with a c-index of 0.811, sensitivity of 0.776, and specificity of 0.778 (13). This study investigated the effectiveness of MuLBSTA in predicting the mortality risk of COVID-19 patients.

2. Objectives

The overall purpose of conducting this research is to investigate the effectiveness of MuLBSTA in estimating the mortality risk of COVID-19 patients.

3. Methods

This cross-sectional study was conducted on 99 patients admitted to COVID-19 inpatient and intensive care units of Imam Reza Hospital, Mashhad University of Medical Sciences, Mashhad, Iran, from December 2020 to February 2021. Patients were selected by simple random sampling. The study was approved by the Mashhad University of Medical Sciences ethics committee (IR.MUMS.REC.1399.570).

The inclusion criteria were 18 years of age and a positive PCR test. The patients who unwillingness to participate in the study were excluded.

After obtaining informed consent, demographic data of participating patients were collected. Then, the MuLBSTA scale was completed based on routine laboratory findings, chest HRCT, Bac-tec blood culture, and sputum culture (as bacterial growth and diagnostic criteria). A follow-up was conducted after 90 days for discharged patients to determine whether they survived the disease.

A demographic information questionnaire and the form of the MuLBSTA scale were completed. The data collected in the demographic information questionnaire included contact information, age, sex, history of diabetes, history of cardiovascular diseases, smoking or history of smoking, history of hypertension, hyperlipidemia, consciousness condition, and weight.

The MuLBSTA scale is a seven-item table with each item's score. The items of this scale include multi-lobular lung involvement (infiltration), blood lymphocyte count, bacterial infection, current smoker, former smoker, history of hypertension, and age of over 60 years. The total score of this scale is a number between 0 and 22. A score of 0-10 predicts low risk, 11-15 predicts moderate risk, and 16-22 predicts high mortality risk over the next 90 days (Table 1) (13).

The collected data were analyzed in SPSS software version 21. The Kolmogorov-Smirnov test assessed the normality of data. Survival rates and risk rates were estimated by the Kaplan-Meyer method. The logistic model assessment used the ROC diagram to determine the best mortality prediction cut-off point. Data were analyzed in SPSS version 21, and the P values of <0.05 were considered statistically significant.

Table 1. MuLBSTA scoring system for mortality risk prediction in patients with viral pneumonia

Parameters	Score	
	No	Yes
Multi-lobular lung involvement (infiltration)	0	5
Lymphocyte count ≤ 109*0.8 per liter	0	4
Bacterial coinfection	0	4
Current smoker	0	3
Former smoker	0	2
Hypertension	0	2
Age ≥60 years	0	2

4. Result

Ninety-nine COVID-19 patients admitted from December 2020 to February 2021 entered the study. The patients had a mean age of 58.89±20.57, 60.81±19.21 for males, and 56.30±22.25 for females. Of the 99 patients, 57 (57.6%) were male (p=0.111). The mean time between the onset of symptoms and hospitalization was 7±3.3 days, and the mean hospitalization time was 5.94±3.69 days. Of the 99 patients, 69 (69.69%) recovered, and 30 (30.31%) died during the study period. The mean MuLBSTA score of patients who recovered and those who died was 10.51±3.99 and 16.53±3.02, respectively. The normal data were analyzed based on their means and standard deviations. For non-normal data, the median (IQR) was used for this purpose. The Kolmogorov-Smirnov test assessed the normality of data.

The logistic regression results showed a positive relationship between the MuLBSTA score and mortality (p<0.001). With each unit increase in the MuLBSTA score, the odds of death of COVID-19 patients increased by 55% (95%CI = 1.29-1.85, OR=1.55) (Table 2).

Table 2. Relationship between MuLBSTA score and mortality rate of COVID-19 patients

Variable	OR	P-Value	95% confidence interval
MuLBSTA	1.55	<0.001	(1.29-1.85)
Constant	0.001	<0.001	

The area under the ROC curve (AUC) of MuLBSTA in predicting mortality during hospitalization was calculated to be 0.88 (95%CI=0.82-0.95, SE=1.55) (Table 3). The sensitivity and specificity of the scale at the cut-off point of 12.5 were found to be 0.90 and 0.67, respectively (Figure 1).

Table 3. Estimates of 90-day mortality risk according to the MuLBSTA scale

90-day mortality risk (%)	Total number of deaths	Frequency	MuLBSTA score
0	0	39	4-10
68.12%	10 (28.6%)	35	11-15
90.34%	20 (80%)	25	16-22

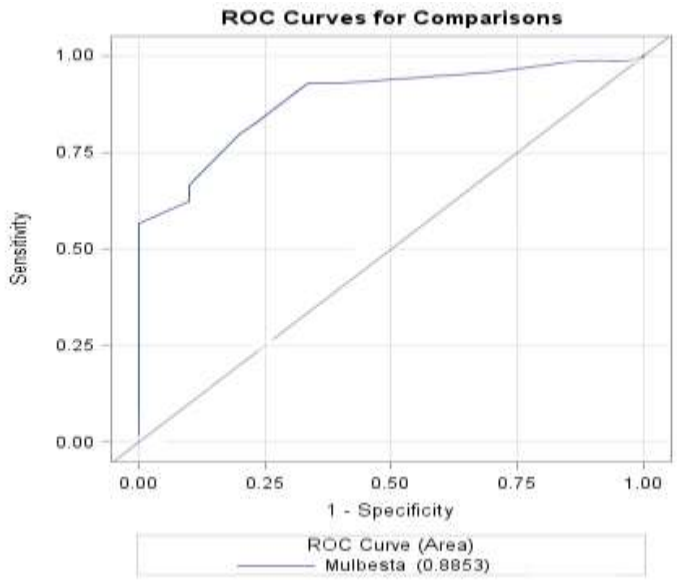

Figure 1. Sensitivity of the MuLBSTA scale for COVID-19 patients

We used the Kaplan-Meier method to estimate patients' survival and risk rates. All of these analyses were also conducted at the 0.05 significance level. For this analysis, patients were

categorized into three groups according to their MuLBSTA score: low risk (with scores of 0-10), moderate risk (with scores of 11-15), and high risk (with scores of 16-22). Then, the total number of deaths and the estimated 90-day mortality risk were determined for each group. In the low-risk group (39 patients), the total number of deaths was zero, and the estimated 90-day mortality risk was also zero. In the moderate-risk group (35 patients), the total number of deaths was 10 (28.6%), and the estimated 90-day mortality risk was 63.12%. From the 25 patients in the high-risk group, the total number of deaths was 20 (80.0%), and the estimated 90-day mortality risk was 90.34%. The 10-day survival rate (from the date of admission) estimated based on the MuLBSTA score was 19.22% for the moderate-risk group and 63.77% for the high-risk group (Figure 2).

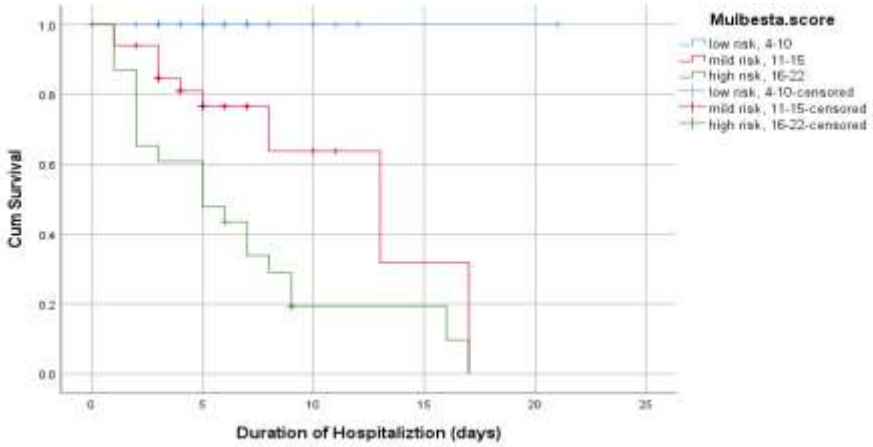

Figure 2. 90-day mortality risk of COVID-19 patients according to MuLBSTA score

The results showed significant differences between patients who recovered and died regarding the mean blood lymphocyte count, LDH, and ESR values. More specifically, later-recovered patients had significantly higher lymphocyte levels and lower LDH and ESR levels (Table 4).

Table 4. Relationship between MuLBSTA variables and mortality

Variable	All patients	Recovered patients	Diseased patients	P-Value
Lymphocyte	20 (10-30)	26 (17-34)	9 (6-20)	<0.001*
LDH	555 (410-699)	514 (392-664)	632.50 (453.50-856.75)	0.02*
SO2	9.88±2.39	62.16±17.73	66.02±28.01	0.55
ESR	34 (15-57)	32 (15.50-52.50)	47.50 (13.75-79.75)	0.09
PO2	44 (35-54)	42.30 (32.62-53.40)	45 (36.15-55.95)	0.18
PCO2	40.90 (38.85-50.65)	41.40 (36.92-50.47)	40 (33.30-60.75)	0.62

5. Discussion

This study investigated the effectiveness of the MuLBSTA scale in estimating the mortality risk of COVID-19 from December 2020 to February 2021.

In terms of demographic characteristics, most of the patients were elderly, with a higher number of males than females. However, the statistical analyses showed no significant relationship between gender and the disease, which is consistent with the findings of Wang et al. (14). In a study by Bei Ma et al., it was stated that women are less likely to get viral infections, probably because of the presence of sex hormones and X chromosome and their impact on innate and acquired immunity. Nevertheless, they observed that men were less likely to contract the disease, so they recommended further research on the relationship between gender and the incidence of COVID-19 (15). Also, since the mortality of COVID-19 patients is closely associated with immunodeficiency, immunological evaluations can provide useful information for predicting the general condition of these patients (13). One of the reasons why COVID-19 is more dangerous for the elderly (higher mortality rate at higher ages) is the generally weaker immune system of this section of the population (2).

In this study, the mean time between the onset of symptoms and hospitalization was seven days, and the mean hospitalization time was about six days, similar to the figures reported in other studies (16, 17). This study also showed that early and supportive treatment initiation could improve the recovery rate. Cheng et al. (18) study results are getting along with our findings.

While the seven items of MuLBSTA (multi-lobular infiltration, lymphocyte count, bacterial infection, current smoker, former smoker, hypertension, and age>60) have been designed for predicting the mortality rate of patients with viral pneumonia, this scale can also be used to estimate the mortality risk of COVID-19 (19). In the present study, the mean MuLBSTA score of patients who died was 16.53±3.02. In a study by Chen et al., patients with MuLBSTA scores of more than 12 were put in the high-risk group, and in a study by Cheng et al., the corresponding mean score was 13.5(18, 20).

In this study, the area under the ROC curve (AUC) of MuLBSTA in predicting mortality during hospitalization was calculated to be 0.88 (95%CI=0.82-0.95, SE=1.55). In a study by Guo et al., the sensitivity and specificity of MuLBSTA in mortality risk assessments were reported to be 0.6364 and 0.9355, respectively (13). Cheng et al. have also reported that MuLBSTA offers better mortality risk assessment than CURB-65 (p=0.0021). Therefore, MuLBSTA can be recommended as the scale of choice for mortality risk predictions (15, 18, 21).

In this study, admitted COVID-19 patients had significantly reduced leukocyte counts (p=0.002). Therefore, it is possible to use reduced leukocyte count to indicate the clinical diagnosis of severe COVID-19 cases. This is also consistent with other studies in this area (15).

In this study, the increased serum LDH level was also significantly related to mortality (p=0.02). Numerous studies have shown a direct relationship between the severity and mortality rate of COVID-19 and cardiovascular diseases and hypertension (19, 21). With more comprehensive studies, it may be possible to use this variable to improve the performance of MuLBSTA.

6. Conclusion

In general, the characteristics of COVID-19 patients monitored in this study were consistent with the scoring system of MuLBSTA. Also, the results of this study suggest that MuLBSTA scores are highly correlated with the severity of COVID-19 and can be used as a measure for rapid situation assessment and rapid and precise decision-making about the course of treatment of COVID-19 patients.

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Conflicts of interest

There are no conflicts of interest.

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