

Proposal of COVID-19 Clinical Risk Score for the management of suspected COVID-19 cases: a case control study

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Abstract

Background

No clinical scoring system has yet been established to estimate the likelihood of COVID-19 and to determine the suitability of diagnostic testing in suspected COVID-19 patients.

Methods

This was a single-center, retrospective, observational study of patients with suspected COVID-19 and confirmed COVID-19. Patient background, clinical course, laboratory and CT findings, and the presence of alternative diagnoses were evaluated. Clinical risk scores were developed based on clinical differences between patients with and those without COVID-19.

Results

Among 110 patients suspected of COVID-19, 60.9% underwent PCR testing based on the judgment of physicians. Two patients were found to have COVID-19. The clinical characteristics of 108 non-COVID-19 patients were compared with those of 23 confirmed COVID-19 patients. Patients with COVID-19 were more likely to have a history of high-risk exposures and abnormal sense of taste and smell. Significantly higher rates of subnormal white blood cell count, lower eosinophil count, and lower procalcitonin level were observed in the COVID-19 group than in the non-COVID-19 group. When blood tests, CT findings, and the presence of alternative diagnoses were scored on an 11-point scale, i.e., “COVID-19 Clinical Risk Score”, the COVID-19 group scored significantly higher than the non-COVID-19 group, with more than four points in the COVID-19 group. All non-COVID cases that did not undergo PCR had a score of 4 or less.

Conclusions

The COVID-19 Clinical Risk Score enables risk classification of patients suspected of having COVID-19 and can help in decision-making in clinical practice, including appropriateness of diagnostic testing.

Introduction

The novel coronavirus disease (coronavirus disease 2019, COVID-19) has been spreading rapidly since the first case of infection was confirmed in December 2019 in Wuhan, China, and cases are now being reported worldwide[1]. In Japan, the number of infected people has been increasing, and outbreaks, not only in the cities but also in medical and nursing care facilities, have become a public health problem[2]. The spread of infection in healthcare facilities can lead to facility disruption and the disintegration of health care systems in the community. Therefore, clinicians are required to properly identify and manage patients with COVID-19.

COVID-19 often causes fever, upper respiratory tract symptoms, cough, malaise, olfactory, and gustatory dysfunction after 7–14 days of the incubation period[3–6]. However, the clinical course and symptoms

are nonspecific, making it difficult to distinguish COVID-19 from common cold and other febrile diseases. Although several hematologic and biochemical changes associated with COVID-19 have been reported[7–9], there is no specific blood test for COVID-19. On the other hand, chest computed tomography (CT) has shown a high frequency of abnormalities, and several CT findings characteristic of COVID-19 have been reported[10–12]. However, there are many pathological conditions such as interstitial pneumonia and pulmonary edema that need to be differentiated. The most problematic issue is that the diagnostic utility of these clinical findings in suspected COVID-19 cases has not been fully evaluated.

The definitive diagnosis is confirmed mainly by polymerase chain reaction (PCR) test for severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) RNA. The sensitivity of the PCR test for COVID-19 is estimated to be approximately 70%[13]; therefore, there is a risk of false negatives. Thus, it is still challenging to manage suspected COVID-19 cases in the absence of a highly sensitive and specific diagnostic test system. In addition, limited medical and human resources make it difficult to perform PCR testing sufficiently in some facilities and geographical regions. To date, no useful clinical indicators have been established for the management of suspected COVID-19 cases in healthcare settings.

In response to the spread of COVID-19 infection in Hokkaido, Japan, Hokkaido University Hospital has systematically managed suspected COVID-19 cases under the leadership of respiratory physicians and infection control teams. In this study, we retrospectively analyzed the clinical characteristics and management details of suspected COVID-19 patients at Hokkaido University Hospital. We also compared the characteristics of suspected and confirmed COVID-19 patients to clarify the clinical differences. Based on these findings, we developed a clinical score (COVID-19 Clinical Risk Score) to ensure accurate management of suspected COVID-19 patients.

Methods

Patients

This single-center, retrospective observational study was approved by Hokkaido University Hospital Division of Clinical Research Administration. The study included suspected or confirmed COVID-19 patients who had been treated between March 13 and May 31, 2020 at Hokkaido University Hospital in Sapporo, Japan. Suspected patients were those whose symptoms and CT findings raised concerns regarding the presence of COVID-19. SARS-CoV-2 RNA PCR was performed in cases of suspected COVID-19 when respiratory physicians (SN, KK, YY, JN, HH, KS, KT, MM) deemed it necessary based on a comprehensive assessment of clinical and imaging findings. Every decision was finalized after discussions with at least two respiratory physicians. A positive nasal swab or sputum specimen on PCR, performed at Hokkaido University Hospital or by referral, was required for the definitive diagnosis of COVID-19. We excluded COVID-19 patients who showed a significant level of recovery and those who had severe complications.

Data collection

The demographic characteristics (age and sex) and clinical data (referral source, symptoms, days from onset, comorbidities, laboratory findings, and CT findings) were collected from medical records by investigators. Medical information of confirmed COVID–19 cases diagnosed outside our hospital was collected from the earliest available data after the onset of COVID–19 symptoms.

CT imaging score

Chest CT imaging findings that could be read by a non-specialist were selected and scored based on previous reports with modifications[10–12]. In addition to (1) ground-glass opacity (GGO) with or without consolidation, (2) multilobar or bilateral lesions, (3) subpleural or lower lung dominant distribution, and (4) absence of atypical findings (consolidation without GGO, hollow shadows, nodules, tree-in-bud appearance, or pleural effusion) were also taken into account. One point was added when each CT finding was observed, and the CT imaging score ranged from 0 to 4. Patients who had previous CT images were evaluated for newly appearing shadows. Each case was evaluated independently by two respiratory physicians to ensure consistency (Figure 1).

Statistical analysis

Descriptive statistics were determined for all study variables. All categorical variables were compared for study outcomes using the Fisher exact test, and continuous variables were compared using the *t* test or Mann-Whitney *U* test, as appropriate. Continuous data were expressed as the mean (standard deviation [SD]) or median (interquartile range [IQR]). Categorical data are expressed as proportions. JMP (SAS Institute Inc., Cary, NC, USA) and Prism 8 (GraphPad Software, San Diego, CA, USA) were used for statistical processing.

Results

Patient recruitment

Figure 2 shows a flowchart of patient recruitment. During the study period, 112 patients with suspected COVID–19 were referred to respiratory physicians; two of whom were excluded because their symptoms had already improved or resolved, so 110 patients were finally analyzed. Among the suspected cases, 60.9% underwent PCR testing based on the judgment of the respiratory physicians. Of these, only one patient showed a positive PCR result, and all others showed negative results. One patient with mild illness who was instructed to stay home without PCR was later found to have COVID–19 on PCR testing. Except for this patient, no other PCR-negative patients or those who did not undergo PCR were subsequently determined to have confirmed COVID–19.

Analysis of cases

The median age of the suspected COVID-19 patients was 68.5 (range: 15–89 years), and 76.4% were male. The departments of referral were internal medicine (43.6%), surgery (30%), and emergency medicine (15.4%). Only 8.2% of the patients had a history of contact with COVID-19 patients, travel to endemic areas, or other high-risk behaviors. Most patients (88.2%) had underlying diseases, with malignancy (32.7%) being the most common. The most frequent presenting symptom was fever (72.4%), followed by cough (28.1%) and dyspnea (20.0%); 12.7% did not show any obvious symptoms. These asymptomatic patients were referred for abnormal chest CT findings. Among all patients, 26.3% had respiratory failure. These results, along with the results of the blood tests, are listed in Table 1. A chest CT was performed in all cases except one, and new abnormal findings were identified in 88.1% of the cases. The mean CT imaging score was 2.01. Based on the patient's background, clinical course, laboratory findings, and CT findings, the respiratory physicians comprehensively considered whether the patient was likely to have COVID-19 or other diagnoses or whether the diagnosis was difficult to determine. A likely alternative diagnosis was considered in 79 (71.8%) of the cases. The differential diagnoses included drug-induced disease, radiation pneumonitis, acute exacerbation of interstitial pneumonia, pulmonary edema, bacterial pneumonia, sepsis, gravity-dependent atelectasis, etc.

We examined whether there was a clinical difference between suspected COVID-19 patients who did and did not undergo PCR testing. Compared with the PCR group, the non-PCR group demonstrated a significantly low percentage of high-risk exposure history (0.0% vs. 13.4%, $P = 0.01$) and respiratory failure (16.3% vs. 34.3%, $P = 0.049$), CT imaging score (1.28 vs. 2.46, $P < 0.001$), and had a high proportion of cases with an alternative diagnosis (86.1% vs. 62.7%, $P = 0.009$) (Table 1).

Next, the data of confirmed COVID-19 patients were analyzed. As shown in Figure 2, we treated 26 confirmed COVID-19 cases, including those identified from the group of suspected cases. Patients whose symptoms had already resolved or whose main cause of symptoms was another co-existing condition were excluded; data from 23 patients were finally analyzed. The median age was 68 (range, 27–97) years, and 69.5% were male. Fever (92.3%) was the most common symptom, followed by cough (47.8%), while anosmia or ageusia was reported in only three patients (13.3%). At the time of data collection, patients with respiratory failure accounted for 39.1% of the study sample. Chest CT was performed in 16 patients (61.5%), and the mean CT imaging score was 3.50. Based on clinical information prior to definitive diagnosis, only one patient (4.5%) had a dominant differential diagnosis (Table 2).

We then compared the clinical findings between patients who did not have COVID-19 and confirmed COVID-19 patients (Table 2). Since all patients with COVID-19 were symptomatic, asymptomatic patients in the non-COVID-19 group were excluded for comparison of symptoms. The COVID-19 group had a higher frequency of sore throat and olfactory or taste disorders than the non-COVID-19 group (17.3% vs. 4.3%, $P = 0.047$, 13.0% vs. 1.1%, $P = 0.02$, respectively.). On blood tests, white blood cell (WBC) count was higher in the non-COVID-19 group than in the COVID-19 group (median, 5,180 vs. 7,300, $P <$

0.001), and large differences in the percentage of WBC counts, up to 8,000/ μ L, existed between the two groups (91.3% vs. 54.6%, $P < 0.001$). On the other hand, there was no significant difference in the rate of lymphocytopenia (63.6% vs. 60.2%, $P = 0.81$) or absolute lymphocyte count (median, 866 vs. 1145, $P = 0.13$) between the two groups. The reduction in eosinophil count ($<50/\mu$ L) was seen in many of the COVID-19 patients and was more frequent than that in the non-COVID-19 patient group (95.5% vs. 35.5%, $P < 0.001$). Analysis of biochemical test results revealed that the percentage of lactate dehydrogenase >250 IU/L and procalcitonin <0.5 ng/mL was significantly higher in patients with COVID-19 (56.5% vs. 34.4%, $P = 0.04$, 100% vs. 68.6%, $P = 0.03$, respectively). The difference in the percentage of low procalcitonin levels was pronounced when the analysis was limited to cases with C-reactive protein (CRP) ≥ 0.5 mg/dL (100% vs. 58.3%, $P = 0.009$). The mean CT imaging score was higher in the COVID-19 patient group than in the non-COVID-19 group (mean, 3.5 vs. 2.0, $P < 0.001$). Moreover, a significantly higher proportion of patients in the non-COVID-19 group than in the COVID-19 group had an alternative diagnosis (4.3% vs. 73.1%, $P < 0.001$).

Developing COVID-19 Clinical Risk Score

In light of the clinical differences between the COVID-19 and non-COVID-19 groups, we developed the "COVID-19 Clinical Risk Score" to determine whether the diagnosis of COVID-19 should be refuted or PCR testing should be carried out (Table 3). Based on the previous results, we decided to incorporate the following items into the clinical score: (A) blood test scores based on WBC count, eosinophil count, and procalcitonin value (maximum 3 points); (B) CT imaging scores (maximum 4 points); and (C) scores based on alternative diagnosis (maximum 4 points). Clinical scores were examined for three groups: non-COVID-19 patients who underwent PCR (non-COVID-19 with PCR group), those who did not undergo PCR (non-COVID-19 without PCR group), and confirmed COVID-19 patients. As shown in Figure 3A-C, all blood test, CT imaging, and alternative diagnosis scores were higher in the COVID-19 group, but all clinical scores had overlapping distributions among the groups. We then summed all three scores and obtained the COVID-19 Clinical Risk Score (maximum 11 points). As a result, the distribution of the COVID-19 Clinical Risk Scores was clearly different among the groups (Figure 3D). The non-COVID with PCR group had higher risk scores than the non-COVID without PCR group (mean 4.4 vs. 2.7, $P < 0.001$), which appeared to reflect the decision-making process in clinical practice. Furthermore, there was no overlap in the distribution of the risk scores between the non-COVID and COVID-19 groups (range, 0-4 vs. 5-11) (Figure 3D). Finally, we propose a preliminary algorithm for the management of suspected COVID-19 patients based on the COVID-19 Clinical Risk Score (Figure 4).

Discussion

In the present study, we analyzed the clinical characteristics of the medical management of suspected COVID-19 patients and compared the characteristics of suspected and confirmed COVID-19 patients who visited our medical institution. Based on our findings, we developed the COVID-19 Clinical Risk Score to guide proper management of suspected COVID-19 patients.

Although Hokkaido in Japan had been under COVID–19 emergency alert during most of the study period, only two patients were confirmed to have COVID–19 among more than 100 suspected cases seen at our hospital. Because our facility is a university hospital with a wide range of specialized departments, the patient backgrounds and referral sources were diverse. Therefore, our patients' backgrounds might be different from those of patients in primary care clinics and city hospitals. Nonetheless, COVID–19 is a disease with a high risk of outbreak and hospital shutdown once it is identified in a medical institution. Even if the actual number of COVID–19 patients is small, there will be a large number of suspected cases. Thus, proper management of suspected COVID–19 cases is critical.

In this study, we compared the clinical characteristics of confirmed COVID–19 patients and non-COVID–19 patients. The significant differences between the two groups were found in the rates of sore throat and olfactory and gustatory disturbances. Although the symptoms of COVID–19 have been described as nonspecific, it has been recently found that olfactory and gustatory disturbances are characteristic of patients with COVID–19[6, 14, 15]. The present study also confirmed that olfactory and taste disorders are more frequent in patients with COVID–19 than in suspected patients. However, the rate of positivity was not high (13.3%); hence, these disorders were not included in the clinical risk score.

Leukopenia and lymphopenia have been reported as hallmarks of COVID–19 blood tests. In the present study, COVID–19 patients had significantly lower WBC counts and leukopenia was added to the risk score, but the rate of lymphocytopenia was not significantly different between COVID–19 and non-COVID–19 patients. Many non-COVID–19 patients had inflammatory diseases in which lymphocytes were depleted due to an elevated WBC count along with elevated neutrophil ratio; therefore, a low lymphocyte count may not be helpful in the diagnosis of COVID–19 in clinical practice. On the other hand, eosinophil count has been reported to be decreased in the early stage of the disease and then to be elevated in COVID–19[16]. Many of the confirmed COVID–19 patients in this study also showed a significant decrease in eosinophil count, and eosinopenia was adopted in the risk score. Previous studies on COVID–19 have shown that elevated procalcitonin level is associated with disease severity[9, 17]. However, in the present study, which compared COVID–19 cases with other febrile illnesses and cases with abnormal images on chest CT, a low level of procalcitonin was evident in patients with COVID–19, whereas the CRP level was elevated. In the early stage of the disease, elevated procalcitonin appears to help reduce the risk of COVID–19. Thus, we selected leukopenia, eosinopenia, and low procalcitonin levels along with high CRP levels as useful routine blood tests for the diagnosis of COVID–19.

In the present study, we scored the chest CT findings and examined their usefulness in the diagnosis of COVID–19. Some of the CT findings characteristic of COVID–19, such as linear or rounded morphology of opacities, may be difficult for non-specialists to read[10–12]. Therefore, we focused on simple chest CT findings that could be read by general physicians and included the absence of atypical findings as an item of CT imaging score. As a result, there was a large difference in CT imaging scores between non-COVID–19 patients without PCR and confirmed COVID–19 patients. Even without professional CT reading, this result suggests that it is possible to distinguish COVID–19 from other diseases to some extent by scoring chest CT findings.

Our focus in this study was to determine the risk of any disease besides COVID-19. This perspective is critical in the calculation of pretest probability prior to diagnostic testing, as exemplified by Well's criteria used for the diagnosis of pulmonary embolism[18, 19]. COVID-19 is a disease with few specific clinical manifestations. Therefore, when only blood tests and CT findings are used as indicators for diagnosis, the score may underestimate or overestimate the likelihood of COVID-19. Based on the clinical course, patient background, and other clinical findings, we aimed to determine whether any other differential diagnosis would be more likely than COVID-19 and added this judgement to the COVID-19 Clinical Risk Score. The results showed a large difference in the risk scores between COVID-19 patients and non-COVID-19 patients. We believe that adding the judgment of the clinicians on differential diagnosis to the objective indicators made the risk score clinically relevant.

The sensitivity of the PCR test is not high enough with COVID-19, and if the PCR test alone is used as an indicator of judgment, many false negatives will be missed. In addition, due to the limitations of medical and human resources, it is not always possible to perform PCR testing on all eligible patients. For appropriate medical care and infection control, it is reasonable to estimate the pretest probability based on the clinical score to determine whether PCR should be performed. The identification of patients who have a low risk of COVID-19 and are not eligible for PCR testing by the COVID-19 Clinical Risk Score is important for the proper use of the PCR test and to conserve resources. Patients with high scores should be carefully considered for re-testing and continuing infection control, even if the PCR results are negative. However, the actual decision to perform PCR will be influenced by a variety of factors, including the prevalence of COVID-19, severity of the patient's illness, fear of medical staff or patients, and policies of medical institutions or administrative government. The clinical score should be used as a reference criterion, and decision making should be flexible in the clinical setting. In addition, if sensitive and simple diagnostic tests are developed in the future, the implications of the clinical score will change. Such testing may take some time to develop, and for the time being, the COVID-19 Clinical Risk Score will be an important indicator in clinical practice.

This study has several limitations. First, since the study was a retrospective study, a prospective validation is needed to prove the usefulness of the clinical risk score. Second, the backgrounds of the suspected and confirmed COVID-19 patients were different. Because only a small number of true COVID-19 patients were identified among the suspected cases, we used data from patients admitted for treatment of COVID-19. Third, we cannot rule out the possibility that some of the patients we classified in the non-COVID-19 group might have had COVID-19. However, since only a single case of infection was identified in the subsequent clinical course of the patients without PCR testing, and none of the nosocomial outbreaks occurred, we believe that our management was successful.

In conclusion, we clarified the clinical features of patients with suspected COVID-19 treated at our institution and identified clinical differences between suspected and confirmed COVID-19 patients. The COVID-19 Clinical Risk Score, based on blood test results, CT imaging findings, and the presence of an alternative diagnosis, was developed to demonstrate the validity of our practice. We hope that the

COVID–19 Clinical Risk Score will contribute to the improvement in the management of suspected COVID–19 cases in the future.

Abbreviations

COVID-19: Coronavirus disease, 2019

CRP: C-reactive protein

CT: computed tomography

GGO: ground-glass opacity

IQR: interquartile range

PCR: polymerase chain reaction

SARS-CoV-2: severe acute respiratory syndrome coronavirus 2

SD: standard deviation

WBC: white blood cell

Declarations

Ethics approval and consent to participate

The research protocol was approved by the Ethics Committee of the Hokkaido University Hospital. The study was based on existing samples collected in the course of routine practice and no additional risks are posed to patients. Therefore, the individual's informed consent was waived by the above ethics committee. Informed consent for study participation was officially announced on the website. All patient data were anonymized prior to analysis.

Consent for publication

Not applicable.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

SN and MS contributed to study conceptualization and design, data acquisition and interpretation, statistical analysis, and drafting of the manuscript. KK, YY, JN, HH, KS, NI, and YN contributed to the acquisition and interpretation of data. YA contributed to the statistical analysis. KS contributed to study concept and design, acquisition and interpretation of data, and finalizing the manuscript.

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Others

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Tables

Table 1. Clinical characteristics of patients with suspected COVID-19

	Total (N = 110)	PCR (n = 67)	No PCR (n = 43)	P value
Characteristics				
Age, years	68 (50-78)	69 (51-76)	67 (40-78)	0.78
Male	84 (76.4)	54 (80.6)	30 (69.8)	0.25
Comorbidities				
Hypertension	32 (29.1)	22 (32.8)	10 (23.3)	0.39
Diabetes	28 (25.4)	14 (20.9)	9 (20.9)	1.00
Malignancy	36 (32.7)	20 (29.9)	16 (37.2)	0.53
Chronic lung disease	27 (24.5)	20 (29.9)	8 (18.6)	0.26
Chronic heart failure	12 (10.9)	6 (9.0)	6 (14.0)	0.53
Coronary artery disease	16 (14.5)	10 (14.9)	6 (14.0)	1.00
Chronic renal disease	17 (15.4)	10 (14.9)	7 (16.3)	1.00
Cerebrovascular disease	14 (12.7)	10 (14.9)	4 (9.3)	0.56
Immunodeficiency	21 (19.1)	10 (14.9)	11 (25.6)	0.21
History				
Days from onset of symptoms	3 (2-7)	3 (2-7)	5 (2-11.5)	0.32
High-risk exposure history	9 (8.1)	9 (13.4)	0 (0.0)	0.01
Symptoms				
Fever	80 (72.4)	47 (70.2)	27 (62.3)	0.53
Cough	31 (28.1)	18 (26.9)	14 (32.6)	0.53
Nasal congestion	3 (2.7)	2 (3.0)	2 (4.7)	0.64
Sore throat	4 (3.6)	2 (3.0)	2 (4.7)	0.64
Dyspnea	22 (20)	17 (25.4)	5 (11.6)	0.09
Anosmia or ageusia	2 (1.82)	1 (1.5)	1 (2.3)	1.00
No symptoms	14 (12.7)	7 (10.5)	7 (16.3)	0.39
Respiratory failure	29 (26.3)	23 (34.3)	7 (16.3)	0.049

Laboratory values				
White blood cell count, cells/ μ L	6600 (5000-9900)	7600 (5400-10800)	7100 (6000-10200)	1.00
Neutrophil count, cells/ μ L	4524 (3089-7380)	4709 (3144-9378)	4981 (3678-7500)	0.81
Lymphocyte count, cells/ μ L	1046 (697-1597)	1089 (677-1587)	1288 (780-1719)	0.50
Eosinophil count, cells/ μ L	58 (0-165)	91 (21-179)	66 (0-196)	0.55
Platelet count, $\times 10^4$ / μ L	18.9 (14.5-25.9)	19.5 (14.5-24.2)	19.7 (16.5-28.3)	0.26
Lactate dehydrogenase, IU/L	215 (177-319)	213 (169-329)	200 (166-250)	0.14
C-reactive protein, mg/dL	4.10 (0.61-8.14)	4.30 (1.26-8.38)	1.36 (0.18-7.03)	0.06
Procalcitonin, ng/mL	0.08 (0.03-0.46)	0.18 (0.04-3.88)	0.04 (0.02-0.44)	0.10
CT imaging Score	2.01 \pm 1.23	2.46 \pm 1.15	1.28 \pm 1.05	<0.001
Differential diagnosis				
High likelihood of COVID-19	5 (4.6)	5 (7.5)	0 (0.0)	0.007
High likelihood of alternative diagnosis	79 (71.8)	42 (62.7)	37 (86.1)	

Data are shown as median (interquartile range), mean \pm SD, or number (%)

Table 2. Clinical characteristics of COVID-19 and non-COVID-19 patients

	COVID-19 (n = 23)	Non-COVID-19 (n = 108)	P value
Characteristics			
Age, years	68 (54-78)	68.5 (49-78)	0.84
Male	17 (70.8)	82 (75.9)	0.72
Comorbidities			
Hypertension	8 (34.8)	32 (29.6)	0.63
Diabetes	4 (17.4)	23 (21.3)	0.78
Malignancy	6 (26.1)	36 (33.3)	0.63
Chronic lung disease	5 (26.1)	27 (25.0)	1.00
Chronic heart failure	4 (17.4)	12 (11.1)	0.48
Coronary artery disease	3 (13.0)	16 (14.8)	1.00
Chronic renal disease	2 (8.7)	17 (15.7)	0.52
Cerebrovascular disease	3 (13.0)	14 (13.0)	1.00
Immunodeficiency	2 (8.7)	20 (18.5)	0.36
History			
Days from onset of symptoms	5 (3.5-7)	3 (2-7)	0.56
High-risk exposure history	15 (65.2)	9 (8.3)	<0.001
Symptoms †			
	(n=23)	(n=94)	
Fever	21 (92.3)	78 (83.0)	0.15
Cough	11 (47.8)	30 (31.9)	0.22
Nasal congestion	2 (8.7)	2 (2.1)	0.25
Sore throat	4 (17.3)	4 (4.3)	0.047
Dyspnea	5 (21.7)	22 (23.4)	1.00
Anosmia or ageusia	3 (13.0)	1 (1.1)	0.02
Respiratory failure	9 (39.1)	29 (30.9)	0.46
Laboratory results (measured value)			
White blood cell count, cells/μL	5180 (4150-6180)	7300 (5575-10425)	<0.001

Neutrophil count, cells/ μ L	3518 (2474-4429)	4800 (3586-8106)	0.007
Lymphocyte count, cells/ μ L	866 (690-1149)	1145 (723-1655)	0.13
Eosinophil count, cells/ μ L	0 (0-11)	83 (20-180)	<0.001
Platelet count, $\times 10^4$ / μ L	16.1 (13.8-20.5)	19.6 (16.1-26.6)	0.05
Lactate dehydrogenase, IU/L	270 (226-390)	210 (168-283)	0.02
C-reactive protein, mg/dL	5.31 (1.5-10.7)	3.72 (0.57-7.38)	0.12
Procalcitonin, ng/mL	0.065 (0.05-0.08)	0.12 (0.03-0.62)	0.33
Laboratory results (cut off value)			
White blood cell count <8000 μ L	21/23 (91.3)	59/108 (54.6)	<0.001
Lymphocyte count <1000 μ L	14/22 (63.6)	56/92 (60.2)	0.81
Eosinophil count <50/ μ L	21/22 (95.5)	33/93 (35.5)	<0.001
Lactate dehydrogenase >250 IU/L	13/20 (56.5)	37 /108 (34.3)	0.04
Procalcitonin <0.5ng/mL	12/12 (100)	33/48 (68.6)	0.03
Procalcitonin <0.5ng/mL and C-reactive protein \geq 0.5mg/dL	11/11 (100)	21/36 (58.3)	0.009
CT imaging findings			
CT imaging score	3.50 \pm 0.86	2.00 \pm 1.23	<0.001
Differential diagnosis			
High likelihood of COVID-19	10 (43.5)	4 (3.7)	<0.001
High likelihood of alternative diagnosis	1 (4.3)	79 (73.1)	

Data are shown as median (interquartile range), mean \pm SD, or number (%)

†Data analysis was performed on excluded asymptomatic cases

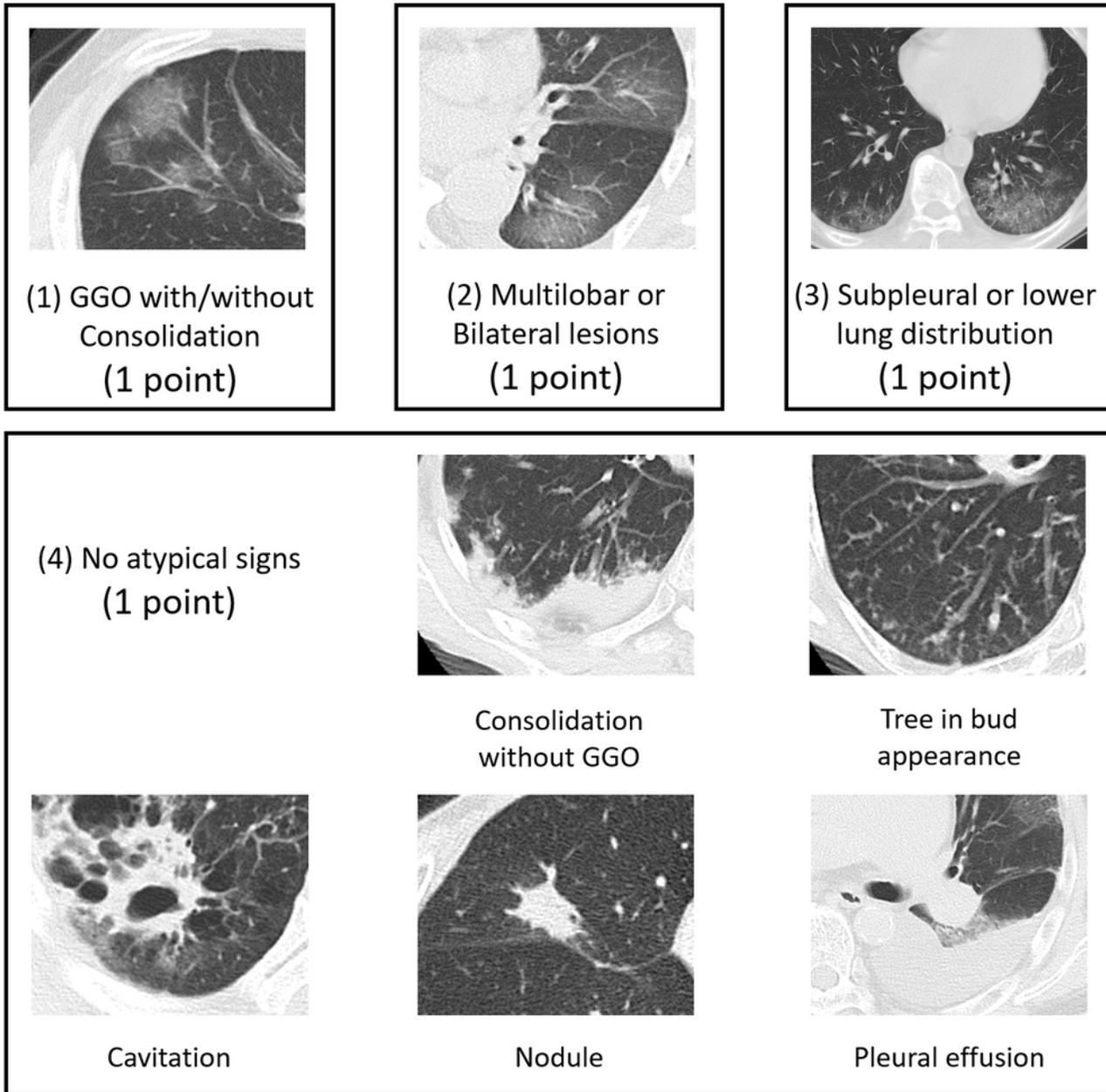
Table 3. COVID-19 Clinical Risk Score

COVID-19 Clinical Risk Score	Score
Blood test score	
WBC < 8000 (count/ μ L)	1
Eosinophil < 50 (count/ μ L)	1
Procalcitonin < 0.5 (ng/mL) and CRP \geq 0.5 (mg/dL)	1
CT imaging score	
GGO with or without consolidation	1
Multilobar or bilateral lesions	1
Subpleural or lower lung dominant distribution	1
No atypical signs*	1
Alternative diagnosis score (choose one)	
More likely other diagnosis	0
Hard to determine	2
More likely COVID-19	4
Total score	Max 11

*atypical signs: consolidation without GGO, cavitation, nodules, tree-in-bud appearance, pleural effusion

Figures

Figure 1



CT imaging score (1) + (2) + (3) + (4) = Max 4 points

Figure 1

CT imaging score All imaging findings were obtained from CT images of non-COVID-19 patients.

Figure 2

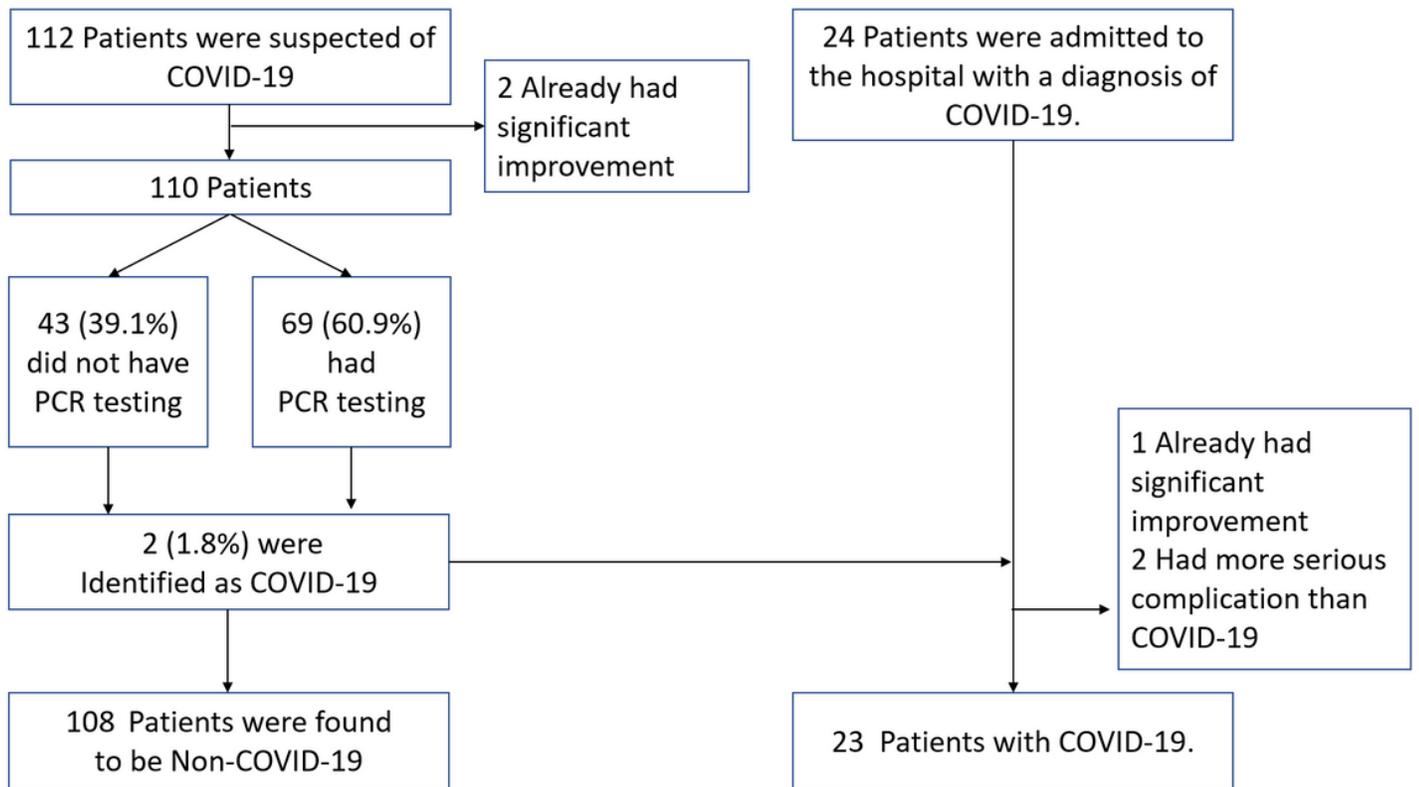


Figure 2

Flowchart of patient recruitment

Figure 3

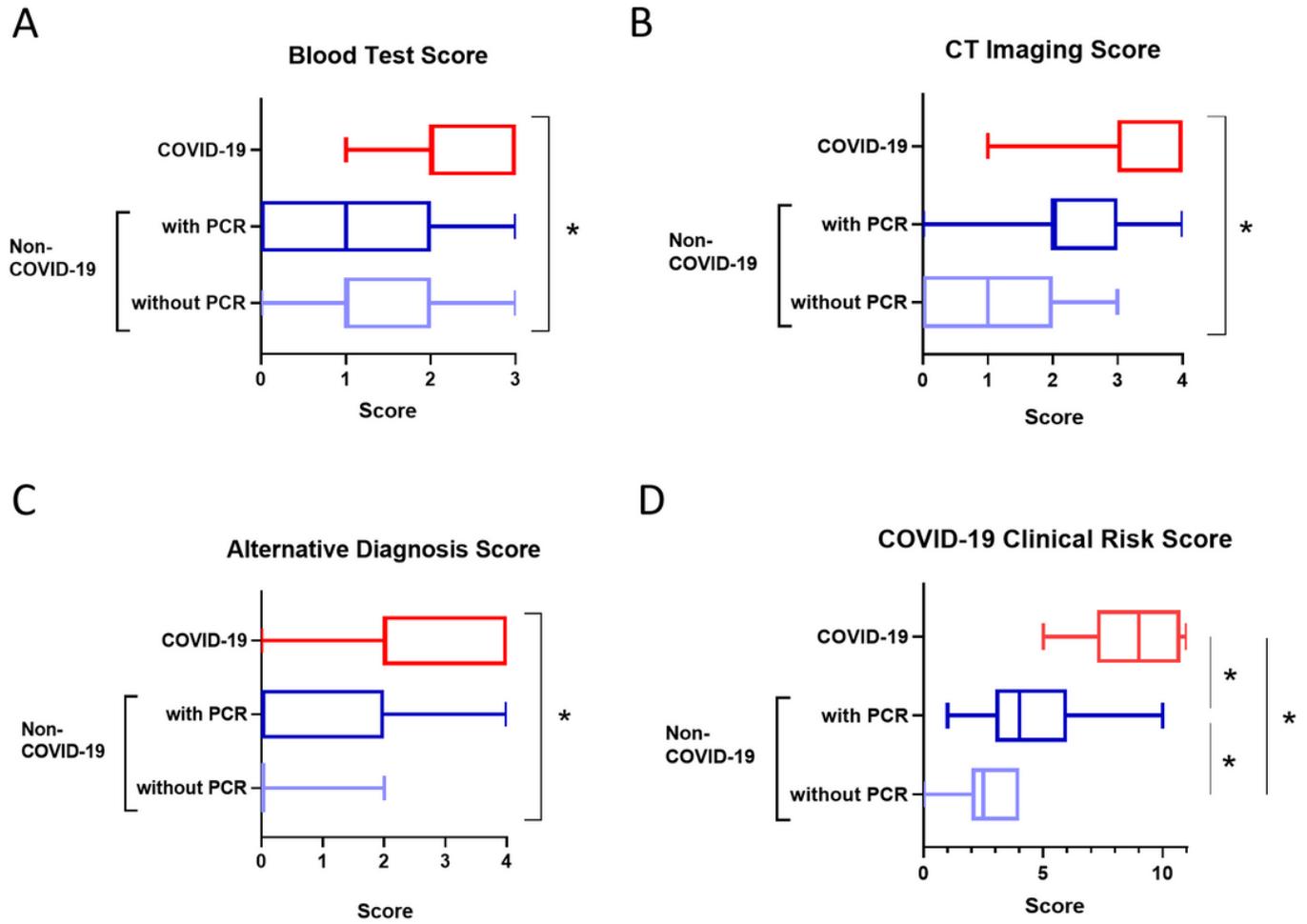


Figure 3

Distribution of each clinical score in patient groups Bars, boxes, and lines represent Min to Max, interquartile range, and median, respectively. *P < 0.001

Figure 4

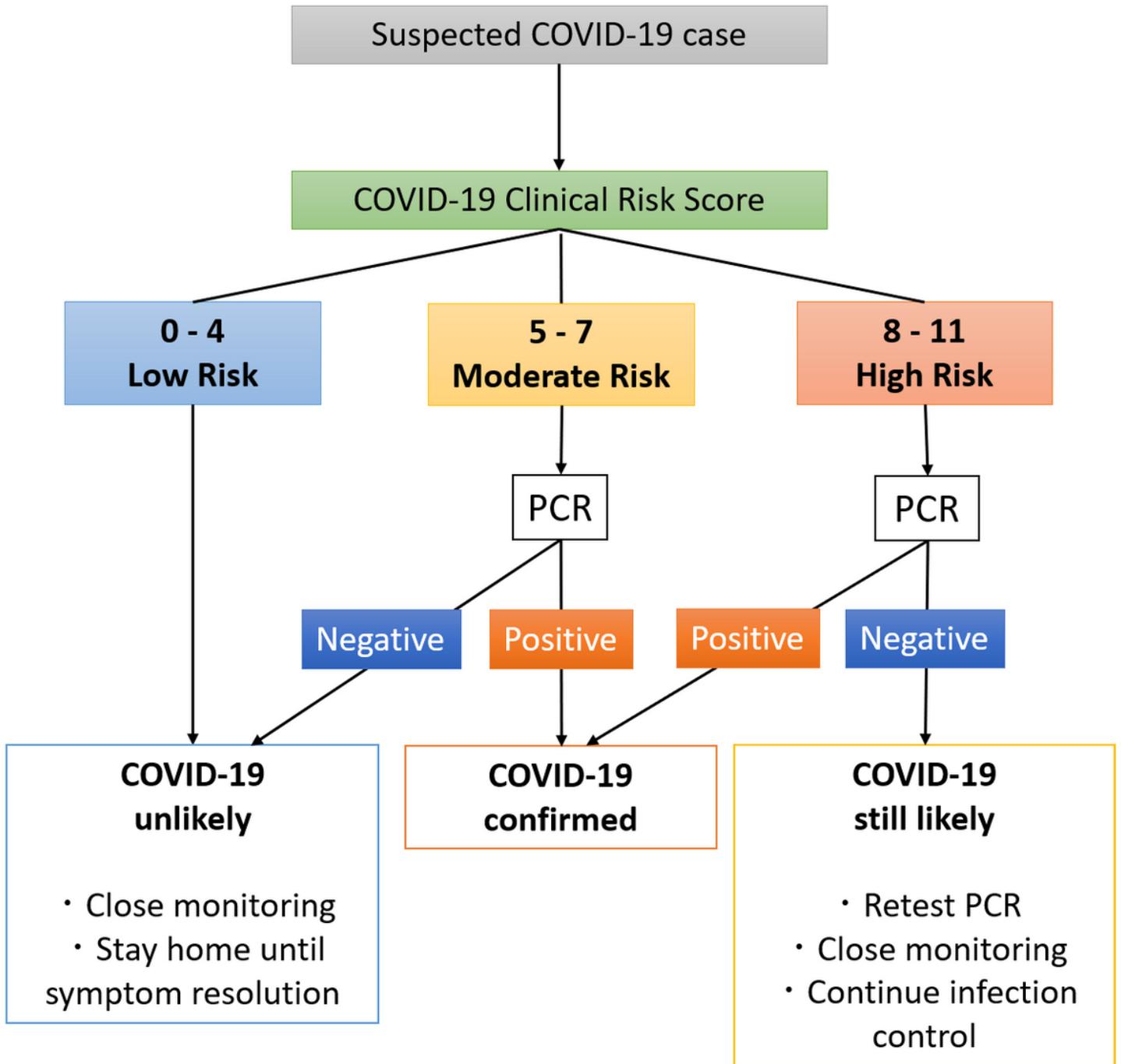


Figure 4

Patient risk classification based on “COVID-19 Clinical Risk Score” and a proposed practice algorithm.