To cite this article: Çekli Y, et al. Prognostic risk scores for hospitalized COVID-19 patients during the omicron period. Turk J Clin Lab 2025; 3: 634-642

Research Article

Prognostic risk scores for hospitalized COVID-19 patients during the omicron period

Omikron Döneminde Hastanede Yatan COVID-19 Hastaları İçin Prognostik Risk Puanları

Yavuz Çekli*[1], Elif Doğan[1], İrem Medeni[2], Cumhur Artuk[1]

[1] Department of Infectious Diseases and Clinical Microbiology, University of Health Sciences, Gulhane Training and Research Hospital, Ankara, Turkey

[2] Ministry of Health, Ankara Provincial Health Directorate, Department of Public Health, Ankara, Turkey

Abstract

Aim: During the COVID-19 pandemic, as the number of cases and deaths increased various algorithms were started to used to facilitate patient management. This study aimed to assess the usefulness of the CALL, CHOSEN, HA2T2, and ANDC scores in prognostic assessment and to investigate the establishment of a new scoring system, referred to as CoNTroLAC.

Material and Methods: We retrospectively analyzed hospitalized COVID-19 patients. Demographic and laboratory parameters, including comorbidity status, neutrophil-to-lymphocyte ratio (NLR), troponin, LDH, age, and CRP, were assessed in relation to mortality. Mortality distributions across CALL, HA_2T_2, and ANDC risk groups were compared with original reports. A new prognostic score, CoNTroLAC, was constructed using six admission-based parameters using ROC analysis.

Results: Mortality was significantly associated with comorbidities, high NLR, elevated troponin, increased LDH, older age, and CRP >10 µg/mL. CALL, HA_2T_2, and ANDC scores demonstrated mortality stratification consistent with findings in their original cohorts. CoNTroLAC, integrating these six parameters, achieved excellent prognostic performance with an AUROC of 0.915. A cut-off score of 12.5 yielded 82.9% sensitivity and 84.7% specificity.

Conclusion: In our Omicron-era cohort, CALL, HA_2T_2, and ANDC scores retained prognostic validity comparable to their original derivation studies. The newly developed CoNTroLAC score, incorporating comorbidity, NLR, troponin, LDH, age, and CRP, demonstrated excellent discrimination and may provide a simple, practical tool for early mortality risk stratification in hospitalized COVID-19 patients.

Keywords: COVID-19, prognostic scores, intensive care unit, mortality

Corresponding Author*: Yavuz Çekli. Department of Infectious Diseases and Clinical Microbiology, Ankara Gülhane Training and Research Hospital, Ankara, Turkey
E-mail: yavuzcekli@yahoo.com
Orcid: 0000-0002-0925-925X
Doi: 10.18663/tjcl.1551968
Received: 30.11.2024 Accepted: 30.09.2025

TJCL Volume 16 Number 3 p: 634-342

Öz

Amaç: COVID-19 pandemisi sırasında, vaka ve ölüm sayıları arttıkça hasta yönetimini kolaylaştırmak için çeşitli algoritmalar kullanılmaya başlandı. Bu çalışmanın amacı, CALL, CHOSEN, HA2T2 ve ANDC puanlarının prognostik değerlendirmedeki yararlılığını değerlendirmek ve CoNTroLAC olarak adlandırılan yeni bir puanlama sisteminin oluşturulmasını araştırmaktır.

Gereç ve Yöntemler: Hastanede yatan COVID-19 hastalarını retrospektif olarak analiz ettik. Eşlik eden hastalık durumu, nötrofil/lenfosit oranı (NLR), troponin, LDH, yaş ve CRP gibi demografik ve laboratuvar parametreleri mortalite ile ilişkili olarak değerlendirildi. CALL, HA_2T_2 ve ANDC risk gruplarındaki mortalite dağılımları orijinal raporlarla karşılaştırıldı. Altı yatış bazlı parametre kullanılarak ROC analizi kullanılarak yeni bir prognostik skor olan CoNTroLAC oluşturuldu.

Bulgular: Mortalite, eşlik eden hastalıklar, yüksek NLR, yüksek troponin, artmış LDH, ileri yaş ve >10 µg/mL CRP ile anlamlı şekilde ilişkiliydi. CALL, HA_2T_2 ve ANDC skorları, orijinal kohortlarındaki bulgularla tutarlı bir mortalite sınıflandırması gösterdi. Bu altı parametreyi entegre eden CoNTroLAC, 0,915'lik bir AUROC ile mükemmel bir prognostik performans elde etti. 12,5'lik bir kesme puanı %82,9 duyarlılık ve %84,7 özgüllük sağladı.

Sonuç: Omicron dönemi kohortumuzda, CALL, HA_2T_2 ve ANDC skorları, orijinal türetme çalışmalarına benzer prognostik geçerliliğini korudu. Eşlik eden hastalık, NLR, troponin, LDH, yaş ve CRP'yi içeren yeni geliştirilen CoNTroLAC skoru, mükemmel bir ayrımcılık göstermiştir ve hastaneye yatırılan COVID-19 hastalarında erken mortalite risk sınıflandırması için basit ve pratik bir araç sağlayabilir.

Anahtar Kelimeler: COVID-19, prognostik skorlar, yoğun bakım ünitesi, mortalite

Introduction

Hospitalized COVID-19 patients present a broad spectrum of illness severity, and early risk stratification is crucial to guide clinical management and resource allocation. In the pre-vaccine era, about 17% of hospitalized patients required ICU care and 15–20% died, reflecting the high stakes of timely prognostication (1, 2). Rapid identification of those at highest risk for deterioration or death allows clinicians to escalate monitoring and therapies, while safely triaging lower-risk patients. Numerous prognostic scoring tools have therefore been proposed to aid in this risk stratification.

Several early risk scores showed promise in predicting severe COVID-19 outcomes. The CALL score (Comorbidity, Age, Lymphocyte count, LDH), developed in China, ranges from 4–13 and stratifies risk of respiratory failure based on age, comorbidities, lymphopenia, and LDH levels (3). It was moderately predictive of 28-day mortality in an Italian cohort (AUC ~0.77) (3). The CHOSEN score was created to identify patients suitable for ED discharge. It uses basic clinical variables (e.g., age, sex, vitals) and showed moderate accuracy for short-term adverse outcomes (AUC ~0.70–0.71). Low scores (≤3) indicated <2% risk of deterioration, while high scores (≥9) signaled >10% risk (4). In its validation, CHOSEN achieved an AUC ~0.70–0.71 for predicting short-term adverse events after ED discharge (4). Other prognostic models incorporated laboratory biomarkers linked to COVID-19 severity. The HA_2T_2 score (Hypoxia, Age, and Troponin) is a cardiac-focused risk index assigning 1 point for hypoxia on admission, 1–2 points for older age (1 if 65–74 years; 2 if ≥75), and 2 points for an elevated troponin-I ≥0.34 ng/mL (5). The ANDC score (Age, Neutrophil-to-lymphocyte ratio, D-dimer, CRP) showed excellent performance in Chinese cohorts (AUC 0.92), but less accuracy in Western populations (AUC ~0.65–0.66) (6, 7).

In this study; CALL, CHOSEN, HA2T2, ANDC scores which were found to have high prognostic value, is aimed to demonstrate their usability in the patient management and the prognostic evaluation of COVID-19 patients during the period of Omicron, when the disease reached the highest number of cases. Further more, we created a new score named CoNTroLAC.

Material and Methods

Study design and participants

This is a retrospective study, which included all patients hospitalized for COVID-19 disease from the Gulhane Training and Research Hospital in the period 01.01.2022 and 15.02.2022. Patients were divided into two groups those who needed intensive care unit (ICU) and those who had clinic hospitalization;

did not require ICU.during their hospitalization. Patients with ICU hospitalization were evaluated with the blood tests and clinical parameters at the time of admission to the polyclinic/emergency department or in 1-5 days before the ICU hospitalization. Patients with clinical hospitalization were considered with examinations and clinical qualifications in the first 5 days after their hospitalization. The decision of hospitalization of the patients from the emergency room/ polyclinic to the COVID-19 clinics in our hospital, which provides 3rd level health services; were given according to clinical parameters such as oxygen need, fever, general condition or oral intake disorder. Our study was approved by the Ethics Committee of our hospital (Date: 14.09.2022, Number: 2022/130) and was planned in accordance with the Declaration of Helsinki.

Patients whose age is >18, who were detected to be positive for SARS CoV-2 polymerase chain reaction (PCR), who were hospitalized, whose data could be accessed from the hospital electronic information system were included in the study. Outpatients, patients aged under 18 years, patients without SARS CoV-2 PCR positivity, patients who refused or discontinued the treatment, patients with COVID-19 disease who were referred from an external center, patients who were detected SARS CoV-2 positive asymptomaticly were excluded from the study. SARS CoV-2 PCR positivity was obtained using nasopharyngeal swab samples. Patients who were seen positive as a result of rapid antigen test were not included in the study. We did not have a patient who was diagnosed with COVID-19 that more than once needed hospitalization. If the same patient needed ICU again after s/he was transferred from the ICU to the clinic hospitalization, her/his first ICU hospitalization was recorded.

Data collection

The data were obtained from the hospital electronic information system. Apart from the anamnesis, clinical course and epicrisis notes of the patients; blood tests and imaging examinations, medical treatments were examined. For CALL; the patient's comorbidity, age, lymphocyte count ($\times 10^3$/µl), lactate dehydrogenase (LDH) (U/L) values were used.

Comorbidities presence were considered as those diagnosed with hypertension, diabetes mellitus, cardiovascular disease, chronic lung disease, liver disease, asthma, malignancy within the last 6 months. For CHOSEN; patient's age, oxygen saturation (Sp02%), albumin (g/dL) rates were taken. For HA2T2; the presence of hypoxia, the patient's age and troponin (ng/mL) values were used. For ANDC; patient's age, neutrophil/lymphocyte count, D-dimer (ng/mL) and C-reactive protein (CRP) (µg/ml) values were utilised.

Endpoints

The primary endpoint of patient follow-up is ex during in hospitalization or discharge from the COVID-19 clinic/ ICU. The secondary endpoint was evaluated as SARS CoV-2 PCR negativity.

Statistical analysis

Chi-square test was used to examine the relationships between nominal variables. The conformity of the variables to the normal distribution was evaluated with the normal distribution tests (Kolmogorov Smirnov/Shapiro-Wilk Tests). Ordinal and non-normally distributed variables were evaluated with the Mann Whitney U test. Student's T-Test was used to examine the variables with normal distribution. For LDH, troponin and CRP results evaluated in COVID-19 patients; the upper levels of the reference range of the laboratory where the examination was performed were accepted as the cut-off values of 250 U/L, 17.5 ng/L and 10 mg/L. These neutrophil/lymphocyte ratio (NLR) results were two breakpoints: 3, which is the pathological limit in adults, and 6, which we hypothesized to reflect the clinical progression of COVID-19 [18-20]. The patients were divided into three groups in terms of age: ≤60, 61-75 years and more than 75 years. Those with one or more diseases associated with COVID-19 disease were considered positive for comorbidity. Thus, the patients into different categories in terms of comorbidity, NLR, troponin, LDH, age and CRP variables. Mortality status of all patients at the end of 30 days was recorded. The characteristics of the parameters included in the score were made with the results obtained in the Pearson chi-square tests for the comparison of categorical variables. According to this; absent/present (0/4) for comorbidity, ≤3.00/3.01-6.00/≥6.01 (0/2/5) for NLR, ≤17.5/>17,5 (0/5) for troponin, ≤250/>250 (0/1) for LDH, ≤60/61-75/≥76 (0/3/4) for age and ≤10/>10 (0/1) for CRP are detected and a score system has been developed. It is named CoNTroLAC and the patients' scores calculated between 0 and 20. Finally, the cut-off point of the scoring has determined by the ROC analysis.

Results

There were 845 patients who were hospitalized between 01.01.22 and 15.02.22 in Gulhane Training and Research Hospital of COVID-19 clinics and ICU. These were excluded from the study: 16 patients' datas could not be accessed, 11 patients refused treatment or were interrupted treatment, taken preoperatively 31 SARS CoV-2 PCR tests were detected positive, 6 patients were receiving active chemotherapy. A total of 781 patients were included in the study and these patients were examined in two groups as those with and without ICU admission. ICU patients were significantly older (mean age 74.9 ± 13.0 vs. 64.0 ± 18.9 years, $p < 0.001$) and had a higher prevalence of comorbidities (96.7% vs. 73.2%, $p < 0.001$). Several biochemical markers associated with disease progression were also markedly elevated in ICU patients. These included LDH (493.6 ± 479.3 vs. 294.8 ± 149.1 U/L), troponin (389.5 ± 1826.8 vs. 7.1 ± 7.3 ng/mL), NLR (18.0 ± 17.8 vs. 1.6 ± 2.9), D-dimer (76.6 ± 74.1 vs. 7.8 ± 19.2 ng/mL), and CRP (121.1 ± 98.2 vs. 76.6 ± 75.1 µg/mL, all with $p < 0.001$) (Table 1).

Comorbidities were strongly associated with mortality ($p < 0.001$), with a death rate of 20.7% in patients with comorbid conditions vs. only 3.2% in those without. A higher neutrophil-to-lymphocyte ratio (NLR) was linked to increased mortality: patients with NLR >6 had a 58.9% death rate compared to only 2.7% for NLR ≤3 ($p < 0.001$). Elevated troponin (>17.5 ng/mL) was also a strong predictor, with a 53.2% mortality rate vs. 7.9% for lower values ($p < 0.001$). CRP >10 µg/mL, LDH >250 U/L, and older age (>75 years) were all significantly associated with higher death rates ($p < 0.01$ for all). Gender was not significantly associated with mortality ($p = 0.896$) (Table 2).

Patients were evaluated with CALL, ANDC, HA2T2 scores; 730 patients for CALL, 497 patients for HA2T2, 745 patients for ANDC was calculated. Clinical progression assessment was determined by the patients' who need ICU hospitalization mortality rate. Since progression assessment was not performed in patients with clinical hospitalization, those individuals were not included in the calculation. In the evaluation of patients hospitalized in ICU according to the CALL scoring; the mortality rate was 50% in the 7-9 score range and 68% in the 10-13 score range. There were no patients in 4-6 score range. Considering the evaluation of patients who were not hospitalized in ICU according to the CALL score, no mortality was observed in the 4-6 score range. Mortality rate was 1.6% in the 7-9 score range; was 2.6% in the 10-13 score range. The mortality rates of the patients according to HA2T2, which is the other scoring we calculated, are shown in table 4. In the evaluation of ICU hospitalized patients according to ANDC scoring, the mortality rate was 100% in <59 score range, 55% in 59 ≤ ≤ 101 score range and 69% in >101 score range. Among all patients, 0.8% mortality was calculated in the <59 score group, 9% in the second group and 35% in >101 score group (Table 3).

The area under the curve was 0.915 as a result of the ROC analysis performed for the CoNTroLAC scoring, which we created out of these scores. The cut-off point was calculated 12.5 in 84.7% specificity and 82.9% sensitivity (Figure 1).

Sensitivity and specificity values of the threshold values of CoNTroLAC scoring in predicting mortality are shown in Table 4.

Table 1. Demographic and clinical characteristics.

Variables	Clinic hospitalization n = 572	ICU hospitalization n = 209	p -value
Male gender, n (%)	301 (52.6)	120 (57.4)	<0.001*
Age, years	64.0 ± 18.9	74.9 ± 13.0	<0.001*
Comorbidity (n,%)	412 (73.2)	202 (96.7)	<0.001*
LDH, U/L	294.8 ± 149.1	493.6 ± 479.3	<0.001*
Lymphocyts, × 10^3/µl	1720.1 ± 11709.7	1033.4 ± 2054.9	0.493
Albumin, g/dL	3.07 ± 3.59	3.15 ± 1.46	0.984
Troponin, ng/mL	7.1 ± 7.3	389.5 ± 1826.8	<0.001*
NLR	1.6 ± 2.9	18.0 ± 17.8	<0.001*
D-dimer, ng/mL	76.6 ± 74.1	7.8 ± 19.2	<0.001*
CRP, µg/mL	76.6 ± 75.1	121.1 ± 98.2	<0.001*

Abbreviations: LDH, lactate dehydrogenase; NLR, neutrophil-to-lymphocyte ratio; CRP, C-reactive protein; ICU, intensive care unit.

Table 2. Factors associated with overall mortality.			
Variables	Death		p-value
Gender, n (%)	Absent	Present	
Female	250 (83.9)	48 (16.1)	0.896
Male	304 (81.5)	69 (18.5)	
Comorbidity (n,%)			
With	432 (79.3)	113 (20.7)	<0.001*
Without	122 (96.8)	4 (3.2)	
NLR			
≤ 3	437 (97.3)	12 (2.7)	<0.001*
3-6	55 (77.5)	16 (22.5)	
>6	62 (41.1)	89 (58.9)	
Troponin, ng/mL			
0-17.5	488 (92.1)	42 (7.9)	<0.001*
>17.5	66 (46.8)	75 (53.2)	
CRP, µg/mL			
≤ 10	77 (92.8)	6 (7.2)	0.009*
>10	477 (81.1)	11 (7.2)	
Age, years			
≤ 60	184 (96.3)	7 (3.7)	<0.001*
61-75	164 (80.4)	40 (19.6)	
>75	206 (74.6)	70 (25.4)	
LDH, U/L			
≤ 250	250 (90.6)	26 (9.4)	<0.001*
>250	304 (77.0)	91 (23.0)	
Abbreviations: LDH, lactate dehydrogenase; NLR, neutrophil-to-lymphocyte ratio; CRP, C-reactive protein; ICU, intensive care unit.			

Table 3. Comparison of CALL, HA_2T_2, and ANDC scores with associated mortality and original study risk estimates			
CALL score	Patient (n)	Mortality	
n (%)	In original study risk of COVID-19 progression rate (%)		
4-6	-	-	<10
7-9	21	10 (50)	10-40
10-13	187	126 (68)	>50
HA2T2 score			In original study mortality rate (%)
0	60	0	0
1	95	11 (11)	3.8
2	124	24 (19)	12.1
3	196	75 (38)	35.1
4	8	4 (50)	48.6
5	12	9 (75)	65.5
ANDC score			In original study mortality rate (%)
<59	116	1 (0.8)	<5
5-101	310	29 (9.4)	5-50
>101	319	112 (35)	>50

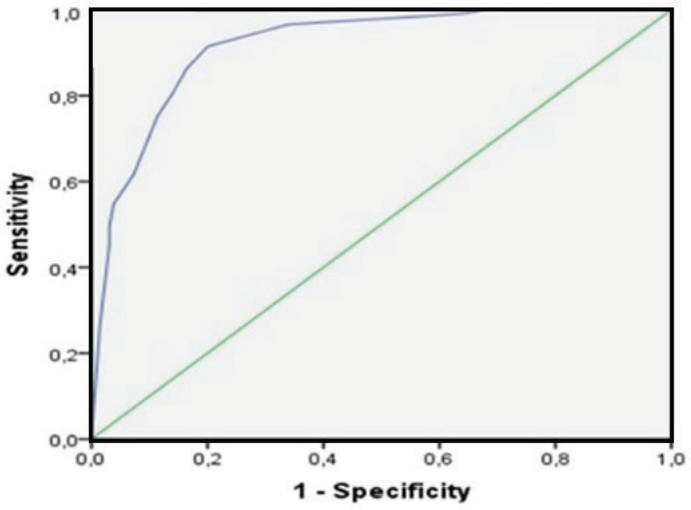

Figure 1. Diagnostic performanve of CoNTroLAC score for predicting mortality.

Table 4. Sensitivity and specificity values of CoNTroLAC scoring results for predicting mortality.

Test result	Sensitivity	Specificity
2.00	1.000	0
3.50	1.000	0.027
4.50	1.000	0.099
5.50	1.000	0.146
6.50	1.000	0.152
7.50	1.000	0.181
8.50	1.000	0.267
9.50	1.000	0.323
10.50	0.991	0.356
11.50	0.983	0.453
12.50	0.966	0.661
13.50	0.915	0.800
14.50	0.863	0.836
15.50	0.803	0.861
16.50	0.752	0.886
17.50	0.615	0.928
18.50	0.547	0.962
19.50	0.496	0.969
20.50	0.453	0.969
21.50	0.265	0.986
23.00	0	1.000

Discussion

In our study of hospitalized COVID-19 patients during the Omicron period, we observed that established risk factors including advanced age, comorbidities, elevated inflammatory markers (NLR, CRP, LDH), and cardiac injury (troponin) were all strongly associated with overall mortality. When evaluated against traditional prognostic indices, our newly developed CoNTroLAC score demonstrated excellent discriminative ability. These results indicate that CoNTroLAC effectively integrates both baseline vulnerability and acute disease severity into a simple bedside tool, and that it may outperform previously published models in accurately stratifying patient risk during the current phase of the pandemic.

The CALL score (Comorbidity, Age, Lymphocyte count, LDH) was initially developed by Ji et al. to predict progression to severe pneumonia (3). In our cohort, CALL high-risk categories likewise corresponded to higher observed mortality (consistent with prior findings). The HA_2T_2 score (based on Hypoxia on admission, Age, and elevated Troponin) was designed to highlight the prognostic impact of myocardial injury in COVID-19 (5, 7). Manocha et al. reported that troponin was the only independent biomarker predictor of 30-day mortality and used it alongside age and oxygen status to derive HA_2T_2, which achieved an AUROC of ~0.83 in the derivation and ~0.78 on validation (5). Consistent with these findings, our troponin analysis showed a significant association with mortality. ANDC was formulated via a nomogram and showed excellent initial performance (AUROC 0.921 in the derivation, 0.975 in internal validation (6, 7), stratifying patients into low-, moderate-, and high-risk groups with <5%, ~5–50%, and >50% mortality, respectively. Our findings were consistent with the cohorts in which these indices were developed.

Each of the six CoNTroLAC components has a well-established link to COVID-19 outcomes, lending biological plausibility to the score. Advanced age and comorbidity burden are among the strongest predictors of mortality in COVID-19 across studies (8-17). Older patients and those with chronic illnesses (cardiovascular, metabolic, etc.) have impaired reserve and immune responses, resulting in higher case fatality rates (18). The NLR and CRP both reflect the hyperinflammatory state and immune dysregulation seen in severe COVID-19 (19-21). Lymphopenia (low lymphocyte count), captured within NLR, was noted early as a risk factor for deterioration (22), while elevated CRP indicates an intense acute phase response; indeed, non-survivors consistently show higher CRP and NLR values than survivors (23). Troponin, a marker of myocardial injury, has emerged as a potent predictor of adverse outcomes: even mild cardiac injury in COVID-19 is associated with significantly increased mortality (5, 15). This aligns with

the understanding that SARS-CoV-2 can precipitate cardiac complications (myocarditis, stress cardiomyopathy, ischemia) in critically ill patients. Likewise, lactate dehydrogenase (LDH) is an indicator of cell injury and tissue hypoxia; high LDH levels correlate with extensive lung involvement and multi-organ damage, and were identified by Ji et al. as a key risk factor for disease progression (8). In our cohort, all six variables (age, comorbidity count, NLR, CRP, troponin, LDH) showed strong univariate associations with mortality, which is consistent with their known pathophysiological significance. Collectively, these factors capture the patient's baseline vulnerability (age/comorbidities) as well as the severity of the infection's systemic impact (inflammation and organ injury), explaining why CoNTroLAC is a clinically relevant and powerful prognostic index.

CoNTroLAC demonstrates significant clinical utility, particularly in the context of the Omicron era of the COVID-19 pandemic. The high AUROC (0.915) of CoNTroLAC in an Omicron-era cohort underscores that it can accurately identify those individuals at elevated risk who might otherwise be overlooked when overall outcomes seem improved. An important strength of CoNTroLAC is its simplicity and reliance on routine admission data. All six parameters are readily obtainable within hours of hospital presentation, without the need for advanced imaging or specialized assays. This is in contrast to some prior prognostic models that required resources like CT scans or biomarkers of limited availability (24-27). Moreover, CoNTroLAC's incorporation of both chronic risk factors and acute illness markers makes it broadly applicable: it performed well despite the shifts in patient demographics and disease characteristics during Omicron, suggesting resilience of the score to evolving conditions.

Several limitations of our study and the CoNTroLAC score should be acknowledged. First, this was a single-center, retrospective study, which may limit the generalizability of our findings. The patient population and clinical practices at our center (e.g. thresholds for hospital admission or troponin testing) might differ from other hospitals and regions. External validation in multi-center cohorts is needed to ensure CoNTroLAC's applicability beyond our setting. Second, the retrospective design carries inherent biases; although we included all consecutive hospitalized patients meeting criteria, unmeasured confounders or missing data could have influenced the results. Third, our study was conducted during a period largely dominated by the Omicron variant. While this lends relevance to current clinical practice, it also means the score's performance in earlier waves (e.g. Delta or pre-vaccine era) or future variants remains uncertain. Changes in viral pathogenicity or population immunity could alter the weight or threshold of some predictors (for example, if a new variant causes less myocardial injury, troponin might become less prognostic). Fourth, we did not incorporate certain acute clinical measurements such as oxygen saturation or radiographic severity in CoNTroLAC, in order to favor simplicity. It is possible that adding such variables could further improve accuracy, but at the expense of ease-of-use; our score must be viewed as a trade-off between completeness and practicality. Additionally, laboratory differences must be considered: assays for biomarkers like troponin or CRP vary between institutions, and our optimal cut-off value of 12.5 for CoNTroLAC may require recalibration if different units or reference ranges are used. Finally, the study's sample size, while sufficient for internal model development, was relatively modest for prognostic research. This could affect the stability of the model coefficients and risk cut-off; hence, larger studies would strengthen confidence in the score. We have reported a strong association of CoNTroLAC with mortality in our dataset (high sensitivity and specificity at the chosen cut-off), but prospective validation will be important to confirm these results and to assess the score's impact on clinical decision-making.

In conclusion, we developed and evaluated the CoNTroLAC risk score as a prognostic tool for hospitalized COVID-19 patients, and found that it provides highly accurate mortality risk stratification. In practical terms, CoNTroLAC can assist clinicians by flagging those patients who might benefit from aggressive monitoring or early therapeutic escalation, ultimately aiding in the prioritization of care and resources.

Ethical Approval

The study was performed in accordance with the Declaration of Helsinki, and was approved by the Gulhane Training and Research Hospital Clinical Research Ethics Committee (Date: 14.09.2022, Decision No: 2022/130).

Funding

The authors declared that this study has received no financial support.

Conflicts of Interest

Authors declare that they have no conflicts of interest.

Informed Consent

The need for informed consent was waived under the approval of the Local Ethics Committee due to the retrospective design.

Authors' Contribution

Concept – Y.Ç. and C.A., Design- Y.Ç., E.D., İ.M., Supervision – Y.Ç. and C.A., Data collection and/or processing – Y.Ç., E.D., İ.M., and C.A., Analysis and/or interpretation – Y.Ç., E.D., İ.M., and C.A., Writing – Y.Ç., Critical review- E.D., İ.M., and C.A. All authors read and approved the final version of the manuscript.

Acknowledgements

None

References

1. Docherty AB, Harrison EM, Green CA, et al. Features of 20 133 UK patients in hospital with covid-19 using the ISARIC WHO Clinical Characterisation Protocol: prospective observational cohort study. BMJ. 2020;369:m1985.
2. Wiersinga WJ, Rhodes A, Cheng AC, Peacock SJ, and Prescott HC. Pathophysiology, Transmission, Diagnosis, and Treatment of Coronavirus Disease 2019 (COVID-19): A Review. JAMA. 2020;324(8):782-93.
3. Ji D, Zhang D, Xu J, et al. Prediction for Progression Risk in Patients With COVID-19 Pneumonia: The CALL Score. Clin Infect Dis. 2020;71(6):1393-99.
4. Brooks SC, Rosychuk RJ, Perry JJ, et al. Derivation and validation of a clinical decision rule to risk-stratify COVID-19 patients discharged from the emergency department: The CCEDRRN COVID discharge score. J Am Coll Emerg Physicians Open. 2022;3(6):e12868.
5. Manocha KK, Kirzner J, Ying X, et al. Troponin and Other Biomarker Levels and Outcomes Among Patients Hospitalized With COVID-19: Derivation and Validation of the HA(2)T(2) COVID-19 Mortality Risk Score. J Am Heart Assoc. 2021;10(6):e018477.
6. Weng Z, Chen Q, Li S, et al. ANDC: an early warning score to predict mortality risk for patients with Coronavirus Disease 2019. J Transl Med. 2020;18(1):328.
7. Wolfisberg S, Gregoriano C, Struja T, et al. Call, chosen, HA(2)T(2), ANDC: validation of four severity scores in COVID-19 patients. Infection. 2022;50(3):651-59.
8. Sanhueza M, Barrera M, Pedemonte JC, and Rojas L. Validation of the CALL score as a mortality prediction tool in a cohort of hospitalized COVID-19 patients in Chile. Front Med (Lausanne). 2023;10:1164615.
9. Djaharuddin I, Munawwarah S, Nurulita A, Ilyas M, Tabri NA, and Lihawa N. Comorbidities and mortality in COVID-19 patients. Gac Sanit. 2021;35 Suppl 2:S530-S32.
10. Ganaza-Domingues KLT, Ramos-Milare A, Lera-Nonose D, et al. Effect of Comorbidities on the Mortality of Patients With COVID-19: A Systematic Review of Reviews and Meta-Analyses. Rev Med Virol. 2025;35(2):e70024.
11. Seyfi S, Azadmehr A, Ezoji K, et al. Mortality in ICU COVID-19 Patients Is Associated with Neutrophil-to-Lymphocyte Ratio (NLR): Utility of NLR as a Promising Immunohematological Marker. Interdiscip Perspect Infect Dis. 2023;2023:9048749.
12. Toori KU, Qureshi MA, Chaudhry A, and Safdar MF. Neutrophil to lymphocyte ratio (NLR) in COVID-19: A cheap prognostic marker in a resource constraint setting. Pak J Med Sci. 2021;37(5):1435-39.
13. Asperges E, Albi G, Zuccaro V, et al. Dynamic NLR and PLR in Predicting COVID-19 Severity: A Retrospective Cohort Study. Infect Dis Ther. 2023;12(6):1625-40.
14. Vrsalovic M and Vrsalovic Presecki A. Cardiac troponins predict mortality in patients with COVID-19: A meta-analysis of adjusted risk estimates. J Infect. 2020;81(3):e99-e100.
15. Kubiliute I, Urboniene J, Majauskaite F, Bobkov E, Svetikas L, and Jancoriene L. Elevated Cardiac Troponin I as a Mortality Predictor in Hospitalised COVID-19 Patients. Medicina (Kaunas). 2024;60(6)
16. Li F, He M, Zhou M, et al. Association of C-reactive protein with mortality in Covid-19 patients: a secondary analysis of a cohort study. Sci Rep. 2023;13(1):20361.
17. Sadeghi Mofrad S, Boozarjomehri Amnieh S, Pakzad MR, et al. The death rate of COVID-19 infection in different SARS-CoV-2 variants was related to C-reactive protein gene polymorphisms. Sci Rep. 2024;14(1):703.
18. Darden DB, Moore FA, Brakenridge SC, et al. The Effect of Aging Physiology on Critical Care. Crit Care Clin. 2021;37(1):135-50.
19. Papanikolopoulou A, Rapti V, Alexiou P, et al. Neutrophil-to-Lymphocyte Ratio (NLR) and Platelet-to-Lymphocyte Ratio (PLR) as Prognostic Markers of COVID-19 Disease Irrespective of Immunosuppression Status: A Case-Control Retrospective Single-Center Study. Pathogens. 2025;14(6)
20. Lagunas-Rangel FA. Neutrophil-to-lymphocyte ratio and lymphocyte-to-C-reactive protein ratio in patients with severe coronavirus disease 2019 (COVID-19): A meta-analysis. J Med Virol. 2020;92(10):1733-34.
21. Garcia-Gasalla M, Berman-Riu M, Pons J, et al. Hyperinflammatory State and Low T1 Adaptive Immune Response in Severe and Critical Acute COVID-19 Patients. Front Med (Lausanne). 2022;9:828678.

22. Rathod BD, Amle D, Khot RS, Prathipati KK, and Joshi PP. Neutrophil-to-Lymphocyte Ratio as a Predictor of Disease Severity and Mortality in Coronavirus Disease 2019: Prospective Study From Central India. Cureus. 2022;14(3):e23696.
23. Bindal A, Patmano M, and Cansun F. Laboratory markers used to predict mortality in severe COVID-19. Ann Med Res. 2022;29(6):545-9.
24. Grifoni E, Valoriani A, Cei F, et al. The CALL Score for Predicting Outcomes in Patients With COVID-19. Clin Infect Dis. 2021;72(1):182-83.
25. Francone M, Iafrate F, Masci GM, et al. Chest CT score in COVID-19 patients: correlation with disease severity and short-term prognosis. Eur Radiol. 2020;30(12):6808-17.
26. Zhang C, Qin L, Li K, et al. A Novel Scoring System for Prediction of Disease Severity in COVID-19. Front Cell Infect Microbiol. 2020;10:318.
27. Liang W, Liang H, Ou L, et al. Development and Validation of a Clinical Risk Score to Predict the Occurrence of Critical Illness in Hospitalized Patients With COVID-19. JAMA Intern Med. 2020;180(8):1081-89.