Prognostic value of pro-inflammatory neutrophils and C-reactive protein in cancer patient with COVID-19: a multi-center, retrospective study

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Research

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1 **Prognostic value of pro-inflammatory neutrophils and C-reactive protein**
2 **in cancer patient with COVID-19: a multi-center, retrospective study**

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33 **Abstracts**

34 **Background:** At present, the epidemic of the novel coronavirus disease 2019
35 (COVID-19) has quickly engulfed the world. Inflammatory cytokines are associated
36 with the severity and outcomes of patients with COVID-19. However, the effects of
37 pro-inflammatory factors in cancer patients with COVID-19 are unknown.

38 **Methods:** A multi-center, retrospective, cross-sectional study, based on 5 designated
39 tertiary hospitals for the treatment of COVID-19 in Hubei Province, China. 112
40 cancer patients with COVID-19, and 105 COVID-19 patients without cancer were
41 enrolled in the study between January 1st, 2020 and April 30th, 2020. The risk
42 assessment of pro-inflammatory factors for disease severity and clinical adverse
43 outcomes was identified by univariable and multivariable logistic regression models.

44 **Results:** Of the 112 cancer patients with COVID-19, 40 (35.7%) patients were in
45 critical condition and 18 (16.1%) patients died unfortunately. Univariate and
46 multivariate analysis demonstrated that hemoglobin count and pro-inflammatory
47 neutrophil and C-reactive protein, can be used as independent factors affecting the
48 severity of COVID-19; Meanwhile, pro-inflammatory neutrophils and C-reactive

protein can be used as an independent influencing factor for adverse clinical outcome.

Moreover, the dynamic changes of neutrophils and C-reactive protein were also presented, and compared with COVID-19 patients without cancer, cancer patients with COVID-19 showed higher neutrophil counts and C-reactive protein levels.

Conclusions: In cancer patients with COVID-19, the significant increase in pro-inflammatory neutrophil and C-reactive protein indicated a more critical illness and adverse clinical outcome, and pro-inflammatory neutrophils and C-reactive protein played a more adverse effect compare with COVID-19 patients without cancer, which may be the cause of critical illness and adverse clinical outcomes of cancer patients with COVID-19.

Keywords: Cancer; COVID-19; Pro-inflammatory; Neutrophils; C-reactive protein.

Background

Since the outbreak of COVID-19 in Wuhan in 2019, the outbreak of COVID-19 has quickly spread to Hubei Province and quickly engulfed China (1, 2). Now the epidemic has rapidly spread to the worldwide. As of May 16, 2020, COVID-19 had spread to 188 countries around the world, which caused more than 4.5 million people being infected, and more than 300,000 people died. The most common manifestations of COVID-19 infected patients include fever, cough, fatigue, dyspnea, and radiological evidence of pneumonia (3). Its mean incubation period is 5.2 days (4). COVID-19 is directly transmitted through respiratory droplets or indirectly through pollutants and be able to secondary transmit within the family (5).

While facing the epidemic, cancer is still a major disease. According to reports, there were more than 4.2 million new cancer cases in China in 2015 (6), and 1.7 billion new cancer cases in the United States in 2019 (7). To data, studies have reported that during this epidemic, cancer patients are more susceptible to COVID-19 (8, 9). However, their research was limited to the study of small samples and solid

80 tumors, lack of laboratory data, and insufficient evidence to support relevant
81 conclusions (10, 11).

82 Moreover, studies have reported that pro-inflammatory factors such as CRP,
83 interleukin 6, neutrophils, etc. were associated with the severity and prognosis of
84 patients with COVID-19 (12-14). In patients with COVID-19, high levels of pro-
85 inflammatory factors predicted a poor prognosis. However, whether inflammatory
86 factors play the same adverse effect in cancer patients with COVID-19 is still unclear.

87 In this study, we collected medical data of 112 cancer patients from 5 designated
88 tertiary hospitals for the treatment of COVID-19 in Hubei Province, where the
89 prevalence of COVID-19 was the earliest and most severely in China. We aim to
90 analyze the laboratory data and outcomes of patients through retrospective research,
91 and then find out the risk correlation of pro-inflammatory factors related to the
92 clinical severity and outcomes of cancer patients with COVID-19. Deepen the
93 understanding of the impact of the COVID-19 on cancer patients, demonstrate the
94 adverse effects of pro-inflammatory factors in cancer patients with COVID-19, and
95 provide help for the treatment of cancer patients.

96 **Methods**

97 **Study design, setting and participants**

98 This was a retrospective, cross-sectional, multicenter study, which was performed in 5
99 designated tertiary hospitals for the treatment of COVID-19 in Hubei, China. These
100 data were from 112 cancer patients infected with COVID-19, and 105 COVID-19
101 patients without cancer, who were enrolled from January 1st to April 30th
102 2020. Clinical retrospective data was retrieved from the medical records, including
103 demographic information, underlying comorbidities, chest computed tomographic
104 (CT) scans, laboratory data, anti-tumor therapy, and outcomes. The clinical outcomes
105 of these cancer patients were monitored up to April 30, 2020, the final date of follow-
106 up, when all the patients were discharged. All data were reviewed by two physicians
107 respectively to verify data accuracy. COVID-19 patients without cancer were
108 randomly selected. This study was reviewed and approved by Ethics Committee of
109 the Tongji Medical College of Huazhong University of Science and Technology
110 (No.TJ-2020S098). The exemption from informed patients' consent was approved by

the ethics committee because of the rapid spread of the infection and the rapid progression of some cases.

Definitions

COVID-19 pneumonia was diagnosed according to the updated COVID-19 Diagnostic Criteria, and clinical diagnostic criteria and laboratory nucleic acid detection confirmation criteria by RT-PCR of nasal and/or pharyngeal specimens. The patient's clinical condition is diagnosed according to Guidelines for the Diagnosis and Treatment of Novel Coronavirus (2019-nCoV) Infection by the National Health Commission of the People's Republic of China (Trial Version 7). The evaluation indicators of clinical outcomes are survival and death.

Statistical methods

We fitted 2 types of models. For univariate analysis, categorical variables were expressed as frequency rates and percentages and compared by using Pearson's chi-square, although the Fisher's exact test was used when the data were limited, and by using Mann-Whitney test. Continuous variables were described using mean, median, and interquartile range (IQR) values and compared by using independent group t tests

when the data were normally distributed; otherwise, the Mann-Whitney test was used. In addition, in multivariate analysis, binary logistic regression analysis is used for binary classification variables such as survival status; ordinal logistic regression analysis is used for ordered classification variables such as disease severity. All statistical analyses were performed with the SPSS (version 23.0) software.

Results

Presenting demographic, Clinical Characteristics and Outcome

A total of 112 cancers infected with COVID-19 (Supplementary Table 1), the median age is 62.95 years old (SD, 15.70), 60 (53.6%) patients are male, 22 (19.6%) patients were non-solid tumor patients. Lung cancer (23, 20.5%) was the most frequent type, following by breast cancer (11, 9.8%) and leukemia (11, 9.8%), hypertension (33, 29.5%) was the most common comorbidity, and 27 (24.1%) patients with multiple comorbidities. 12 (10.7%) patients received anti-tumor therapy with chemotherapy within 28 days before diagnosis of COVID-19, 58 (51.8%) patients developed severe condition, 40 (35.1%) patients developed critical condition, and 18 (16.1%) patients died unfortunately.

laboratory findings

Relative to COVID-19 patients without cancer, cancer patients with COVID-19 show a higher risk of critical illness. Therefore, we analyzed the laboratory parameters of cancer patients with COVID-19 on admission (Supplementary Table 2). Relative to the normal reference value range and COVID-19 patients without cancer, cancer patients with COVID-19 showed a lower erythrocyte count, $\times 10^9/L$ (3.88, IQR [3.21-4.09]) and hemoglobin count, $\times 10^9/L$ (114.00, IQR [102.00-273.50]), a higher neutrophil count, $\times 10^9/L$ (3.95, IQR [2.73-6.04]) and higher levels of CRP, mg/L (35.10, IQR [5.68-81.90]).

Independent factors for the severity of COVID-19

Further, we analyzed the correlation between inflammatory factors in laboratory parameters and the severity of COVID-19. Univariate analysis showed that the erythrocyte count, hemoglobin count, neutrophil count, lactate dehydrogenase, CK-MB, troponin I, procalcitonin, CRP, IL-6, and IL-10 may be factors that affect the severity of COVID-19 (Table 1). Compared with non-critically condition patients, critically illness patients showed lower erythrocyte count and hemoglobin count,

higher neutrophil count and higher levels of LDH, CK-MB, troponin I, procalcitonin, CRP, IL-6, and IL-10. Moreover, Multivariate analysis showed that hemoglobin counts (OR, 0.89; 95% CI, 0.81-0.98; $P = 0.022$), neutrophil counts (OR, 1.80; 95% CI, 1.09-2.97; $P = 0.021$), and CRP (OR, 1.04; 95% CI, 1.001-1.071; $P = 0.043$) levels were found to be independent predictors of COVID-19 severity (Table 2). Lower hemoglobin number, higher neutrophil count, and higher CRP levels were predictive of critical condition.

Independent factors for the adverse clinical outcome of COVID-19

Meanwhile, we analyzed the correlation between inflammatory factors in laboratory parameters and the adverse clinical outcomes of COVID-19. Univariate analysis showed that erythrocyte count, hemoglobin count, neutrophil count, LDH, procalcitonin, CRP, and IL-6 may be factors that affect the adverse clinical outcome of COVID-19 (Table 3). Compared to surviving patients, non-surviving patients also showed lower erythrocyte count and hemoglobin count, higher neutrophil counts, and higher levels of LDH, procalcitonin, CRP, and IL-6. Multivariate analysis showed that neutrophil counts (OR, 1.286; 95% CI, 1.007-1.536; $P = 0.005$) and CRP (OR,

1.047; 95% CI, 1.016-1.079; $P = 0.003$) levels were found to be independent predictors of adverse clinical outcomes of COVID-19 (Table 4). Higher neutrophil counts and higher levels of CRP were predictive of adverse clinical outcomes.

Dynamic changes of pro-inflammatory neutrophils and CRP

The above results indicated that the pro-inflammatory neutrophils and CRP are independent predictors of COVID-19 severity and clinical adverse outcomes. Therefore, we analyzed the continuous dynamic changes of neutrophil counts and CRP levels in surviving and non-surviving patients in critical condition. This dynamic process of change was from admission to discharge or death. The neutrophil count showed an overall higher level and an upward trend in the dynamic changes of non-surviving patients, but it showed an overall lower level and a downward trend in the dynamic changes of surviving patients (Figure 1A). Meanwhile, CRP showed an overall higher level and an upward trend in the dynamic changes of non-surviving patients, but showed an overall lower level and a downward trend in the dynamic changes of surviving patients (Figure 1B). This further identified the inflammatory

cytokines neutrophils and CRP as predictors of the adverse clinical outcome of COVID-19.

Clinical factors of severity and adverse clinical outcomes

Studies have reported that cancer patients with non-solid tumors, comorbidities and chemotherapy after infection with COVID-19 are more critically ill or have a higher mortality rate. Therefore, we analyzed the correlation of clinical factors other than laboratory parameters with COVID-19 severity and adverse clinical outcomes in 112 cancer patients with COVID-19 to verify the reliability of our data. The results showed that patients with non-solid tumor cancer and myeloma were more critical illness after infection with COVID-19 (Supplementary Figure 1A-B). Patients with thyroid cancer were milder after infection with COVID-19 (Supplementary Figure 1C). Cancer patients with anemia, pleural effusion, multiple complications, and chemotherapy were more critical illness after infection with COVID-19 (Supplementary Figure 1D-F). Moreover, gastric cancer patients, cancer patients with multiple comorbidities and chemotherapy had a higher mortality rate after infection with COVID-19 (Supplementary Figure 1H-J). Compared with COVID-19 patients

without cancer, cancer patients with COVID-19 were more critical illness and had a higher mortality (Supplementary Table 3).

Discussion

In this study, we retrospectively analyzed the laboratory data and clinical outcomes of 112 cancer patients with COVID-19 and compared 105 patients with COVID-19 patients without cancer as controls. Our data demonstrated that although univariate analysis indicate that the levels of pro-inflammatory neutrophils, procalcitonin, CRP, and IL-6 are associated with the severity and adverse clinical outcomes of COVID-19, multivariate analysis indicate that only neutrophils and CRP can be used as independent predictors of disease severity and adverse clinical outcomes. Moreover, the dynamic changes of pro-inflammatory neutrophils and CRP indicated that the neutrophils count and the level of CRP in non-surviving patients remain at an overall higher level and gradually increase, and compared with COVID-19 patients without cancer, cancer patients with COVID-19 showed a higher neutrophil count and higher levels of CRP, meanwhile showed more critical illness and higher mortality rate.

Meanwhile, studies have reported that patients infected with COVID-19 show increased levels of pro-inflammatory neutrophils, procalcitonin, CRP and IL-6 (15). Moreover, studies have reported that the neutrophil count, IL-6 and CRP can be used as predictors of clinical outcome and disease severity (12, 16, 17). Recently, some studies have shown that cancer patients with COVID-19 have higher level of CRP, and higher neutrophil counts, D-dimer and LDH are associated with poor prognosis (9, 18). Our data also demonstrated that the expression of pro-inflammatory neutrophils and C-reactive protein was significantly increased in cancer patients with COVID-19, and further through multivariate regression analysis showed that they can be used as independent predictors of the severity and the clinical adverse outcome of COVID-19.

In addition, many studies have reported that cancer patients become more severe and have a poor prognosis after being infected with COVID-19 (18, 19). Recent research on cancer patients with COVID-19 had shown that non-surviving patients exhibit higher neutrophil counts and C-reactive protein levels (20). However, the correlation between the dynamic changes of cytokine levels and the prognosis of

237 patients during disease has not been studied. Therefore, while discovering the same
238 results, we further analyzed the dynamic changes of pro-inflammatory neutrophils and
239 CRP, and further verified that the pro-inflammatory neutrophils and C-reactive
240 protein were adverse effects in cancer patients with COVID-19.

241 Meanwhile, studies have reported that inflammation promotes tumorigenesis and
242 development at all stages, and tumors can also promote the production of
243 inflammatory cells and inflammatory mediators (21). Inflammation could activate
244 neutrophils and their extracellular trap formation to promote tumor development (22).
245 Tumor development and progression can also induce inflammation. Neutrophils and
246 CRP are inflammatory marker. Elevated levels of neutrophil counts and CRP may
247 also play a causal role in the pathogenesis of cancer (23). Moreover, COVID-19 as an
248 acute inflammatory disease. Due to coronavirus infection, monocytes and
249 macrophages secrete large amounts of inflammatory cytokines and inflammatory
250 mediators such as CRP and IL-6. This can trigger cytokine release syndrome, which
251 causes ARDS to cause death (14). Neutrophils can cause neutrophil extracellular traps
252 (NETs), leading to organ damage and mortality in COVID-19 (24).

253 Therefore, higher neutrophil counts and CRP levels in cancer patients with COVID-
254 19 may be the result of the combined effect of cancer and COVID-19, and lead to
255 mutual promotion, and may also be the key to triggering a “cytokine storm” and
256 leading to critical illness and mortality. Pro-inflammatory neutrophils and C-reactive
257 protein may be one of the factors that make the cancer patients more serious and have
258 a poor prognosis after being infected with COVID-19.

259 Although we demonstrated the adverse effects of pro-inflammatory neutrophils and
260 CRP in cancer patients with COVID-19, our research still had several limitations.
261 First, this was a retrospective study, and the number of study cases is somewhat small.
262 There were also deficiencies in the number of medical records in the control group.
263 Second, we did not consider enough risk factors to establish a risk assessment model
264 and have not fully considered the unmeasured confounding factors. In the end, the
265 mechanism by which pro-inflammatory neutrophils and CRP aggravate the disease of
266 COVID-19 and cause poor prognosis remains to be further investigated.

267 **Conclusions**

In summary, we presented some clinical features, laboratory data and outcomes of cancer patients after being infected with COVID-19. Pro-inflammatory neutrophils and CRP can be used as independent predictors of the severity and the adverse clinical outcomes of COVID-19. Moreover, compared with COVID-19 patients without cancer, cancer patients with COVID-19 have higher neutrophil counts and CRP levels. Therefore, pro-inflammatory neutrophils and CRP play a greater adverse role in patients with COVID-19 cancer, as a mediator to accelerate the interaction of cancer and COVID-19, and promote the occurrence of “cytokine storm”, which may be COVID-19 causes of critical illness and adverse clinical outcomes in cancer patients with COVID-19. During the outbreak of COVID-19, we need to be more alert to the levels of pro-inflammatory neutrophils and CRP after cancer patients infected with COVID-19, so as to better give corresponding treatment measures.

Abbreviations

CRP: C-reactive protein; CK-MB: Creatine kinase-MB; IL: Interleukin; LDH: Lactate dehydrogenase.

284 **Ethics approval and consent to participate**

285 This study was reviewed and approved by Ethics Committee of the Tongji Medical
286 College of Huazhong University of Science and Technology (No.TJ-2020S098). The
287 exemption from informed patients' consent was approved by the ethics committee
288 because of the rapid spread of the infection and the rapid progression of some cases.

289 **Consent for publication**

290 Not applicable.

291 **Availability of data and materials**

292 Not applicable.

293 **Competing interests**

294 The authors declare that they have no competing interests.

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Authors' contributions

YL and JC designed the study and take responsibility for the integrity of the data and the accuracy of the data analysis. BZ and YY interpreted the results and wrote the manuscript. YY performed the analysis. SH substantially revised it. YZ, JL, SL, FX, LZ, XL and WD collected and analyzed the data. All authors read and approved the final manuscript.

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 379

380 **Figure legend.** Figure 1. Dynamic changes of inflammation-related indicators. A.
381 Dynamic changes of neutrophil counts in surviving patients and non-surviving patients
382 with COVID-19. B. Dynamic changes of C-reactive protein levels in surviving patients
383 and non-surviving patients with COVID-19.

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Table 1. Univariate analysis of the correlation between laboratory parameters and severity of cancer patients with COVID-19

Laboratory Parameters	Moderate (N=14)	Severe (N=58)	Critical (N=40)	<i>P</i> Value
Erythrocyte count, $\times 10^{12}/L$	3.99 $\pm$ 0.55	3.88 $\pm$ 0.60	3.12 $\pm$ 0.94	<0.001 [#]
Hemoglobin count, g/L	123.93 $\pm$ 12.06	121.44 $\pm$ 17.69	93.00 $\pm$ 27.42	<0.001 [#]
Platelet count, $\times 10^9/L$	213.79 $\pm$ 70.00	219.29 $\pm$ 91.78	181.80 $\pm$ 134.17	0.235 [#]
White blood cell count, $\times 10^9/L$	4.39 (3.92-6.32)	5.88 (4.80-8.20)	6.49 (4.67-10.70)	0.083 [*]
Lymphocyte count, $\times 10^9/L$	1.32 $\pm$ 0.44	1.41 $\pm$ 1.73	7.09 $\pm$ 27.18	0.228 [*]
Neutrophil count, $\times 10^9/L$	2.71 (2.17-4.06)	3.95 (2.91-5.83)	4.88 (2.71-8.28)	0.031 [*]
Monocyte count, $\times 10^9/L$	0.44 $\pm$ 0.17	0.53 $\pm$ 0.27	0.75 $\pm$ 2.24	0.668 [#]
Aspartate aminotransferase, U/L	27.87 $\pm$ 9.68	38.40 $\pm$ 26.57	65.76 $\pm$ 104.82	0.076 [#]
Alanine aminotransferase, U/L	29.38 $\pm$ 14.93	35.64 $\pm$ 24.31	36.49 $\pm$ 38.48	0.73 [#]

Alkaline phosphatase, U/L	66.79±23.33	94.98±63.76	245.43±565.63	0.078 [#]
Creatinine, µmol/L	62.89±13.89	85.40±107.09	79.92±54.12	0.665 [#]
Creatine kinase, U/L	64.00 (48.50-92.15)	62.00 (40.00-87.00)	63.00 (30.00-108.00)	0.903 [*]
Lactate dehydrogenase, U/L	193.22±40.96	260.58±107.11	451.86±447.58	0.001 [#]
CK-MB, ng/ml	0.83±0.51	0.76±0.52	2.18±3.02	0.004 [#]
Troponin I, ng/L	2.53±1.91	8.83±15.55	38.97±93.84	0.041 [#]
Fibrinogen, g/l	3.56±1.06	4.45±1.41	4.35±1.58	0.123 [#]
D-dimer, mg/L	0.53±0.47	1.67±2.26	3.75±4.96	0.003 [#]
Procalcitonin, µg/L	0.04 (0.01-0.13)	0.06 (0.03-0.25)	0.60 (0.22-1.40)	<0.001 [*]
CRP, mg/L	0.78 (0.28-11.68)	24.10 (4.90-55.95)	82.33 (44.81-124.50)	<0.001 [*]
IL-6, pg/ml	6.42 (3.81-11.00)	10.05 (4.45-29.51)	32.79 (10.51-53.41)	<0.001 [*]
TNF-α, pg/ml	4.62±3.51	6.05±11.51	3.19±3.66	0.399 [#]
IL-4, pg/ml	2.27±0.78	3.50±5.35	2.46±1.45	0.486 [#]
IL-2, pg/ml	2.67±0.40	3.03±0.90	2.86±1.23	0.591 [#]
IL-10, pg/ml	3.30±0.83	4.07±1.73	6.19±3.97	0.003 [#]
IFN-γ, pg/ml	2.09±0.66	2.47±1.04	3.08±3.73	0.471 [#]
CD3 ratio, %	81.06±6.98	66.42±20.46	70.79±12.53	0.082 [#]
CD4 ratio, %	50.87±4.41	39.62±14.47	37.40±14.69	0.06 [#]
CD8 ratio, %	27.04±4.93	23.69±12.91	28.50±10.96	0.253 [#]
CD4/CD8 ratio, %	1.93±0.34	2.08±1.15	1.53±0.96	0.108 [#]

Abbreviations: CRP, C-Reactive Protein; CKMB, Creatine Kinase-MB; P<0.05 was considered statistically significant. # Indicates that the SK normality test follows the normal distribution, and expressed as mean ± standard deviation. * Indicates that the SK normality test follows a non-normal distribution, and expressed as median (interquartile range).

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Table 2. Multivariate analysis of the correlation between laboratory parameters and severity of cancer patients with COVID-19

Laboratory Parameters	Regression coefficients	OR	P Value	95%CI
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Erythrocyte count, $\times 10^{12}/L$	1.389	4.01	0.337	0.24-68.44
Hemoglobin count, g/L	-0.116	0.89	0.022	0.81-0.98
Neutrophil count, $\times 10^9/L$	0.589	1.80	0.021	1.09-2.97
Lactate dehydrogenase, U/L	0.003	1.00	0.224	0.998-1.007
CK-MB, ng/ml	0.462	1.59	0.595	0.29-8.71
Troponin I, ng/L	0.024	1.02	0.133	0.99-1.06
D-dimer, mg/L	-0.172	0.84	0.456	0.53-1.32
Procalcitonin, $\mu g/L$	0.034	1.03	0.831	0.76-1.41
CRP, mg/L	0.035	1.04	0.043	1.001-1.071
IL-6, pg/ml	0.008	1.01	0.405	0.99-1.025
IL-10, pg/ml	0.299	1.35	0.344	0.73-2.50

Abbreviations: CRP, C-Reactive Protein; CKMB, Creatine Kinase-MB; $P < 0.05$ was considered statistically significant.

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Table 3. Univariate analysis of the correlation between laboratory parameters and severity of cancer patients with COVID-19

Laboratory Parameters	Alive (N=94)	Death (N=18)	<i>P</i> Value
Erythrocyte count, $\times 10^{12}/L$	3.69 $\pm$ 0.77	3.20 $\pm$ 0.99	0.02 [#]
Hemoglobin count, g/L	113.63 $\pm$ 23.66	99.67 $\pm$ 31.06	0.033 [#]
Platelet count, $\times 10^9/L$	210.19 $\pm$ 102.75	177.72 $\pm$ 130.28	0.245 [#]
White blood cell count, $\times 10^9/L$	5.53 (4.30-7.85)	8.94 (5.94-12.26)	0.003 [*]
Lymphocyte count, $\times 10^9/L$	1.03 (0.79-1.57)	0.86 (0.51-1.39)	0.134 [*]
Neutrophil count, $\times 10^9/L$	3.69 (2.71-5.63)	7.40 (3.66-10.95)	0.003 [*]
Monocyte count, $\times 10^9/L$	0.42 (0.31-0.62)	0.41 (0.20-0.65)	0.542 [*]
Aspartate aminotransferase, U/L	29.00 (20.00-45.00)	35.50 (21.25-76.00)	0.428 [*]
Alanine aminotransferase, U/L	25.00 (18.00-37.00)	23.50 (15.50-44.25)	0.886 [*]
Alkaline phosphatase, U/L	74.00 (61.00-104.00)	103.00 (76.00-288.50)	0.01 [*]
Creatinine, $\mu mol/L$	65.00 (53.68-79.48)	64.10 (54.18-106.68)	0.556 [*]

Creatine kinase, U/L	63.00 (40.50-88.50)	64.50 (42.25-170.25)	0.608*
Lactate dehydrogenase, U/L	222.50 (183.78-298.25)	460.55 (223.75-639.25)	0.001*
CK-MB, ng/ml	0.70 (0.40-1.10)	1.35 (0.58-2.52)	0.016*
Troponin I, ng/L	3.80 (1.90-10.25)	14.10 (6.30-39.38)	0.003*
Fibrinogen, g/l	4.28±1.43	4.38±1.62	0.788#
D-dimer, mg/L	0.90 (0.24-1.84)	3.18 (0.01-6.57)	0.324*
Procalcitonin, µg/L	0.09 (0.03-0.30)	0.61 (0.36-2.52)	<0.001*
CRP, mg/L	24.10 (3.79-61.60)	93.02 (77.45-182.25)	<0.001*
IL-6, pg/ml	10.10 (5.42-32.68)	39.18 (24.70-89.36)	0.001*
TNF-α, pg/ml	2.69 (2.10-3.58)	2.26 (1.50-2.84)	0.09*
IL-4, pg/ml	2.27 (1.63-3.34)	2.10 (1.40-2.77)	0.405*
IL-2, pg/ml	2.69 (2.39-3.53)	2.59 (2.18-3.27)	0.521*
IL-10, pg/ml	4.01 (2.70-5.38)	5.34 (3.32-8.98)	0.09*
IFN-γ, pg/ml	2.19 (1.63-3.29)	1.78 (1.38-2.83)	0.129*
CD3 ratio, %	69.90±17.82	68.19±14.08	0.764#
CD4 ratio, %	40.54±14.13	37.15±15.28	0.471#
CD8 ratio, %	26.27±12.16	23.38±8.64	0.453#
CD4/CD8 ratio, %	1.88±1.03	1.75±1.16	0.705#

Abbreviations: CRP, C-Reactive Protein; CKMB, Creatine Kinase-MB; P<0.05 was considered statistically significant. # Indicates that the SK normality test follows the normal distribution, and expressed as mean ± standard deviation. * Indicates that the SK normality test follows a non-normal distribution, and expressed as median (interquartile range).

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Table 4. Multivariate analysis of the correlation between laboratory parameters and clinical adverse outcomes in cancer patients with COVID-19

Clinical Factor	Regression coefficients	OR	P Value	95%CI
Erythrocyte count, ×10 ¹² /L	-0.86	0.423	0.704	0.005-35.822
Hemoglobin count, g/L	0.33	1.034	0.656	0.894-1.196
Neutrophil count, ×10 ⁹ /L	0.252	1.286	0.005	1.007-1.536

Lactate dehydrogenase, U/L	0.002	1.002	0.104	1.000-1.004
Procalcitonin, µg/L	-0.056	0.945	0.319	0.847-1.056
CRP, mg/L	0.046	1.047	0.003	1.016-1.079
IL-6, pg/ml	0.011	1.011	0.153	0.996-1.026

Abbreviations: CRP, C-Reactive Protein; P<0.05 was considered statistically significant.

Figure 1. Dynamic changes of inflammation-related indicators.

Supplementary Files

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