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A new parameter in COVID-19 pandemic: initial lactate dehydrogenase (LDH)/Lymphocyte ratio for diagnosis and mortality

Istemi Serin, Nagehan Didem Sari, Mehmet Hilmi Dogu, Sakine Damla Aciikel, Gulnhal Babur, Avni Ulusoy, Medpha Irem Onar, Emre Cem Gokce, Oguz Altnok, Feyza Yaylaci Mert, Ayse Karakilic, Muhammed Baltik, Begum Gulesir

* University of Health Sciences, Istanbul Training and Research Hospital, Department of Hematology, Fatih, Turkey
** University of Health Sciences, Istanbul Training and Research Hospital, Department of Infectious Diseases and Clinical Microbiology, Turkey
*** University of Health Sciences, Istanbul Training and Research Hospital, Department of Internal Medicine, Turkey
**** University of Health Sciences, Bagcilar Training and Research Hospital, Department of Internal Medicine, Turkey

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**A B S T R A C T**

*Background.* COVID-19 (Coronavirus Disease-2019) is a pandemic disease, infecting more than 26.5 million people. Since there is no specific and effective treatment; early diagnosis and optimal isolation of the patient are of vital importance. Real-time polymerase chain reaction-based (RT-PCR) analyses do not achieve sufficient sensitivity in the diagnosis of the disease.

*Methods.* The data collected from 2217 patients diagnosed as COVID-19 between March 2020 and June 2020 and hospitalized or discharged with home isolation were retrospectively analyzed. Demographic data, comorbidities, PCR results, initial computed tomography (CT), laboratory values, Lactate Dehydrogenase (LDH)/Lymphocyte ratio, initial treatments and last status were recorded. The diagnostic sensitivity of LDH/Lymphocyte ratio, which is the main purpose of the study, was analyzed statistically.

*Results.* In order to test the effectiveness of LDH/Lymphocyte ratio for COVID-19 for diagnostic purposes, CT results were considered as gold standard. The area under the curve (AUC) was found to be 0.706 (p < 0.001; cut-off > 0.06) (Sensitivity: 76.4, specificity: 59.60). For the evaluation of LDH/Lymphocyte ratio in terms of survival, AUC was found to be 0.749 (p < 0.001; cut-off > 0.21) (Sensitivity: 70.59, specificity: 73.88).

*Conclusion.* Studies based on radiological findings have demonstrated that CT involvement has higher sensitivity. LDH/Lymphocyte ratio was analyzed in terms of diagnosis and mortality with using specific CT involvement as gold standard method which was found to be a more sensitive due to PCR false negative. 0.06 and 0.21 were obtained as cut off values for diagnosis and mortality.

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**Introduction**

COVID-19 (Corona Virus Disease-2019) has emerged as a pandemic factor that has infected more than 26.5 million people, 3.5 million being actively sick, since the first case appeared [1]. It caused by Sars-Cov-2 (Severe Acute Respiratory Syndrome Coronavirus 2) virus. The fatality rate is highest in patients aged >65 years or those with certain comorbidities [2–4]. The population of patients with hypertension, chronic respiratory and cardiac diseases, diabetes mellitus, renal failure and malignancy are defined as the most severely affected group [5].

In the studies where the incubation period of the virus is performed, the median reaches from 4 days to 14 days [4–6]. Although there are clinical findings on a wide scale ranging from mild respiratory symptoms to severe respiratory failure, it is possible to say that severe cases are around 4–5% [7,8]. It is evident that early diagnosis, treatment and optimal isolation of the patient and his/her environment are vital at the point of treatment due to the spread of the disease. In the literature, we see that there are many publications on the diagnosis of the disease. The analysis of various samples based on real-time polymerase chain reaction (RT-PCR), which was used as the gold standard diagnostic method, cannot achieve sufficient speed and sensitivity in the diagnosis of the disease. This, in particular, delays the isolation of patients and accelerates disease spread.

There are differences in the sensitivity of the PCR samples studied with various samples. In the most recent study of Wenling Wang et al. [9], the sensitivity order was as follows: Bronchoalveolar lavage 93%, throat culture 72%, nasal sample 63%, fibrobronchoscopy brush biopsy 46%, pharyngeal sample 32%, faeces 29%, blood 1 and urine 0%. Evaluation with bronchoalveolar lavage is quite difficult in emergency conditions and it does not seem possible due to the high risk of transmission.
Therefore, negative results in potential cases lead to different opinions about the approach to patients.

PCR comparison with diagnostic methods based on thorax computed tomography (CT) has also been studied in the literature and the sensitivity appears to be high in favor of CT [10]. In our study, the data from 2217 patients who were admitted to the emergency room of our hospital between March 2020 and June 2020; diagnosed as COVID-19 and hospitalized or discharged with home isolation were retrospectively analyzed. Clinical features, treatments, laboratory and imaging results and mortality data of this patient group were retrospectively examined. Based on the hypothesis that it could present a new diagnostic method in terms of the early diagnosis and early isolation, it was aimed at providing early diagnosis for especially those patients with typical radiological involvement and clinical findings through the Lactate Dehydrogenase/Lymphocyte (LDH/Lymphocyte) ratio.

The basis of our study and the starting point of our hypothesis is the other clinical studies based on LDH, which is an important indicator in the early diagnosis of pneumonia, is also important in the early diagnosis of atypical pneumonia [11–13]. Although LDH is an enzyme originating from many organs and systems, it increases significantly especially in patients with lung involvement. In addition, we see that lymphopenia, which will occur secondary to viral infections, is also present in COVID-19 cases. The study was conducted with the hypothesis that the combination of these laboratory values would yield a more sensitive result in early diagnosis.

Material and methods

Our study was conducted upon obtaining the approval from the local ethics committee and the relevant departments of the Ministry of Health. (Ethics committee approval number: 2257, 8.5.2020, Ministry of Health Approval Number: 2020-04-30T15_07_44.). The data of 2217 patients who were admitted to the emergency room of our hospital between March 2020 and June 2020; diagnosed as COVID-19 and hospitalized or discharged with home isolation were retrospectively analyzed. Demographic data of patients such as age, gender, comorbidities such as chronic obstructive pulmonary disease (COPD), asthma, hypertension (HT), chronic heart failure (CHF), diabetes mellitus (DM), coronary artery disease (CAD), malignancy, rheumatic diseases (RD), cerebrovascular accident (CVA) and others; nasopharyngeal PCR swab results (first 3 results, positive or negative), initial CT results, initial leukocyte, neutrophil, lymphocyte, hemoglobin, platelet, urea, creatinine, D-Dimer, aspartate aminotransferase (AST), alanine transaminase (ALT), total protein, albumin, creatine kinase (CK), C-reactive protein (CRP), procalcitonin, LDH values, LDH/Lymphocyte ratio, initial treatments (hydroxychloroquine, azithromycin, oseltamivir, additional antibiotic therapy, lopinavir/ritonavir, favipiravir usage), follow-up subtypes (inpatient or outpatient) and their last status (alive, death) were recorded. CT results were collected under three separate headings as no involvement, unilateral and bilateral involvement. The relation of the patients’ recorded data to individual survival was examined. In addition, the diagnostic sensitivity of LDH/Lymphocyte ratio, which is the main purpose of the study, was analyzed statistically. LDH/Lymphocyte ratio was analyzed in terms of diagnosis and mortality with using specific CT involvement as the gold standard method which was found to be a more sensitive method due to PCR false negativity.

Statistical analysis

The analysis of the data was carried out using SPSS 25 and Medcalc package programs. Descriptive statistics are presented by giving frequency and percentage tables for categorical variables and arithmetic mean, standard deviation, median, minimum and maximum values for quantitative variables. Chi-square test was used for comparisons between two categorical variables, and independent sample t-test was used for comparison of categorical variables and quantitative variables since the categorical variable contains two categories. The logistic regression analysis was carried out by including the factors determined to have an impact on survival conditions as a result of binary comparisons. ROC analysis was applied to test the acceptability of LDH/Lymphocyte ratio as diagnostic test and to determine the predictive values in mortality.

Results

Demographic data, comorbidities, initial PCR and CT results, last status and follow up subtypes

The data of 2217 patients in total were examined. 53% of the patients were male (n: 1175); 47% were female (n: 1042). The mean age was $47.66 \pm 17.23$. 60.2% (n: 1334) of the them received inpatient treatment; 39.8% (n: 883) received outpatient treatment. The mortality rate of the patients was determined as 3.1% (n: 68). The most common comorbidity of the patients was hypertension with 20.6% (n: 456). Hypertension was followed by diabetes mellitus with 16.2% (n: 360). The positivity rate of the 1st PCR results of the patients was 69.5% (n = 1541). The PCR result is negative, but 2. PCR result positive patient rate was 4.74% (n = 105). First two negative but the third positive was 1.17 (n = 38) of them. 9.61% (n = 213) of patients have 3 negative PCR results. Initially, typical COVID-19 involvement was detected with CT in 71.9% (n: 1594); while 1387 of them were bilateral; 207 of them were unilateral involvement (Table 1).

Drug usage for COVID-19 treatment

Hydroxychloroquine was used in 82.3% of the patients (n: 1824); this was followed by azithromycin with 44.5% (n: 987). Additional antibiotic therapy was needed in 14.6% of patients (n: 324), 2.7% (n: 60) of patients were receiving favipiravir (Table 2).

| Table 1 | Demographic Data, Comorbidities, Initial PCR and CT Results, Last Status and Follow Up Subtypes. |
|---------|---------------------------------------------------------------|
| Age     | Min–Max                     | Median ± s.d./n-%                      |
| Gender  | Female                     | 1042 ± 47%                           |
|         | Male                       | 1175 ± 53%                           |
| COPD    |                             | 48 ± 2.2%                            |
| Asthma  |                             | 103 ± 4.6%                           |
| CHF     |                             | 51 ± 2.3%                            |
| CAD     |                             | 165 ± 7.4%                           |
| HT      |                             | 456 ± 20.6%                          |
| DM      |                             | 360 ± 16.2%                          |
| CRF     |                             | 63 ± 2.8%                            |
| Malignancy |                         | 82 ± 3.7%                            |
| CVA     |                             | 14 ± 0.6%                            |
| RD      |                             | 29 ± 1.3%                            |
| Others  |                             | 159 ± 7.2%                           |
| 1st PCR |                             | 676 ± 30.5%                          |
| CT      |                             | 1541 ± 69.5%                         |
| (-)     |                             | 298 ± 13.4%                          |
| (+)     |                             | 1594 ± 71.9%                         |
| Without involvement | | 298 ± 13.4% |
| Unilateral |                         | 207 ± 9.3%                           |
| Bilateral |                         | 1387 ± 62.6%                         |
| Exitus  | Alive                      | 68 ± 3.1%                            |
|         | 2149 ± 96.9%               |
| Inpatient |                           | 1334 ± 60.2%                         |

COPD: Chronic Obstructive Pulmonary Disease, CHF: Chronic Heart Failure, CAD: Coronary Artery Disease, HT: Hypertension, DM: Diabetes Mellitus, CRF: Chronic Renal Failure, CVA: Cerebrovascular Accident, RD: Rheumatic Diseases, PCR: Polymerase Chain Reaction, CT: Computed Tomography.
Table 2
Drug Usage for COVID-19 Treatment.

| Drug                  | n (%)   |
|-----------------------|---------|
| HQ                    | 393     |
| Azithromycine         | 1824    |
| Oseltamivir           | 987     |
| Lop/Rit              | 757     |
| Favipiravir           | 72      |
| Anti-biotherapy       | 1893    |
|                       | 324     |

HQ: Hydroxychloroquine, Lop/Rit: Lopinavir/Ritonavir.

Table 3
Laboratory Results.

| Parameter               | Min-Max  | Median | Mean ± s.d./n-% |
|-------------------------|----------|--------|-----------------|
| WBC (/µL)               | 240–63860| 6310   | 6946.62 ± 3342.65 |
| Neutrophil (/µL)        | 10–46100 | 3880   | 4557.97 ± 2910.17  |
| Hemoglobin (g/L)        | 5.1–15.6 | 13.8   | 13.68 ± 3.68      |
| Lymphocyte (/µL)        | 25–23100 | 1520   | 1809.66 ± 5146.25 |
| Thrombocyte (/µL)       | 1000–1434000| 217000 | 238147.55 ± 127522.25 |
| LDH (U/L)               | 68–1840  | 235    | 268.56 ± 140.39   |
| CRP (mg/L)              | 0–453    | 12     | 40.36 ± 84.73     |
| Procalcitonin (mg/mL)   | 0–162    | 0.05   | 1.57 ± 10.38      |
| D-Dimer (µg/ml)         | 0–41     | 0.6    | 1.75 ± 4.54       |
| Urea (mg/dL)            | 0.45–435 | 28.75  | 35.18 ± 27.92     |
| Creatinine (mg/dL)      | 0.1–8.9  | 0.77   | 1.18 ± 4.04       |
| AST (U/L)               | 5–506    | 27     | 34.26 ± 28.98     |
| ALT (U/L)               | 2–619    | 22     | 30.99 ± 36.92     |
| Total Protein (g/dL)    | 3.74–8.02| 7.05   | 7.54 ± 5.72       |
| Albumin (g/dL)          | 1.23–6   | 4.18   | 4.24 ± 1.8        |
| CK (U/L)                | 1–21140  | 84     | 163.92 ± 619.66   |
| LDH/Lymph               | 0–6.65   | 0.116  | 0.17 ± 0.31       |

WBC: White Blood Cell, LDH: Lactate Dehydrogenase, CRP: C-Reactive Protein, AST: Aspartate Aminotransferase, ALT: Alanine Aminotransferase, CK: Creatine Kinase, LDH/Lymp.: Lactate Dehydrogenase/Lymphocyte.

Laboratory results

Mean absolute lymphocyte count was 1809.66 ± 5146.25; mean LDH 268.56 ± 140.39 and mean LDH/Lymphocyte ratio was 0.17 ± 0.31 (Table 3).

Comorbidity and drug usage—survival analysis

COPD, CHF, CAD, HT, DM, CKD and malignancy were found to have a significant statistical relationship with survival (p < 0.001). Those with any comorbidity had high mortality than those without comorbidity (p < 0.001) (Table 4).

When the relationship between drug usage and survival was examined, no statistically significant relationship was found for hydroxychloroquine and azithromycin (p = 0.616, p = 0.995). Significantly more deaths were observed in patients using oseltamivir (p = 0.031), lopinavir/ritonavir (p = 0.022), supplemental antibiotic therapy (p < 0.001) and favipiravir (p < 0.001) (Table 5).

Follow up subtype, CT findings, 1st PCR and presence of involvement in CT and survival analysis

When the effects of involvement subtypes on survival in CT are examined, it was revealed that patients with bilateral CT involvement showed significantly high mortality (p < 0.001). In patients with CT involvement, there was more statistically deaths than those without CT involvement (p = 0.014) (Table 6).

Laboratory results, LDH/Lymphocyte ratio and age and survival analysis

When the relationship between laboratory data and survival is examined, high LDH/Lymphocyte ratio (p = 0.001), high leukocyte (p = 0.001), high neutrophil (p < 0.001), low hemoglobin (p = 0.001), high LDH (p < 0.001), high CRP (p < 0.001), high D-Dimer (p = 0.025), high urea (p < 0.001), high AST (p = 0.003) and low albumin (p = 0.003) were found to have statistically significant high mortality (Table 7).

Logistic regression analysis of data

The p values for step, block and model were less than 0.001 and p = 0.718 at the end of the Hosmer and Lemeshow test. The model was found to be feasible and analyses continued. As a result of logistic regression analysis; 1 unit increase in age was found to increase the mortality risk by 1.034 times, while 1 unit increase in CRP was found to increase the risk 1.007 times (Table 8).

ROC analysis: LDH/Lymphocyte ratio for diagnosis and survival

In order to test the usability of the LDH/Lymphocyte ratio in diagnosis for COVID-19 disease, individuals who showed unilateral and bilateral specific CT involvement were considered positive due to less false negativity of CT compared to PCR and evaluations were performed by accepting the CT results as a gold standard. As a result of ROC analysis, the area under the curve (AUC) was found to be 0.706 (p < 0.001; cut-off > 0.06) and it was concluded that the LDH/Lymphocyte ratio was diagnostic for COVID-19. The sensitivity at the cut-off point is 76.4 and specificity is 59.60 (Table 9).

ROC analysis was performed to evaluate the LDH/Lymphocyte ratio in terms of survival conditions and the area under the curve (AUC) was found to be 0.749 (p < 0.001; cut-off > 0.21). The sensitivity at cut-off point is 70.59 and specificity is 73.88 (Table 10).

Discussion

Our study contains 3-months data of COVID-19 and has single center homogenization. It is clear that it will make a significant contribution to the literature not only in terms of revealing the data or determining the survival relationship, but also in terms of the new alternative it offers at the point of diagnosis.

It is possible to say that most of the patients who applied for emergency services were isolated by hospitalization. This not only provided an advantage in terms of isolation, but also facilitated clinical follow-up and data transfer. All deaths were among inpatients. Our hospital’s mortality rate was 3.1% with 68 patients, which is in line with the literature data.

The positive rate of PCR result was 69.5%. It should be emphasized that all PCR negative cases have CT involvement. This is in line with the discussions carried out in the literature before. Studies based on radiological findings have demonstrated higher CT involvement and sensitivity [14,15]. In our study, typical COVID-19 involvement was found in 71.9% of patients with baseline CT (n: 1594); 1387 of them are bilateral; 207 of them consisted of unilateral involvement. This data is the first in the literature.

Significant statistical relationship between LDH/Lymphocyte ratio and survival, which form the basis of our study, has been shown. In order to test the usability of the LDH/Lymphocyte ratio in diagnosis for COVID-19, the patients with unilateral and bilateral specific CT involvement were considered positive due to less false negativity than PCR and the evaluations were performed by accepting the CT results as the gold standard. As a result of ROC analysis; the area under the curve (AUC) was found to be 0.706 (p < 0.001; cut-off > 0.06) and it was concluded that the LDH/Lymphocyte ratio...
ratio was diagnostic for COVID-19. The sensitivity at cut-off point is 76.4 and specificity is 59.60. ROC analysis was performed to evaluate the LDH/Lymphocyte ratio for survival and the area under the curve (AUC) was found to be 0.749 (p < 0.001; cut-off > 0.21). The sensitivity at cut-off point is 70.59 and specificity is 73.88. Our LDH/Lymphocyte ratio is usable in terms of mortality and putting cut-off in terms of diagnosis and mortality, they have been a big contribution of our study to the literature. Our ratio is very impressive in early diagnosis and mortality prediction due to its easy application, especially since COVID-19 has no specific treatment yet and the importance of early isolation is unquestionable.

The most frequently used treatment is hydroxychloroquine, which is an expected finding. At this point, when examining the use of favipiravir specifically; we see that it was used for 2.7% of patients. Due to the rapid increase in case numbers all around the world and the limited and contradictory data from the initial cases, the permission to use favipiravir is subject to the regulations of Ministry of Health. With the increasing experience in dealing with cases, its scope of usage has broadened. While it was initially only being used in the intensive care unit, lately its application has been extended to other patients.

Looking at the survival data; in parallel with the literature, the relationship between comorbidities such as COPD, HT, DM, CHF, CAD and presence of malignancy and survival has been revealed. Similarly, statistical significance between any presence of comorbidity and no comorbidity was also shown in our study [16–20]. In the data between drug usage and survival, there was no significant relationship between hydroxychloroquine and azithromycin and survival. Contrary to expectations, a survival relationship was found on the use of oseltamivir, additional antibiotic therapy and favipiravir. It should be taken into consideration that all patients requiring additional antibiotic therapy or those who have to use favipiravir are fragile patients in intensive care conditions who require hospitalisation and close follow-up. The mortality rate is higher in this patient group as expected. Further data requirements are obvious in terms of favipiravir and treatment responses [21,22]. Again, the majority of this patient group consists of critical patients that are in line with the National Institutes of Health (NIH) guidelines. It is worth noting that clinical pictures such as ARDS (acute respiratory distress syndrome), septic shock, cardiac dysfunction, multiorgan failure are common in this patient population [16].

When it is examined in terms of CT involvement and survival, new data were obtained. Especially it is important to find a significant relationship between bilateral involvement and survival. This is a practical and usable finding for clinicians. It should be said that it can be used more easily than the specific findings described in the

### Table 4
Comorbidity and Survival Analysis.

| Comorbidity | Alive | Exitus | Chi-Square | p     |
|-------------|-------|--------|------------|-------|
| COPD        | (-)   | n 2109 | 60         |       |
|             | (+)   | 79.7  | 2.8        | 26.023 <0.001* |
| Asthma      | (-)   | n 46  | 8          |       |
|             | (+)   | 83.3  | 16.7       |       |
| Asthma      | (-)   | n 2046| 68         |       |
|             | (+)   | 96.8  | 3.2        |       |
| CHF         | (-)   | n 103 | 0          |       |
|             | (+)   | 100   | 0          |       |
| CHF         | (-)   | n 2104| 62         |       |
|             | (+)   | 97.1  | 2.9        |       |
| CAD         | (-)   | n 45  | 6          |       |
|             | (+)   | 88.2  | 11.8       |       |
| CAD         | (-)   | n 2002| 50         |       |
|             | (+)   | 97.6  | 2.4        |       |
| HT          | (-)   | n 428 | 28         |       |
|             | (+)   | 93.9  | 6.1        |       |
| DM          | (-)   | n 1812| 45         |       |
|             | (+)   | 97.6  | 2.4        |       |
| DM          | (-)   | n 337 | 23         |       |
|             | (+)   | 93.6  | 6.4        |       |
| DM          | (-)   | n 2096| 58         |       |
|             | (+)   | 97.3  | 2.7        |       |
| CRF         | (-)   | n 84.1| 15.9       |       |
|             | (+)   | 53    | 10         |       |
| Malignancy  | (-)   | n 2076| 59         |       |
|             | (+)   | 97.2  | 2.8        |       |
| Malignancy  | (-)   | n 73  | 9          |       |
|             | (+)   | 89.0  | 11.0       |       |
| CVA         | (-)   | n 2136| 67         |       |
|             | (+)   | 97.0  | 3.0        |       |
| CVA         | (-)   | n 2121| 67         |       |
|             | (+)   | 96.9  | 3.1        |       |
| RD          | (-)   | n 28  | 1          |       |
|             | (+)   | 96.6  | 3.4        |       |
| RD          | (-)   | n 1310| 18         |       |
|             | (+)   | 98.6  | 1.4        |       |
| Comorbidities| (-) | n 839 | 50         |       |
|            | (+)   | 94.4  | 5.6        |       |

COPD: Chronic Obstructive Pulmonary Disease, CHF: Chronic Heart Failure, CAD: Coronary Artery Disease, HT: Hypertension, DM: Diabetes Mellitus, CRF: Chronic Renal Failure, CVA: Cerebrovascular Accident, RD: Rheumatic Diseases.
previous literature data especially regarding the pandemic patient density [18]. It should be noted that the relationship between laboratory data and survival is parallel to the literature. As a result of logistic regression analysis; 1 unit increase in age was found to increase the mortality risk by 1.034 times, while 1 unit increase in CRP was found to increase the risk 1.007 times. These findings seem to be a potentially original contribution to the existing literature [19,20].

**Limitations**

Our study has some limitations. The potential relationship between the LDH/Lymphocyte ratio and other infectious diseases is unknown. For this reason, the relationship between this ratio and mixed infection or other viral pneumonias can lead to confusion as it is not clear. Another important limitation point is that new treatment options were not available for the patients included in the study and they were included in the study mostly at the beginning of the pandemic. Therefore, it should be noted that our current treatment approach and guidelines are different.

**Conclusion**

As a result, in our study, we revealed a single center data and examined the LDH/Lymphocyte ratio. LDH/Lymphocyte ratio was analyzed in terms of diagnosis and mortality with using specific CT involvement as the gold standard method which was found to be a more sensitive method due to PCR false negativity; 0.06 and 0.21 were obtained as cut off values for diagnosis and mortality.

**Ethics statement**

The study protocol has been approved by Istanbul Training and Research Hospital Ethics Committee and Ministry of Health. (Ethics committee approval number: 2257, 8.5.2020, Ministry of Health Approval Number: 2020-04-30T15_07_44).
### Table 7
Laboratory Results, LDH/Lymphocyte Ratio and Age and Survival Analysis.

|                | Alive | Exitus | Mean       | T     | p     |
|----------------|-------|--------|------------|-------|-------|
| WBC            | 2087  | 68     | 6875.7992 ± 3240.9091 | −3.514 | 0.001* |
| Neutrophil     | 2087  | 68     | 9120.3235 ± 5235.11566 | −4.595 | <0.001* |
| Lymphocyte     | 2087  | 68     | 4469.1145 ± 2771.72802 | −1.058 | 0.290  |
| Hemoglobin     | 2087  | 68     | 13.7232 ± 3.703  | 3.221  | 0.001* |
| LDH            | 2087  | 68     | 22834.7266 ± 12698.53875 | −4.602 | <0.001* |
| CRP            | 1933  | 63     | 37.1391 ± 82.22079  | −7.985 | <0.001* |
| Procalcitonin  | 828   | 42     | 1.465 ± 10.3107 | −1.344 | 0.179  |
| D-             | 1319  | 49     | 1.6503 ± 4.3289  | −2.313 | 0.025* |
| Urea           | 1570  | 66     | 34.0283 ± 25.99135 | −4.615 | <0.001* |
| Creatinine     | 1573  | 67     | 1.1625 ± 4.1117 | −0.767 | 0.443  |
| AST            | 1557  | 67     | 33.5605 ± 27.92626 | −3.082 | 0.003* |
| ALT            | 1557  | 67     | 50.5075 ± 44.63161 | 0.978  | 0.332  |
| T-Protein      | 989   | 43     | 7.5046 ± 5.47817  | −0.469 | 0.641  |
| Albumin        | 1120  | 51     | 4.2733 ± 1.83266  | 3.022  | 0.003* |
| LDH/Lymphocyte | 2144  | 68     | 3.4951 ± 0.69199  | −3.569 | 0.001* |
| CK             | 1270  | 56     | 142.9036 ± 215.04916 | −1.321 | 0.192  |
| Age            | 2147  | 67     | 47.0671 ± 16.94875 | −9.409 | <0.001* |

WBC: White Blood Cell, LDH: Lactate Dehydrogenase, CRP: C-Reactive Protein, AST: Aspartate Aminotransferase, ALT: Alanine Aminotransferase, T-Protein: Total Protein, CK: Creatine Kinase, LDH/Lymph: Lactate Dehydrogenase/Lymphocyte.

### Table 8
Logistic Regression Analysis.

|                | B     | S.E.  | Wald | p     | HR (95 CI) |
|----------------|-------|-------|------|-------|------------|
| COPD           | 1.333 | 0.711 | 3.517| 0.061 | 3.791(0.942–15.263) |
| CHF            | −0.509| 0.773 | 0.433| 0.510 | 0.601(0.132–2.735) |
| CAD            | 0.546 | 0.502 | 1.183| 0.277 | 1.726(0.645–4.618) |
| HT             | −0.475| 0.476 | 0.993| 0.319 | 0.422(0.244–1.583) |
| DM             | 0.165 | 0.462 | 0.127| 0.721 | 1.179(0.477–2.917) |
| CRP            | 0.482 | 0.714 | 0.456| 0.656 | 1.019(0.84–1.258)  |
| Malignancy     | 0.097 | 0.728 | 0.018| 0.894 | 1.010(0.265–4.591) |
| Without Involvement in CT | 0.01 | 0.995 | 0.01 | 0.997 | 0.00–100 |
| Bilaterally    | −17.555| 4457.776| 0    | 0.000 | 100(0.203–5.862)  |
| WBC            | 0.086 | 0.858 | 0.01 | 0.920 | 1.09(2.03–5.862)  |
| Neutrophil     | 0     | 0     | 1.296| 0.255 | 1(1–1.296)       |
| Hemoglobin     | −0.042| 0.101 | 0.169| 0.681 | 0.959(0.786–1.17) |
| D-Dimer        | 0.007 | 0.003 | 0.247| 0.809 | 1.006(0.95–1.066) |
| Urea           | 0.009 | 0.005 | 0.00 | 0.995 | 1.009(0.999–1.019) |
| Albumin        | 0.006 | 0.004 | 0.092| 0.918 | 1.006(0.999–1.014) |
| LDH/Lymphocyte | 0.23  | 0.308 | 0.555| 0.456 | 1.258(0.687–2.303) |
| Age            | 0.033 | 0.017 | 3.971| 0.046 | 1.034(1.001–1.068) |
| Constant       | −8.532| 1485.927| 0    | 0.995 | 0          |

COPD: Chronic Obstructive Pulmonary Disease, CHF: Chronic Heart Failure, CAD: Coronary Artery Disease, HT: Hypertension, DM: Diabetes Mellitus, CRF: Chronic Renal Failure, CT: Computed Tomography, WBC: White Blood Cell, CRP: C-Reactive Protein, AST: Aspartate Aminotransferase, LDH/Lymph: Lactate Dehydrogenase/Lymphocyte.

### Table 9
ROC Analysis: LDH/Lymphocyte Ratio for Diagnosis.

|                | AUC(95 CI) | SE    | p       | Cut-off |
|----------------|------------|-------|---------|---------|
| CT             | 0.708(0.685–0.728) | 0.017 | <0.001* | >0.06  |

CT: Computed Tomography, AUC: Area Under the Curve, SE: Standard Error.
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Conflict of interest

None to declare.

Author contributions

All authors contributed to the collection of patients data. IS wrote the manuscript and made tables.

Data availability

The authors declare that data supporting the findings of this study are available within the article.

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Table 10

ROC Analysis: LDH/Lymphocyte Ratio for Survival.

| AUC(95% CI) | SE | p      | Cut-off |
|-------------|----|--------|---------|
| Survival    | 0.749(0.731–0.767) | 0.033 | <0.001* | >0.21 |

AUC: Area Under the Curve, SE: Standart Error.