

A nomogram for predicting the severity of COVID-19 using laboratory examination and CT findings

Yani Kuang

Taizhou Hospital affiliated to Wenzhou Medical University, Zhejiang, China

Susu He

Taizhou Hospital affiliated to Wenzhou Medical University, Zhejiang, China

Shuangxiang Lin

Taizhou Hospital affiliated to Wenzhou Medical University, Zhejiang, China

Rui Zhu

Taizhou Hospital affiliated to Wenzhou Medical University, Zhejiang, China

Rongzhen Zhou

Taizhou Hospital affiliated to Wenzhou Medical University, Zhejiang, China

Jian Wang

Taizhou Hospital affiliated to Wenzhou Medical University, Zhejiang, China

Renzhan Li

Sanmen People's Hospital, Zhejiang, China

Haiyong Lin

First People's Hospital of Wenling, Zhejiang, China

Zhibang Zhang

Tiantai People's Hospital, Zhejiang, China

Peipei Pang

Hangzhou GE Healthcare, China

Wenbin Ji (✉ wb.j@163.com)

Taizhou Hospital affiliated to Wenzhou Medical University, Zhejiang, China <https://orcid.org/0000-0002-7667-9430>

Research Article

Keywords: COVID-19, SARS-CoV-2, clinical characteristics, severity prediction

Posted Date: July 24th, 2020

DOI: <https://doi.org/10.21203/rs.3.rs-46841/v1>

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Version of Record: A version of this preprint was published at International Journal of Clinical Medicine on January 1st, 2020. See the published version at <https://doi.org/10.4236/ijcm.2020.1112059>.

Abstract

Background: The outbreak of COVID-19 has a significant impact on the health of people around the world. In the clinical condition of COVID-19, the condition of critical cases changes rapidly with a high mortality rate. Therefore, early prediction of disease severity and active intervention play an important role in the prognosis of severe patients.

Methods: All the patients with COVID-19 in Taizhou city were retrospectively included and segregated into the non-severe and severe group according to the severity of the disease. The clinical manifestations, laboratory examination results, and imaging findings of the 2 groups were analysed for comparing the differences between the 2 groups. Univariate and multivariate logistic regression were used for screening the factors that could predict the disease, and the nomogram was constructed.

Results: A total of 143 laboratory-confirmed cases were included in the study, including 110 non-severe patients and 33 severe patients. The median age of patients was 47 years (range, 4–86 years). Fever (73.4%) and cough (63.6%) were the most common initial clinical symptoms. By using the method of multivariate logistic regression, the variables to construct nomogram include age (OR: 1.052, 95% CI: 1.020–1.086, $P = 0.001$), body temperature (OR: 2.252, 95% CI: 1.139–4.450, $P = 0.020$), lymphocyte count (OR: 1.128, 95% CI: 1.000–1.272, $P = 0.049$), ADA (OR: 1.163, 95% CI: 1.023–1.323, $P = 0.021$), PaO₂ (OR: 0.972, 95% CI: 0.953–0.992, $P = 0.007$), IL-10 (OR: 1.184, 95% CI: 1.037–1.351, $P = 0.012$), and bronchiectasis (OR: 3.818, 95% CI: 1.694–8.605, $P = 0.001$). The AUC of the established nomogram was 0.877.

Conclusions: This study established a stable nomogram for predicting the severity of COVID-19, and the clinicians can use the established nomogram for predicting the severity of newly diagnosed COVID-19 patients and to conduct active intervention for minimising the mortality rate and improving the prognosis of severe patients.

Background

In December 2019, the first pneumonia case of unknown origin was reported in Wuhan [1–3], the capital of China's Hubei province. The pathogen was identified as a new enveloped RNA betacoronavirus, which was considered to have developmental similarity with SARS-CoV [4]. The World Health Organisation (WHO) named the virus severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and named the resulting disease as coronavirus disease 2019 (COVID-19). Most of the infected individuals present with acute viral pneumonia, which spreads from person to person [5–8].

In January 30, 2020, the WHO declared COVID-19 as the sixth public health emergency of international concern (PHEIC). As of March 6, 2020, there were 97,769 laboratory-confirmed cases worldwide [9]. The statistics of SARS-CoV (severe acute respiratory syndrome coronavirus), which appeared in 2003, reported 8,422 infected people [10, 11]. In 2012, MERS-CoV (Middle East respiratory syndrome

coronavirus) was prevalent only in the Middle East [12–15]. However, COVID-19 has become a globally widespread disease [9, 16, 17], and the number of confirmed cases continues to rise [18].

According to the *Diagnosis and Treatment Protocol for Novel Coronavirus Pneumonia (Trial Version 5)*, COVID-19 can be divided into 4 clinical types [19]. Clinical types are closely related to the prognosis of patients where critical type patients develop acute symptoms and have a high mortality rate. At present, the severity of the disease is mainly based on patients' symptoms, laboratory examination, and CT performance, and then the clinicians make the adjustment of treatment measures. There are few methods and studies for the prediction of disease severity.

Hence, the purpose of this study was to predict the severity of COVID-19. We collected Taizhou all cure COVID-19 cases and retrospectively analysed the epidemiological characteristics, initial laboratory examination results, and CT images after hospitalisation. We aim to identify factors to construct a model for predicting the severity of COVID-19, for understanding the trend of disease progression in patients with newly diagnosed COVID-19, and for reducing the mortality and improving the prognosis of patients with a high risk of severe COVID-19.

Methods

Study participants and design

From January 17 to March 11, 2020, patients were consecutively enrolled in 4 hospitals in Taizhou city. The 4 hospitals include a municipal hospital and 3 county-level hospitals, namely the Taizhou Hospital Enze district, Wenling First People's Hospital, Sanmen People's Hospital, and Tiantai People's Hospital. All the patients were admitted after laboratory confirmation of SARS-CoV-2 infection. After diagnosis, all the patients were transferred to Taizhou Public Health Centre for isolation treatment, and the last patient was discharged from hospital on March 11, 2020 (the deadline for the study).

Data source

We obtained electronic medical records and data of all the cured and discharged COVID-19 cases from the 4 hospitals from January 17 to March 11, 2020. The diagnostic criteria were positive tests using high throughput real-time reverse transcription polymerase chain reaction (RT-PCR) of nasal swabs and pharyngeal swabs, as recommended by the WHO interim guidelines. As all the confirmed diseases in Taizhou were treated at the public health centre of Enze district of Taizhou hospital, the medical records of some patients before admission were provided by the doctors from the respective hospitals. The cases from Wenling People's Hospital, Sanmen People's Hospital, and Tiantai People's Hospital were sent to the Taizhou Hospital researchers by the participants in the hospital. Only laboratory-confirmed cases were included in the study.

All clinical data were reviewed and extracted by a team of experienced respiratory clinicians in Taizhou hospital. The data were recorded in an Excel spreadsheet; if a data is missing, a request is made to the

hospital where the participant is located, and the hospital participant then contacts the attending clinician. We extracted recent exposure history, clinical symptoms or signs, and laboratory examination results for admission from the electronic medical record. Imaging examinations included chest X-ray or computed tomography (CT) of the thorax. All the patients who underwent CT scanning were evaluated and reviewed by senior radiologists at Taizhou hospital. Any major differences between the 2 reviewers was resolved by discussion with the third panel of reviewers. All laboratory examinations were performed according to the patients' clinical care needs, including a complete blood count, blood chemical analysis, coagulation test, assessment of liver and kidney function as well as electrolytes, c-reactive protein (CRP), calcitonin, lactate dehydrogenase, lymphocyte factor assay, blood gas analysis, and creatine kinase measurements.

Study definitions and criteria

We segregated all the patients into severe group and non-severe group according to the *Diagnosis and Treatment Protocol for Novel Coronavirus Pneumonia (Trial Version 5)* released by the National Health Commission & State Administration of Traditional Chinese Medicine [19]. The severe group included the serious and critical types, while the non-severe group included the mild and moderate types. The mild type was defined as having mild clinical symptoms with no signs of pneumonia based on imaging results. The moderate type was defined as having symptoms such as fever, respiratory tract symptoms, and the appearance of pneumonia based on imaging results. The serious type was defined based on the following conditions: 1. respiratory distress with respiratory rate (RR) $>30/\text{min}$; 2. oxygen saturation $<93\%$ at rest; and 3. arterial blood oxygen partial pressure (PaO_2)/oxygen concentration (FiO_2) $<300 \text{ mmHg}$ ($1 \text{ mmHg} = 0.133\text{KPa}$). The critical type was defined based on any of the following conditions: 1. respiratory failure and the need for mechanical ventilation; 2. shock; and 3. organ failure that requires intensive care unit (ICU) care.

The date of exposure refers to the earliest date of exposure to a source of transmission (people in Wuhan or confirmed patients). The incubation period was defined as the time interval between the potential earliest date of exposure to the source of transmission and the earliest date of occurrence of symptoms (clinical symptoms such as cough and fever). The specific contact date (if the date was unclear, the case was excluded from the analysis) was recorded, and the incubation period was calculated based on the specific information of the exposure date. Treatment delay indicates the time between the onset of symptoms and hospitalisation. Body temperature under the armpit $\geq 37.5^\circ\text{C}$ was defined as fever.

Laboratory confirmation

All cases were confirmed by the Zhejiang Center for Disease Control and Prevention (Zhejiang CDC). The nucleic acid extraction was carried out with the kit (Biogas, Nklier Technology Co. LTD, Shenzhen, China) recommended by the Chinese Center for Disease Control and Prevention (China CDC). RT-PCR assays were performed in accordance with the protocol established by the WHO, and nucleic acid sequencing was performed using NGS (next-generation sequencing) technology.

Statistical analysis

We used Microsoft corp. EXCEL, version 2019 (Microsoft Corporation, American), R software, version 3.5.2 (MathSoft company, American), and MedCalc for Windows, version 15.0 (MedCalc Software, Ostend, Belgium), for data processing and analysis. Independent *t* sample test was used for comparing the difference between the 2 groups of continuous variables. The differences between the 2 groups were compared by the chi-square test or Fisher's exact test. Logistic regression analysis was performed on the indicators with statistically significant differences between the 2 groups ($P < 0.05$). The R software was used for generating the nomogram and MedCalc software was used for generating the receiver operating characteristic (ROC) curve. Test results with $P < 0.05$ was considered statistically significant.

Ethical approval

The retrospective multicentre cohort study was approved by the ethics review committee of Taizhou Hospital, Sanmen People's Hospital, Wenling First People's Hospital, and Tiantai People's Hospital, and the written informed consent was waived.

Results

Demographic characteristics of the patients

As of March 11, 2020, a total of 146 confirmed patients in Taizhou were transferred to isolation hospitals and were discharged after the treatment. Three cases were not included in this study owing to the partial data. We obtained basic information, clinical data, and CT images of 143 patients (96.6%), among whom 66 were women (46.2%), and 77 were men (53.8%). The demographic and clinical characteristics of the patients are shown in Table 1. On admission, the degree of severity of COVID-19 was categorized as non-severe in 110 patients and severe in 33 patients. Of all the patients, 60 patients (42.0%) had contacts with a confirmed patient, 70 (49.0%) had contacts with a person in the Wuhan area, 4 (2.8%) had contacts with both a confirmed patient and a person in the Wuhan area, and 9 (6.3%) had an unclear contact history. The median age of all the patients was 47 years (range, 4–86 years), 56.8% were aged 30–60 years. The median age of the non-severe patients was 44.5 years (range, 4–80 years), while the median age of the severe patients was 55.0 years (range, 27–86 years). 129 patients (90.2%) had a history of smoking, including 100 patients (90.9%) in the non-severe group and 29 patients (87.9%) in the severe group.

The mean incubation period was 6.9 days (standard deviation [SD], 3.472 days), and the mean treatment delay period was 3.0 days (SD, 2.631 days). Fever (73.4%) was the most common symptom. A total of 91 patients (63.6%) developed cough: sputum (28.7%), yellow sputum (5.6%), and dry cough (29.4%). Sore throat (10.5%), nasal congestion (5.6%), muscle soreness (9.8%), and chest tightness (17.5%) were relatively few. Of all the patients, 24.5% had at least one coexisting illness (hypertension and/or chronic obstructive pulmonary disease). The average body temperature of the patients was 38.0°C (range, 37°C–39°C; SD, 3.741°C), and only 1 case (0.7%) had a high fever (>40°C).

Laboratory examination results of the two groups

As some of the patients were first admitted to the county hospital, some laboratory tests were not carried out owing to the conditions. A total of 123 cases was included for the analysis of laboratory examination results, and those without such examination were recorded as UNKNOWN. There were 28 cases in the severe group and 95 cases in the non-severe group. Table 2 shows the details of the laboratory results of all the cases. In the non-severe group, except for the increase in blood glucose level (14 ± 60 mmol/L), the decrease of serum albumin (39 ± 5.2 g/L), erythrocyte sedimentation rate (35 ± 24 μ mol/L), and serum sodium (130 ± 25 mmol/L), and the increase of CRP (15 ± 19 mg/L) and amyloid A (190 ± 330 mg/L) were observed. All other test results were within the normal range (Table 2).

In the severe group, following parameters showed a decreased value: lymphocyte count decreased ($(0.91 \pm 0.43) \times 10^9$), erythrocyte sedimentation rate (38 ± 24 μ mol/L), serum albumin (130 ± 25 g/L), glomerular filtration rate (82 ± 26 mL/min), arterial blood oxygen partial pressure ($83 (\pm 24)$ mmHg), calcitonin level (0.086 ± 0.090 μ g/L), total CD3 value ($56 \pm 13\%$), absolute CD4 value ($290 \pm 200/\mu$ L), and absolute CD8 value ($190 \pm 130/\mu$ L). Following parameters showed an increased value in the severe group: blood glucose level (13 ± 53 mmol/L), lactate dehydrogenase level (350 ± 180 U/L), CPR level (35 ± 31 mg/L), amyloid protein A level (430 ± 420), fibrinogen detection value (4.5 ± 1.3 s), D dimer level (0.54 ± 0.63 g/L), pH level (7.8 ± 2.0), myoglobin (84 ± 80 ng/mL), IL-10 (9.4 ± 9.2 pg/mL), C1q (240 ± 38 mg/L), PT (16 ± 19 s), absolute CD3 value ($490 \pm 330/\mu$ L). Other test results were within the normal range.

CT manifestations of the two groups

Five (3%) CT images could not be evaluated owing to poor respiratory artefact quality. CT images of 138 (97%) patients at admission were obtained. Among them, 34 patients were severe (31%) and 104 patients were non-severe (75%). The lesions in 135 patients (98%) were mainly distributed in the external or subpleural of the lung; 37 patients (27%), middle or inner zone of lung; and 34 patients (25%), both. Among them, the lesions in the middle or inner band of the lungs were more commonly observed in the severe patients (47% vs 20%). Mass (81%) was the most common lesion shape followed by patchy (68%). Irregularity in the shapes of the lung segments was observed only in severe patients, while the nodular shape was observed only in non-severe patients. Most of the lesions presented with mixed density (63%).

In 60% of the CT images, the lesion was distributed along the pulmonary bronchial tree, and in 62% of the CT images, the lesion was adjacent to vasodilation. Fifty-two percent of the CT images showed interlobular septal thickening, and 30% of the CT images showed fibrous foci. Other concomitant signs such as cavitation or calcification (1%), enlarged lymph nodes (3%), pleural effusion (2%), chronic bronchitis (4%), emphysema, or pulmonary bullous (4%) were rare. Consolidation (68% vs 41%), bronchial inflation signs (59% vs 41%), and bronchiectasis (71% vs 39%) were more common in the severe group.

Results of univariate logistic regression analysis predicting the severity of COVID-19 patients

Univariate logistic regression was performed for all the collected variables, and the results are shown in Table 4. For all the factors such as clinical characteristics, laboratory results, and CT findings, the variables associated with the severity of COVID-19 were age (Odds ratio [OR]: 1.052, 95% confidence interval [CI]: 1.020–1.086, $P = 0.001$), days from the symptom onset to hospitalisation (OR: 1.213, 95% CI: 1.034–1.939, $P = 0.016$), days from the symptom onset to diagnosis (OR: 1.213, 95% CI: 1.084–1.357, $P < 0.001$), body temperature (OR: 2.252, 95% CI: 1.139–4.450, $P = 0.020$), Neutrophil count (OR: 0.087, 95% CI: 0.026–0.274, $P < 0.001$), Lymphocyte count (OR: 1.128, 95% CI: 1.000–1.272, $P = 0.049$), IgM (OR: 2.226, 95% CI: 1.015–4.883, $P = 0.046$), ADA (OR: 1.163, 95% CI: 1.023–1.323, $P = 0.021$), albumin (OR: 0.847, 95% CI: 0.725–0.988, $P < 0.035$) CRP (OR: 1.024, 95% CI: 1.007–1.042, $P = 0.006$) Glomerular filtration rate (OR: 0.965, 95% CI: 0.942–0.988, $P = 0.004$), amyloid A (OR: 1.002, 95% CI: 1.001–1.003, $P = 0.001$), PCT (OR: 1.43E+11, 95% CI: 1334.315–1.53E+19, $P = 0.006$), PaO₂ (OR: 0.972, 95% CI: 0.953–0.992, $P = 0.007$), oxygen concentration (OR: 1.027, 95% CI: 1.001–1.053, $P = 0.044$), oxygenation index (OR: 0.992, 95% CI: 0.988–0.996, $P < 0.001$), myoglobin (OR: 1.011, 95% CI: 1.002–1.020, $P = 0.014$), IL-10 (OR: 1.184, 95% CI: 1.037–1.351, $P = 0.012$), consolidation (OR: 3.103, 95% CI: 1.399–6.885, $P = 0.005$), and bronchiectasis (OR: 3.818, 95% CI: 1.694–8.605, $P = 0.001$).

To construct a clinical-image nomogram for the prediction of severe COVID-19.

All the variables with $P < 0.05$ were screened for multivariable logistic regression. Finally, variables selected for predicting severe COVID-19 were age (OR: 1.03, 95% CI: 0.99–1.07, $P = 0.1565011$), body temperature (OR: 2.28, 95% CI: 1.01–5.18, $P = 0.0480145$), Lymphocyte count (OR: 0.11, 95% CI: 0.03–0.38, $P = 0.0006512$), ADA (OR: 1.27, 95% CI: 1.08–1.49, $P = 0.0037539$), PaO₂ (OR: 0.98, 95% CI: 0.95–0.99, $P = 0.0511345$), IL-10 (OR: 1.15, 95% CI: 0.99–1.34, $P = 0.063646$), bronchiectasis (OR: 5.25, 95% CI: 1.77–5.62, $P = 0.0028594$). The final equation is: Nomoscore = 34.663 + Age × 0.028 + Temperature × 0.826 + L × -2.250 + ADA × 0.239 + PaO₂ × -0.023 + IL-10 × 0.143 + Bronchiectasis × 1.659.

The constructed equation was used for drawing the ROC, with the area under the curve being 0.877. The Youden index was used for determining the optimal threshold, and the corresponding sensitivity and specificity were 74.29% and 82.73%, respectively.

Discussion

In this retrospective study, by analyzing the medical history, clinical information, laboratory examination and CT images of COVID-19 patients who had cured and discharged from hospital, we found some factors related to the severity of the disease, such as age, body temperature, Lymphocyte count, ADA, PaO₂, IL-10, bronchiectasis, and established a stable nomogram. The nomogram established by us was highly sensitive and specific (74.29%, 82.73%). Clinicians could use this nomogram to predict the severity of COVID-19 patients newly diagnosed with a simple and feasible operation.

In the early stage of the COVID-19 outbreak, the severity of COVID-19 is judged mainly based on real-time clinical symptoms, laboratory examination, and imaging manifestations of the patient, which may lead to

delayed treatments to some extent. Most of the patients in China have been cured and discharged from the hospital, so Chinese doctors have accumulated some experience for the diagnosis and treatment of COVID-19.

42% of the patients have been living in Wuhan for a long time or have been to Wuhan or had contact with people returning from Wuhan. This result was similar to that of other studies [20]. Our study also found that the average age of COVID-19 infected patients was 47.0 years (range, 4–86 years), which was similar to the findings of a previous study [20]. The results of this study showed no statistical difference between men and women, but the study by Chen Nanshan et al [21] found that the proportion of men was higher than that of women. However, the number of cases in their study was only 99; hence, more data are needed for confirming the accuracy of this result. Most of the patients (62.3%) went to the hospital within 2 days of symptom onset. The average incubation period reported by Weijie Guan et al. was 4 days (2–7 days) [20], while that reported by Li Qun et al was 5.2 days (4.1–7.0 days). [24]Fever and cough were the most common clinical symptoms in all the cases, with fever occurring in 73.4% and cough in 63.6% of the patients. Compared with other studies, our results were different. In the study by Guan Weijie et al. [20], 43.8% of the patients were found to have fever at the first visit, but the number increased to 88.7% after hospitalisation. In our study, of all the patients with fever, more than half had mild to moderate fever (37.5°C – 39°C), and only a few had a high fever (23.1%).

The laboratory test results of both the groups were abnormal to different degrees, especially in patients with severe diseases. Blood glucose, serum sodium, serum albumin, amyloid A, and CRP values were found to be outside the normal range in both the groups. We suggested that the difference in laboratory results between the 2 groups can be used for assessing the degree of illness to some extent. However, the accuracy still needs to be confirmed with larger data. In addition, the possible explanation was that SARS-CoV-2, a novel virus, greatly triggers the body's innate immune response, adaptive response, and specific immune response after entering the body through the respiratory tract [22]. The specific immune response depends primarily on T cells, and the critical protective role of T cell immune response to coronavirus infection has been well documented in several animal models [23].

In the early stage of the disease or in non-severe patients, the body's innate immune response and specific response can prevent the spread and clearance of the virus, similar to the immune response to other viruses invading the body. The response includes increased blood glucose level, accelerated CRP rates, increased amyloid A level, and other adaptive responses, as well as diluent serum albumin and blood sodium reduction. With the progress of the disease, despite the efforts of T cells, CD4, CD8 and other lymphocytes were reduced in severe patients or in the later stage of the disease owing to the virulence of the virus or the decline of the body's immunity. Whether the mechanism is similar to that of HIV causing CD4 cell depletion remains to be investigated [24, 25]. These results reflect the body reached the maximum for clearing the virus, so that this stage may result in decreased lung function, liver function, kidney function, heart function, and even blood clotting. The specific manifestations were reduced PaO_2 , increased transaminase, decreased glomerular filtration rate, increased PT and D timer values, and increased myoglobin (Table 2). At the same time, if the treatment is working well or if the

patient's immune system recovers, the multiple organ dysfunction gets reversed. However, if the disease continues to progress or the treatment measures are not effective, multiple organs will fail, especially the lung, resulting in death. In Dawei Wang's study of 138 inpatients in Wuhan, the mortality rate was 4.3% [22], while the mortality rate was 1.4% in another study [20]. Accurate death rates require further statistics.

In all the cases in this study, only one 18-year-old patient presented no obvious imaging manifestations at the time of admission, and all the others showed imaging changes. Among the remaining 138 cases assessed using imaging changes, the lesions were more localized in the lung periphery (98%), and only a few severe patients showed inner or middle band lesions. This result was similar to that in the Wenzhou case imaging study [26]. The possible explanation was that the blood supply of the subpleural was less than that of the intrapulmonary and mediastinum band, with a reduction in lymphatic reflux, resulting in a relatively low virus clearance capacity. There were more patchy heterogeneous density shadows in the severe patients. The possible explanation was that different exudate protein content would lead to different density on CT imaging, resulting in a variety of shapes and density changes. In 60% of all the patients, the lesions were distributed along the lung texture, suggesting that the spread along the bronchi may be one of the mechanisms for the spread of the virus. In addition, CT signs such as consolidation, bronchial inflation, and bronchiectasis were more common in the severe group; therefore, these signs could be used for assessing the severity of the disease.

In this study, age, body temperature, lymphocyte ratio, ADA value, blood oxygen partial pressure, IL-10, and bronchiectasis signs were selected by statistical methods for predicting the severity of COVID-19 patients, and the role of each variable in the prediction of severe COVID-19 was directly demonstrated in the form of the nomogram. Clinicians can predict the severity of newly admitted patients according to their age, laboratory examination, and CT performance, and grasp the trend of the patient's condition for conducting more active treatments. This will greatly facilitate the clinical treatment of COVID-19 and benefit potential severe COVID-19 patients.

This study has some limitations. First, this study is a retrospective study and not a random study, which may affect the integrity of the data and reduce the credibility of the results. Second, this study only collected cases in Taizhou city. It would be better to collect a larger range of cases and analyse larger data. Third, there was no long-term follow-up in this study, which could not strongly reflect the specific benefits brought to the patients by predicting the development of the disease. In the future, we will work as far as possible with hospitals in other regions to share each other's data, expand the amount of data in our research, and continuously improve our predictive models. In addition, we will conduct long-term follow-up visits to the patients studied to see how the severity of COVID-19 affects the patient's physical condition and quality of life later in life. If we have the conditions, we will conduct joint prospective studies in areas where new cases are occurring to verify the validity and stability of our model.

Conclusions

In this study, the variables (age, body temperature, lymphocyte ratio, ADA value, blood oxygen partial pressure, IL-10, bronchiectasis sign) were screened based on the analysis of cured and discharged COVID-19 patients in Taizhou area for the prediction of severity, and a stable nomogram was constructed. Clinicians can use the nomogram constructed in this study for predicting the severity of newly diagnosed COVID-19 patients, grasp the risk of their progression to severe COVID-19, and conduct an active intervention as soon as possible.

Abbreviations

CT

Computed tomography; WHO:World Health Organization; SARS-CoV-2:Severe acute respiratory syndrome coronavirus 2; SARS-CoV:Severe acute respiratory syndrome coronavirus; MERS-CoV:Middle east respiratory syndrome coronavirus; PHEIC:Public Health Emergency of International Concern; COVID-19:Coronavirus disease 2019; CDC:Center for Disease Control and Prevention; RT-PCR:reverse transcription polymerase chain reaction; NGS:high throughput sequencing PaCO₂:Arterial blood oxygen partial pressure; RR:Respiratory Rate;FiO₂:oxygen concentration; PH:potential of hydrogen;C1q:Human Complement Component C1q;IL-10:Interleukin-10;TCD3:Total cluster of differentiation 3;PT:Prothrombin time; ADA:adenosine deaminase; CK:Creatinine kinase; LDH:Lactate dehydrogenase; CRP:C-reactive protein; HIV:human immunodeficiency virus; CD3/4/8:cluster of differentiation 3/4/8;

Declarations

Ethics approval and consent to participate

The retrospective multicentre cohort study was approved by the ethics review committee of Taizhou Hospital, Sanmen People's Hospital, Wenling First People's Hospital, and Tiantai People's Hospital, and the written informed consent was waived.

Consent for publication

All authors agreed to publish the manuscript in the Journal of Infectious Diseases of Poverty

Availability of data and materials

All datasets are presented in the main paper.

Competing interests

The authors declare that they have no competing interests.

Funding

None

Authors' contributions

YK, SH and WJ designed the study and took the lead in drafting the manuscript and interpreting, SL and PP developed the statistical methods, SH, RZ, JW, RZZ, RL, HL, ZZ were participated in the collection of experimental data. All authors read and approved the final manuscript for publication

Acknowledgements

We thank Jingjing Li and Shuying Ying for their contribution to date collection for this study. We would also like to thank Editage (www.editage.cn) for English language editing.

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Figures

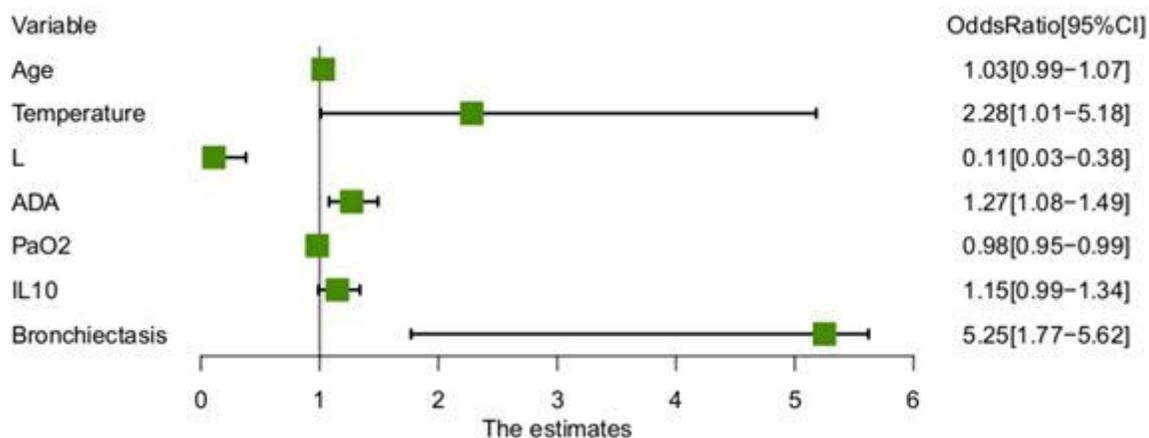


Figure 1

Multivariate logistic regression results predicting severity of COVID-19

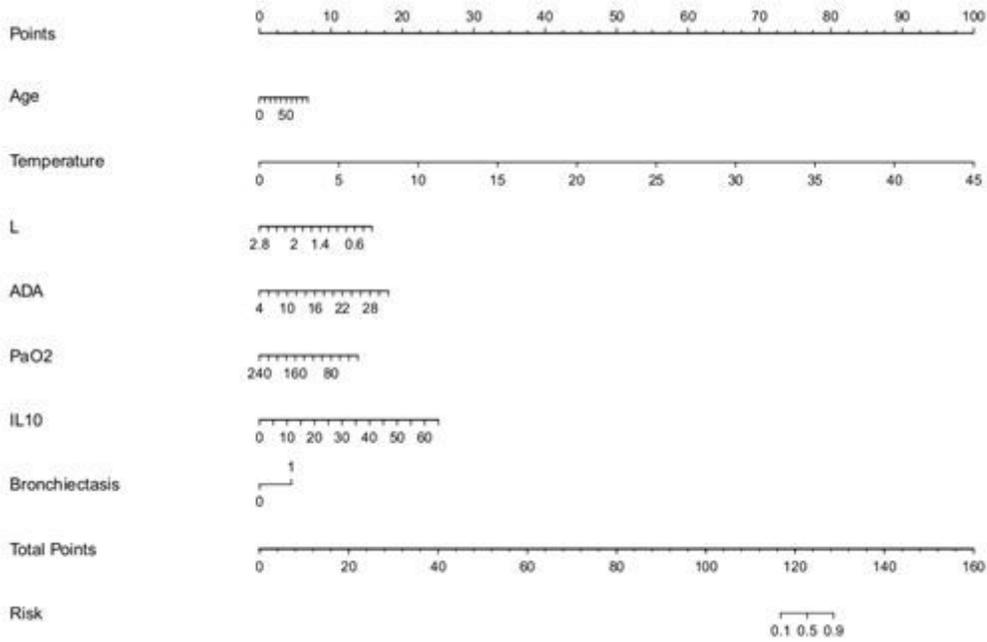


Figure 2

The nomogram for predicting severe COVID-19 According to the patient's age, body temperature, lymphocyte count, ADA value, PaO2 value, IL-10 value, and whether bronchiectasis was present, the corresponding score was found by perpendicular to the first horizontal line. The probability of predicting severe COVID-19 is obtained by perpendicular the total score to the last horizontal line

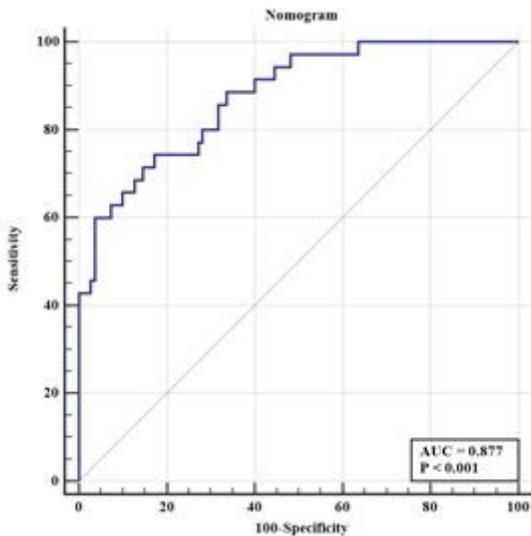


Figure 3

The receiver operating characteristic (ROC) curve of the nomogram predicting severe COVID-19