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Assessment of the Modified CHA2DS2VASc Risk Score in Predicting Mortality in Patients Hospitalized With COVID-19

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Since the modified CHA2DS2VASC (M-CHA2DS2VASc) risk score includes the prognostic risk factors for COVID-19; we assumed that it might predict in-hospital mortality and identify high-risk patients at an earlier stage compared with troponin increase and neutrophil-lymphocyte ratio (NLR). We aimed to investigate whether M-CHA2DS2VASC RS is an independent predictor of mortality in patients hospitalized with COVID-19 and to compare its discriminative ability with troponin increase and NLR in terms of predicting mortality. A total of 694 patients were retrospectively analyzed and divided into 3 groups according to M-CHA2DS2VASC RS which was simply created by changing gender criteria of the CHA2DS2VASC RS from female to male (Group 1, score 0-1 (n = 289); group 2, score 2-3 (n = 231) and group 3, score ≥4 (n = 174)). Adverse clinical events were defined as in-hospital mortality, admission to intensive care unit, need for high-flow oxygen and/or intubation. As the M-CHA2DS2VASC RS increased, adverse clinical outcomes were also significantly increased (Group 1, 3.8%; group 2, 12.6%; group 3, 20.8%; p <0.001 for in-hospital mortality). The multivariate logistic regression analysis showed that M-CHA2DS2VASC RS, troponin increase and neutrophil-lymphocyte ratio were independent predictors of in-hospital mortality (p = 0.005, odds ratio 1.29 per scale for M-CHA2DS2VASC RS). In receiver operating characteristic analysis, comparative discriminative ability of M-CHA2DS2VASC RS was superior to CHA2DS2VASC RS score. Area under the curve (AUC) values for in-hospital mortality was 0.70 and 0.64, respectively. ($AUC_{M\text{-}CHA2DS2\text{-}VASc}$ vs. $AUC_{CHA2DS2\text{-}VASc}$ z test = 3.56, p 0.0004) In conclusion, admission M-CHA2DS2VASc RS may be a useful tool to predict in-hospital mortality in patients with COVID-19. **(Am J Cardiol 2020;135:143−149)**

Older age, male gender, hypertension (HTN), diabetes mellitus (DM), previous cardiovascular disease and high neutrophil-lymphocyte ratio (NLR) were identified as the risk factors associated with mortality in COVID-19.[1−3] Also, cardiovascular system was noticeably influenced[4,5] and troponin rise was strongly related to increased risk of mortality.[6] The CHADS2VASc risk score is principally used for estimating the risk of ischemic stroke in patients with atrial fibrillation (AF) and also predicts mortality in various cardiovascular diseases.[7,8] COVID-19 is highly associated with in-hospital arterial or venous tromboembolic events.[9] As the CHADS2VASc score is mainly designed to estimate the risk of trombosis and many of its components are also prognostic risk factors for COVID-19 except female gender; we aimed to increase its predictive ability for mortality by simply changing the gender parameter from female to male. Main purposes of our study were defined as investigation of the modified CHADS2VASc (M-CHADS2VASc) score as an independent predictor of in-hospital mortality and comparison of its discriminative performance with troponin increase and NLR in terms of predicting mortality.

Methods

A total of 717 Turkish patients diagnosed with COVID-19 from March 20 to May 25, 2020 were enrolled in our study which was conducted in Sisli Hamidiye Etfal Education and Research Hospital, in Istanbul, Turkey. Data were retrospectively analyzed. Exclusion criteria were defined as end stage malignancies and severe frailty based on the attending physician's discretion. Of the screened patients, those with the following were excluded: 10 owing to frailty, 5 due to end-stage malignancy and 8 due to loss of records. This resulted in 694 research subjects meeting the criteria for final analysis. This study complied with the edicts of the 1975 Declaration of Helsinki and was approved by the local ethics committee.

Demographic, laboratory and clinical information were obtained from electronic medical records. Demographic and clinical data included age, gender, presence of DM,

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HTN, hyperlipidemia, smoking status, congestive heart failure, previous cardiovascular disease, chronic obstructive pulmonary disease (COPD), previous cerebrovascular disease, chronic renal disease, and length of hospital stay. The laboratory data confined to the first week of hospitalization included complete blood count and detailed biochemical parameters. NLR was calculated by dividing the neutrophil count by the lymphocyte count. Myocardial injury was defined as high sensitive cardiac troponin I above the 99th percentile reference upper limit of the healthy people. Severe infection was identified by the presence of any of the following: respiratory rate ≥30 breaths/min; blood oxygen saturation ≤93%; PaO2/ FiO2 ratio <300; >50% lesion progress in 24 to 48 hours showed by lung imaging, respiratory failure necessitating mechanical ventilation, and admission to the intensive care unit.[10]

CHADS score was determined by assigning one point for each factor such as congestive heart failure, hypertension, age >75 years and DM, and 2 points were given for a history of transient ischemic attack and/or stroke. CHA2DS2VASC score was calculated by giving one point for each factor such as congestive heart failure, HTN, age 65 to74 years, DM, vascular disease and female gender, and 2 points were given for age 75 years or older and a history of transient ischemic attack and/or stroke.[11] Gender criteria of the CHA2DS2VASC score was arbitrarily switched from female to male because male sex was reported as an important predictor of mortality according to recent studies conducted with COVID-19 patients. Thus, we aimed to improve the predictive ability of the CHADS2-VASc score for mortality. This novel score was named as modified CHA2DS2VASC (M-CHA2DS2VASC) score.

Study population was categorized into three groups according to their M-CHA2DS2VASC scores; group 1, score 0-1 (n = 289); group 2, score 2-3 (n = 231) and group 3, score ≥4 (n = 174). Adverse clinical end points were defined as in-hospital mortality, need for high-flow oxygen and/or invasive mechanical ventilation therapy (intubation) and intensive care unit (ICU) admission.

Continuous variables were reported as median and interquartile ranges whereas categorical variables were presented as percentages. The Kolmogorov-Smirnov test was performed to test the normality of distributions.The one-way analysis of variance (ANOVA) with post-hoc analysis (Tukey and Bonferonni tests) or Kruskal-Wallis test for continuous variables and the chi-square test for categorical variables were used for comparison between the study groups based on the M-CHA2DS2VASC tertiles. Independent predictors of in-hospital mortality was determined by the logistic regression analysis. The predictive accuracy and performance of the CHA2DS2-VASc RS, M-CHA2DS2VASC RS, CHADS RS, high troponin level and NLR were calculated with receiver operating characteristic (ROC) curves for in-hospital mortality. These ROC curves were compared using the De-Long method. A goodness-of-fit test for the scoring systems was performed using the Hosmer-Lemeshow method to evaluate differences between the model-predicted and observed event rates. C statistics was used to assess of the predictive ability of the model used in logistic regression analysis. Values of p <0.05 were considered statistically significant. SPSS 22 software (SPSS Inc, Chicago, Illinois) was used to carry out all statistical analysis.

Results

Tables 1 and 2 demonstrated the demographic, clinical features, and laboratory parameters of the study group according to M-CHA2DS2VASC RS. Patients in the high M-CHADSVASC RS tertile were older with a more frequent history of DM, HTN, hyperlipidemia, stroke, cardiovascular disease, heart failure, chronic kidney disease, malignancy (p <0.001, for all), and COPD (p = 0.004). Troponin I, creatine kinase-MB, neutrophil counts, glucose, urea, creatinine, C reactive protein, procalcitonin (p <0.001, for all), and ferritin levels (p = 0.004) were tended to increase progressively from a lower M-CHA2DS2VASC to higher M-CHA2DS2VASC tertile. But hemoglobin levels and lymphocyte counts were tended to decrease from a lower M-CHA2DS2VASC to higher M-CHA2DS2VASC tertile (p <0.001 respectively). Additionally the incidence of severe infection (40 [13.8%], 67 [29%], 64 [36.8%] group 1, group 2 and group 3, respectively; p<0.001), length of hospital stay (7 [5-9, 8 {6-11}, 9 [6-13] group 1, group 2 and group 3, respectively; p <0.001), NLR (p <0.001), alanin aminotransferase (p <0.001), aspartat aminotransferase (p = 0.001), total bilirubine (p = 0.01), and activated partial thromboplastin time (p = 0.005) levels were higher compared with patients with a lower M-CHADSVASC tertile than higher M-CHA2DS2VASC tertile. In-hospital medications were similar between the groups except oseltamivir and favipravir therapy (p = 0.008 and 0.02, respectively).

Figure 1 shows the rates of in hospital mortality, intensive care unit admission, invasive mechanic ventilation, and high flow oxygen demand among the groups. The high M-CHA2DS2VASC tertile had a significantly higher prevalence of adverse events compared with the other 2 groups.

The results of univariate and multivariate logistic regression analysis were demonstrated in Table 3. A multivariate logistic regression analysis was performed for in hospital mortality, based on the following variables: M-CHA2DS2-VASC RS, Troponin I level, NLR, chronic kidney disease, smoking, COPD, previous malignancy, lactate dehydrogenase (LDH), procalcitonin, and ferritin levels. Among these variables, M-CHA2DS2VASC RS, Troponin I, NLR, LDH, procalcitonin and ferritin levels were identified as independent predictors of in hospital mortality. CHADS, and CHA2DS2VASc scores were not included in this model because they contained similar variables with M-CHA2DS2VASc score. The predictive ability of our model was evaluated using C statistics and had a good discriminative capacity in predicting in-hospital death (C statistics 0.88, 95% confidence interval (CI) 0.84 to 0.92). Nonsignificant results from the Hosmer−Lemeshow test demonstrated that the calibrations of both our model and M-CHA2DS2-VASc to predict adverse events were accurate in our study. (p 0.28 and 0.10, respectively)

ROC analysis comparing the predictive accuracy of M-CHA2DS2VASC RS, CHA2DS2VASC RS, CHADS RS Troponin I and NLR for in hospital mortality is shown in Figure 2. Based on a 95% CI, the areas under the curve (AUC) for M-CHA2DS2-VASc RS, CHA2DS2-VASc RS,

Table 1
The clinical and demographic features of the study population according to M-CHADSVASC score

	M-CHADSVASC 0-1 (n = 289)	M-CHADSVASC 2-3 (n = 231)	M-CHADSVASC > 4 (n = 174)	p Value	Post-hoc analysis
Age (years)	48 (38-55)	64 (57-72)	76 (70-81)	<0.001	Group1vs2 p <0.001 Group1vs3 p <0.001 Group2vs3 p <0.001
Men	152 (52.6%)	136 (58.9%)	112 (64.4%)	0.04	
Diabetes mellitus	14 (4.8%)	79 (34.2%)	94 (54%)	<0.001	
Hypertension	30 (10.4%)	154 (66.7%)	165 (94.8%)	<0.001	
Hypercholesterolemia	10 (3.5%)	38(16.5%)	62 (35.6%)	<0.001	
Smoker	46 (15.9 %)	55 (23.8 %)	31 (17.8 %)	0.07	
Previous CVD	3 (1%)	47 (20.3%)	111 (63.8%)	<0.001	
COPD	22 (7.6%)	37 (16%)	28 (16.1%)	0.004	
Heart failure	0	3 (1.3%)	39 (22.4%)	<0.001	
Chronic kidney disease	10 (3.5%)	16 (6.9%)	37 (21.3%)	<0.001	
Previous stroke	0	5 (2.2 %)	28 (16.1%)	<0.001	
Severe infection	40 (13.8%)	67 (29%)	64 (36.8%)	<0.001	
Previous malignancy	7 (2.4%)	17 (7.4%)	30 (17.2%)	<0.001	
Length of hospital stay (days)	7 (5-9)	8 (6-11)	9 (6-13)	<0.001*	Group1vs2 p 0.007 Group1vs3 p <0.001 Group2vs3 p 0.18
CHADSVASC RS	0 (0-1)	2 (1-3)	4 (3-5)	<0.001*	Group1vs2 p <0.001 Group1vs3 p <0.001 Group2vs3 p <0.001
M-CHADSVASC RS	1 (0-1)	3 (2-3)	4 (4-5)	<0.001*	Group1vs2 p <0.001 Group1vs3 p <0.001 Group2vs3 p <0.001
CHADS RS	0	1 (1-2)	2 (2-3)	<0.001*	Group1vs2 p 0.001 Group1vs3 p <0.001 Group2vs3 p <0.001
NLR	2.96 (2-4.96)	3.43(2.45-6.39)	5.02(2.82-9.98)	<0.001*	Group1vs2 p <0.001 Group1vs3 p <0.001 Group2vs3 p 0.003
In-hospital medications					
Hydroxychloroquine	286 (99%)	230 (99.6%)	171 (98.3%)	0.44	
Oseltamivir	187 (64.7%)	137 (59.3%)	87 (50%)	0.008	
Favipravir	34 (11.8%)	46 (19.9%)	33 (19%)	0.02	
Azithromycin	54 (18.7%)	50 (21.6%)	48 (27.6%)	0.08	
Lopinavir/ritonavir	18 (6.2%)	15 (6.5%)	4 (2.3%)	0.12	

CVD = cardiovascular disease; COPD = chronic obstructive pulmonary disease; NLR = neutrophil-lymphocyte ratio; RS = risk score.
* Kruskal-Wallis test.

CHADS RS Troponin I, NLR were 0.70, 0.64, 0.65, 0.88, and 0.76, respectively ($p < 0.001$, for all). We performed a pair-wise comparison of ROC curves, and found that the predictive value of M-CHA2DS2-VASc RS with regard to in hospital mortality was better than the CHADS and CHA2DS2-VASc RS, similar to that of NLR, whereas inferior to the troponin I. (by DeLong method, $AUC_{M\text{-}CHA2DS2\text{-}VASc}$ vs $AUC_{CHA2DS2VASc}$ z test = 3.56, p = 0.0004; $AUC_{M\text{-}CHA2DS2VASc}$ vs AUC_{CHADS} z test = 2.78, p = 0.005; $AUC_{M\text{-}CHA2DS2VASc}$ vs AUC_{NLR} z test = 1.58 p = 0.11; $AUC_{M\text{-}CHA2DS2VASc}$ vs $AUC_{TROPONIN\text{-}I}$ z test = 6.08 $p < 0.001$).

Discussion

The results of our study suggest that M-CHA2DS2-VASC score has a good discriminative ability to predict in-hospital mortality in patients hospitalized with COVID-19. Similar to the current reports investigating the prognostic risk factors for COVID-19; our results indicated that male sex was strongly associated with increased risk of in-hospital mortality. In this respect, the discriminative performance of the CHADS2VASC score was obviously improved by simply changing its gender component from female to male. Additionally, the M-CHA2DS2VASC score was found to be superior to the CHADS and CHA2DS2-VASC scores; whereas similar to NLR and inferior to troponin increase in terms of predicting mortality. Also, it was determined as an independent predictor of in-hospital mortality in COVID-19 patients.

Previous studies demonstrated that patients with cardiac injury had more in-hospital adverse clinical outcomes in COVID-19.[12] Similarly, our findings showed that the highest troponin levels and the vast majority of deaths were recorded in group 3 patients (M-CHA2DS2-VASc scores (≥4). Elevation in cardiac troponin levels was commonly reported few days after hospitalization, especially 1 week preceding the death.[13] Therefore, using M-CHA2DS2-VASC score at the time of hospital admission may be more advantageous for earlier risk stratification in comparison

Table 2
Biochemical characteristics of the study population according to M-CHADSVASC score

	M-CHADSVASC 0-1 (n = 289)	M-CHADSVASC 2-3 (n = 231)	M-CHADSVASC >4 (n = 174)	p Value	Post-hoc analysis
Troponin I (ng/dl)	2.9 (2.3-5.7)	7 (3.8-22)	20.5 (8.3-73.5)	<0.001*	Group1vs2 p <0.001 Group1vs3 p <0.001 Group2vs3 p <0.001
CK-MB (ug/L)	0.9 (0.5-1.6)	1.4 (0.9-3)	2 (1.1-3.5)	<0.001*	Group1vs2 p <0.001 Group1vs3 p <0.001 Group2vs3 p 0.007
D-dimer (ug/L)	531 (340-817)	722 (479-1340)	874 (643-1575)	<0.001*	Group1vs2 p <0.001 Group1vs3 p <0.001 Group2vs3 p 0.005
White blood cell (/mm^3)	5560 (4380-7455)	6350 (4650-8610)	7120 (5235-10515)	<0.001*	Group1vs2 p 0.025 Group1vs3 p <0.001 Group2vs3 p 0.045
Neutrophil (/mm^3)	3780 (2770-5540)	4420 (3100-6570)	5228 (3645-8028)	<0.001*	Group1vs2 p 0.001 Group1vs3 p <0.001 Group2vs3 p 0.025
Lymphocyte (/mm^3)	1250 (920-1675)	1150 (800-1580)	1015 (707-1500)	0.001*	Group1vs2 p 0.24 Group1vs3 p <0.001 Group2vs3 p 0.094
Hemoglobin (g/dL)	13.7 (12.5-14.8)	13.6 (11.8-14.6)	12.2 (10.6-13.7)	<0.001*	Group1vs2 p 0.135 Group1vs3 p <0.001 Group2vs3 p <0.001
Platelet (10^3/mm^3)	186 (150-229)	194 (154-244)	200 (154-274)	0.23	
Urea (mg/dl)	26 (20-32)	36 (27-51)	48 (36-79)	<0.001*	Group1vs2 p <0.001 Group1vs3 p <0.001 Group2vs3 p <0.001
Creatinine (mg/dl)	0.8 (0.66-0.98)	0.9 (0.73-1.11)	1.1 (0.82-1.58)	<0.001*	Group1vs2 p <0.001 Group1vs3 p <0.001 Group2vs3 p <0.001
AST (U/L)	23 (17-32)	29 (19-45)	27 (20-41)	0.001*	Group1vs2 p 0.002 Group1vs3 p 0.003 Group2vs3 p 0.99
ALT (U/L)	21 (14-33)	28 (19-44)	27 (18-40)	<0.001*	Group1vs2 p <0.001 Group1vs3 p <0.001 Group2vs3 p 0.99
Total bilirubine (mg/dl)	0.50 (0.40-0.68)	0.52 (0.42-0.74)	0.58 (0.44-0.90)	0.01*	Group1vs2 p 0.68 Group1vs3 p 0.008 Group2vs3 p 0.27
Glucose (mg/dl)	110 (101-124)	126 (109-160)	130 (106-185)	<0.001*	Group1vs2 p <0.001 Group1vs3 p <0.001 Group2vs3 p 0.99
LDH (U/L)	250 (208-331)	258 (221-314)	268 (217-358)	0.24*	
Ferritin (ug/L)	148 (65-401)	174 (75-362)	230 (99-480)	0.004*	Group1vs2 p <0.001 Group1vs3 p <0.001 Group2vs3 p <0.001
CRP (mg/L)	28 (12-78)	54 (17-99)	46 (21-127)	0.001*	Group1vs2 p 0.04 Group1vs3 p 0.001 Group2vs3 p 0.56
Procalcitonin (ug/L)	0.12 (0.11-0.13)	0.12 (0.11-0.24)	0.14 (0.11-0.38)	<0.001*	Group1vs2 p <0.001 Group1vs3 p <0.001 Group2vs3 p 0.015
APTT (sec)	25.3 (23.4-26.9)	25.2 (23.2-27.1)	26.2 (24.1-28.1)	0.005*	Group1vs2 p 0.99 Group1vs3 p 0.008 Group2vs3 p 0.017

ALT = alanin aminotransferase; AST = aspartate aminotransferase; APTT = activated partial thromboplastin time; CK-MB = creatine kinase MB; CRP = C-reactive protein; LDH = lactate dehydrogenase.
* Kruskal-Wallis test.

with troponin rise in COVID-19 patients. Early identification of the patients with poor prognosis also provides improvement in treatment strategies and thereby prevention of in-hospital adverse outcomes.

Most of the variables of the CHA2DS2VASC score such as older age, DM, HTN, and previous cardiovascular disease are also confirmed to be prognostic risk factors in patients hospitalized with COVID-19.[14] Accordingly, our

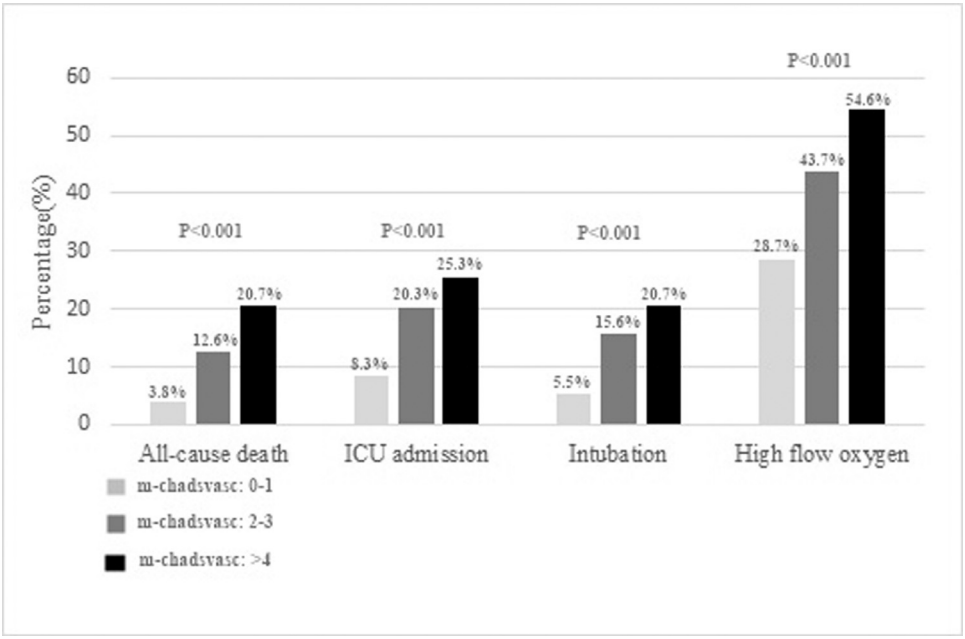

Figure 1. The rates of the in hospital mortality, intensive care unit admission, invasive mechanic ventilation and high flow oxygen demand among the groups.

results showed that patients with higher M-CHA2DS2-VASC scores had worse clinical conditions, such as older age, higher incidence of DM, HTN, and impaired renal and left ventricular functions. Besides, they had an evidence of more severe systemic inflammation, including higher levels of C-reactive protein, procalcitonin, and leukocyte counts as well as higher levels of ferritin and LDH. Furthermore, the course of the infection was much more severe in that group, that may explain the reason why the higher incidence of in-hospital mortality, ICU admission, invasive mechanical ventilation, and/or high-flow oxygen demand were recorded among them. Based on this, using the M-CHA2DS2VASC score seems to be reasonable for predicting in-hospital mortality in COVID-19.

It had been reported that lymphocyte counts were decreased thereby NLR values were significantly increased

Table 3
Univariable and multivariable predictors of in hospital mortality

	Univariate		Multivariate	
	Odds Ratio (95%CI)	p value	Odds Ratio (95%CI)	p value
M-CHADSVASC RS	1.43 (1.25-1.62)	<0.001	1.29 (1.08-1.54)	0.005
CHADSVASC RS	1.27 (1.13-1.44)	<0.001		
CHADS RS	1.55 (1.28-1.87)	<0.001		
Troponin I	1.001 (1.001-1.004)	<0.001	1.001 (1.000-1.001)	<0.001
NLR	1.16 (1.12-1.21)	<0.001	1.07 (1.02-1.11)	0.003
Male gender	1.93 (1.15-3.25)	0.012		
Age	1.056 (1.038-1.075)	<0.001		
Hypertension	1.92(1.17-3.16)	0.009		
Diabetes mellitus	1.80 (1.09-2.95)	0.02		
Cardiovascular disease	1.51 (0.89-2.55)	0.12		
Heart failure	3.20 (1.54-6.68)	0.001		
Previous stroke	1.88 (0.75-4.70)	0.17		
Chronic kidney disease	2.09 (1.06-4.11)	0.03	1.35 (0.59-3.07)	0.47
Smokers	0.69 (0.36-1.36)	0.29	0.81 (0.37-1.76)	0.59
COPD	0.93 (0.45-1.94)	0.85	0.74 (0.30-1.76)	0.53
Previous malignancy	1.98 (0.95-4.11)	0.06	1.39 (0.54-3.58)	0.49
D-dimer	1.001 (1.001-1.003)	<0.001	1.00 (1.000-1.001)	0.24
LDH	1.005 (1.004-1.007)	<0.001	1.004 (1.001-1.006)	0.001
CRP	1.013 (1.010-1.017)	<0.001		
Procalcitonin	4.41 (2.71-7.17)	<0.001	2.37 (1.35-4.19)	0.003
Ferritin	1.001 (1.001-1.002)	<0.001	1.001 (1.000-1.001)	0.003

CI: Confidence interval, CRP: C reactive protein, COPD: chronic obstructive pulmonary disease, LDH: lactate dehydrogenase, NLR: neutrophil-lymphocyte ratio, RS: risk score.

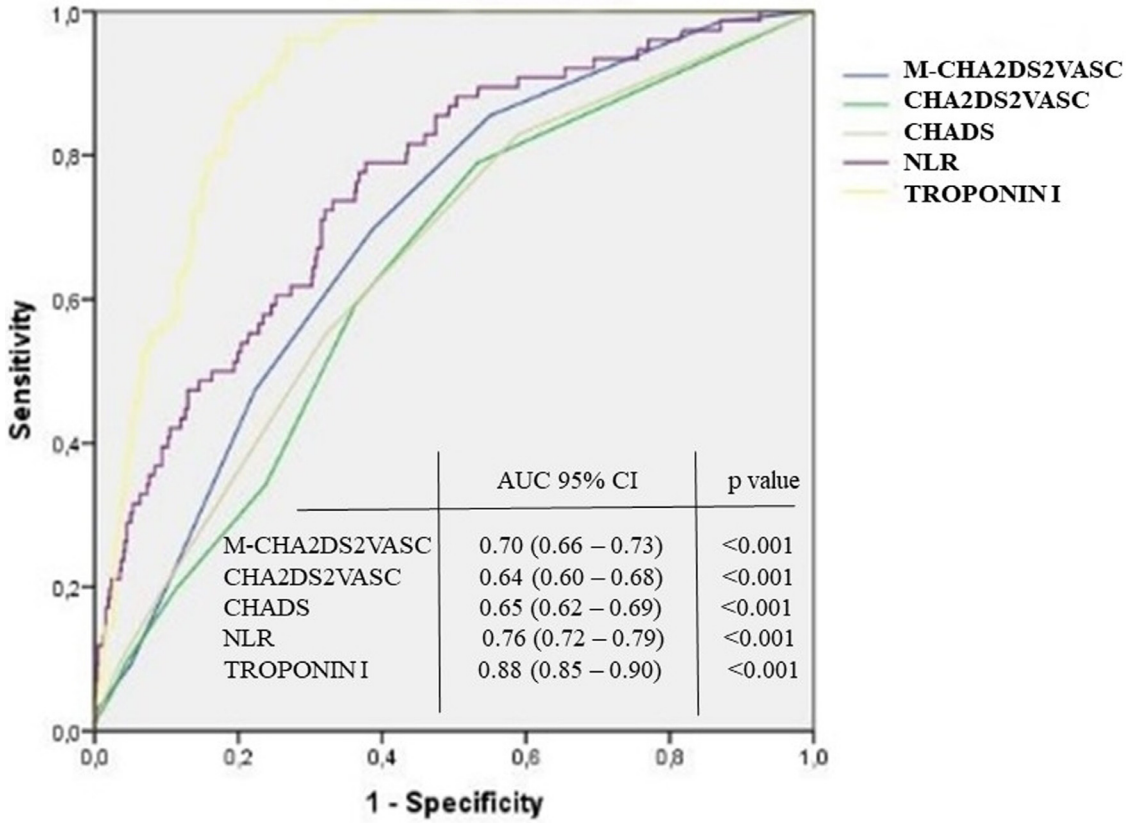

Figure 2. ROC analysis comparing the predictive accuracy of M-CHA2DS2VASc RS, CHA2DS2VASc RS, CHADS RS, Troponin I and NLR for in hospital mortality. AUC = area under the curve; CI = confidence interval.

as a result of bone marrow depression induced by severe COVID-19.[15] Increased NLR indicated an advanced inflammation that may enounce a worse prognosis. Thus, NLR was appeared to be an important determinant of adverse outcomes in patients with COVID-19.[16] Consistent with previous reports, our study indicated that a higher NLR was associated with increased number of in-hospital adverse events and defined as an independent predictor of mortality. Calculation of NLR depends on a blood test and it may take a few days after hospitalization to reach high levels as the complete blood count may be completely normal at first admission. Hence, M-CHA2DS2VASC score may provide earlier and easier identification of high-risk COVID patients at admission compared with NLR.

Likewise, Liang et al[17] conducted a study to develop a clinical risk prediction score for identifying critically ill patients at the time of hospital admission among COVID-19 patients. The score was consisted of detailed clinical, biochemical, and radiographic components that probably strengthened its predictive capacity and was later validated in a large cohort of patients. They reported that their new score was effective for identifying severe COVID-19 illness defined as a composite of admission to the ICU, invasive ventilation, or death. However, as it was designed as a web-based risk score, it might be much more practical to use the easily calculable M-CHA2DS2VASC score for screening the patients, especially at the time of hospital admission.

Our study had some limitations. It was a relatively modest sample sized, retrospective study conducted in a single center. Our results may not represent the entire population because response to COVID-19 may differ in various ethnic groups.Since the retrospective nature of our study, some parameters might be not fully recorded in all patients. Although the predictive accuracy of the M-CHA2DS2-VASC score was good enough according to our findings, further prospective studies with a larger number of patients and longer follow-up time are needed to determine the clinical utility of it in patients with COVID-19.

Our study demonstrated that M-CHA2DS2VASC score might be useful for predicting in-hospital mortality in patients with COVID-19. Using this easily calculable score may also allow early identification of high risk COVID-19 patients and optimization of their treatment strategies; thereby reducing the risk of subsequent adverse events during hospitalization.

Author Contributions

Gokhan Cetinkal: Conceptualization, Formal analysis, Writing - Original Draft; **Betul Balaban Kocas:** Writing - Original Draft, Writing - Review & Editing; **Ozgur Selim Ser:** Data curation, Visualization; **Hakan Kilci:** Data curation, Visualization; **Kudret Keskin:** Writing - Review & Editing; **Safiye Nur Ozcan:** Data curation, Investigation; **Yildiz Verdi:** Data curation, Investigation; **Mustafa Ismet Zeren:** Visualization; **Tolga Demir:** Supervision; **Kadriye Kilickesmez:** Supervision.

Disclosures

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