E-ISSN: 2706-9575
P-ISSN: 2706-9567
IJARM 2023; 5(3): 31-37
Received: 16-05-2023
Accepted: 25-07-2023

Gehad Abd Alalim Ali Goma
Department of Clinical Pathology, Faculty of Medicine, Tanta University, Tanta, Egypt

Mohamed Sayed Hantera
Department of Chest Diseases, Faculty of Medicine, Tanta University, Tanta, Egypt

Ghada Abd Almomen Soliman
Department of Clinical Pathology, Faculty of Medicine, Tanta University, Tanta, Egypt

Sahar AF Hammoudah
Department of Clinical Pathology, Faculty of Medicine, Tanta University, Tanta, Egypt

Corresponding Author:
Gehad Abd Alalim Ali Goma
Department of Clinical Pathology, Faculty of Medicine, Tanta University, Tanta, Egypt

Procalcitonin levels in COVID-19 patients recruited from Tanta University Hospitals

Gehad Abd Alalim Ali Goma, Mohamed Sayed Hantera, Ghada Abd Almomen Soliman and Sahar AF Hammoudah

DOI: https://doi.org/10.22271/27069567.2023.v5.i3a.497

Abstract
Background: Recent research have found a positive association between increased levels of procalcitonin (PCT) and the degree of severity of COVID-19. Increased PCT values have been linked to a 5-fold higher risk of developing severe SARS-CoV-2 infection, according to a meta-analysis. The objective of this study is to better understand how PCT level changes in COVID-19 patients can be used as a diagnostic indicator.
Methods: Based on the New Coronavirus Pneumonia Prevention and Control Program (6th edition), this prospective work was conducted on 75 adult individuals with COVID-19 confirmed by laboratory who were non-pregnant females. Three groups were created out of the subjects. Group I consists of 25 expected Covid-19 patients who had moderate pneumonia. Group II includes 25 moderately ill Covid-19 suspects. Group III: 25 possible Covid-19 patients with severe serious pneumonia
Results: Regarding group I, there was a substantial negative relationship between PCT and total leucocyte count (TLC) at admission, days 3, 5, 7, and discharge, as well as among pct and platelets at discharge (p>0.05), but there was a substantial positive relationship between PCT and neutrophil at admission and day 3, as well as between PCT and ferritin at day 3 and 7 (p>0.05).
In group II, there was a substantial positive relationship between PCT and TLC at day 5 and discharge, as well as between PCT and CRP at admission, day 3, and discharge. However, except at admission (p>0.05), there was a substantial negative correlation between PCT and lymphocyte at discharge and between pct and platelets as well.
Regarding group III, there was a substantial negative connection between PCT and d dimer at admission (p>0.05), but positive association was established between PCT and CRP at days 5, 7, and discharge (p>0.05). In order to distinguish between groups, (moderate + severe) and group I (mild), the serum PCT average exhibited 94% sensitivity, 84% specificity, 87.5% negative predictive value, and 92.2% positive predictive value.
Conclusions: PCT may serve as a marker for the degree of disease and help assess the degree of illness of individuals with covid-19. Serial PCT readings might also be helpful in determining the prognosis.

Keywords: Procalcitonin, COVID-19, prognosis

Introduction
The World Health Organization has announced the emerging spread of corona virus disease-2019 (COVID-19) as an international public health emergency. The majority of infected people have reported moderate manifestations like a sore throat, dry cough, and fever. Most situations have come to an end on their own. However, some individuals have been found to have ARDS (Acute Respiratory Distress Syndrome), septic shock, organ failure, pulmonary oedema, severe pneumonia, and other fatal outcomes [1].
Corona virus disease in 2019 is caused on by infection with the novel positive-sense RNA virus recognized as the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) that shares 79% of its amino acid sequences with the severe acute respiratory syndrome coronavirus (SARS-CoV) and 50% of its amino acid sequences with the Middle East respiratory syndrome coronavirus (MERS-CoV) [2].
Although the majority of patients only experience minor symptoms, severe COVID-19 cases can occasionally be linked to multi-organ failure and acute respiratory distress syndrome. Therefore, it is essential to assess the disease's severity and look into potential biomarkers in order to make quick and accurate clinical decisions [3].

A protein containing 116 amino acids and a molecular weight of 13 kDa is called procalcitonin (PCT).It is a prohormone of calcitonin and a biomarker utilized in algorithms for the diagnosis and treatment4 of individuals with sepsis and lower respiratory tract infection. The presence of a systemic inflammatory response raises PCT plasma levels [4].

Recent investigations have shown an advantageous association among increased PCT levels and severity of COVID-19. Additionally, a meta-analysis revealed that elevated amounts of PCT are associated with a 5-fold increased probability of developing severe infection with SARS-CoV-2 [5].

The objective of this work is to better understand how PCT level variations in COVID-19 patients may be used as a diagnostic indicator.

Patients and Methods

Based on the New Coronavirus Pneumonia Prevention and Control Program (6th edition), this prospective research was conducted on 75 adult individuals with COVID-19 confirmed by laboratory who were non-pregnant females. From September 2020 to February 2022, patients were chosen from Tanta University's quarantine hospital, outpatient clinic, and chest department.

Before being enrolled in this study, each individual gave their informed permission. The Tanta University Faculty of Medicine's ethical board gave its approval.

Children, pregnant women, any kind of cancer or chronic inflammation, other pneumonia causes, autoimmune conditions, renal failure, trauma, and acute surgery were within the exclusion criteria in each group.

The New Coronavirus Pneumonia Prevention and Control Program (6th edition) divides pneumonia caused by COVID-19 into 4 categories: critical, severe, moderate, and mild pneumonia. Asymptomatic infections or little clinical manifestation without abnormal chest radiograph results are considered mild pneumonia. The presence of both clinical manifestation and atypical chest radiograph results is considered to indicate moderate pneumonia. Whenever the illness proceeds until one or more of the following situations occurs, patients are classified with severe pneumonia: (i) a substantially greater breathing rate of around 30 breaths/minute; (ii) an oxygen saturation level of 93% when at rest; or (iii) a PaO 2/FiO 2 value of less than 300 mmHg (1 mmHg = 0.133 kPa). When any of the following situations exist in addition to critical pneumonia, admission at intensive care unit(ICU) is necessary for therapy and monitoring: (1) the need for artificial ventilating due to respiratory failure; (2) shock; or (3) another organ failure.

Three groups were created out of the subjects. Group I consists of 25 probable Covid-19 patients who had moderate pneumonia. Group II consists of 25 moderately ill Covid-19 suspects. Group III consists of 25 Covid-19 suspects who have severe and serious pneumonia.

The following was applied to the study groups: clinical factors such as age and sex, CT chest, clinical assessment, history collection, and clinical examination serum ferritin, Complete blood count (CBC), D-dimer, C-reactive protein (CRP), culture, and sensitivity of blood or sputum samples to rule out other causes of pneumonia are routine laboratory tests. Particular investigations include the Real-Time PCR diagnostic test for the COVID-19 coronavirus and serial measurements of PCT levels using the ELISA technique at admission, day 3, day 5, day 7, and at discharge.

Statistical analysis

Using the IBM SPSS statistical software program edition 20.0 (IBM Corp., Armonk, New York), information was input into the computer and assessed. Numbers and percentages have been employed for describing qualitative information. The normality of the distribution has been assessed using the Shapiro-Wilk test. The range (minimum and maximum), mean, standard deviation, median, and interquartile range (IQR) have been utilized for characterizing the quantitative information. The 5% level was used to determine if the findings were significant.

To compare various groups, the tests utilized have been the Chi-square test for categorical data, Monte Carlo corrections include chi-square adjustment when over 20 percent of the cells have anticipated counts below 5, F-test (ANOVA) correction for quantitative parameters with normal distributions, the Post Hoc Test (Tukey) for pair-wise comparisons and the comparisons between more than two groups, With the Kruskal-Wallis test for quantitative parameters with anomalous distribution, for pair-wise comparisons and Post Hoc (Dunn's multiple comparison test) for contrasting between over two study groups.

Results

Regarding age, a substantial variation was existed among groups I and group II as well as between groups I and group III (p<0.05). Regarding age, no apparent variation was existed among groups II and III (p>0.05). Regarding the sex, a substantial variation was existed among groups I and group II as well as among groups I and group III (p< 0.05). Regarding the sex, no discernible variation was existed among groups II and III (p>0.05). (Table 1)

Table 1: Comparison between the three studied groups regarding to demographic data

	Mild (n = 25)		Moderate (n = 25)		Severe (n = 25)		P
	No.	%	No.	%	No.	%	
Male	6	24	14	56	17	68	0.006*
Female	19	76	11	44	8	32	
Age (Mean ± SD)	39.12 ± 6.25		57.40 ± 14.76		58.48 ± 13.57		<0.001*
Post-hoc	p_1<0.001*,p_2<0.001*,p_3=0.947						

SD: Standard deviation, p1: p value for contrasting between mild and moderate p2: p value for contrasting between mild and severe p3: p value for contrasting between mild and severe Statistically significant at p≤ 0.05

Regarding the total leucocyte count (TLC) at all measures, there was no apparent distinction between the tested groups (p>0.05). The lymphocytes at admission, day 7, and discharge were substantially different throughout the study groups (p< 0.05). While a substantial variation was existed among groups I and III, as well as between group II and III, with respect to the lymphocytes at day3, 7, and at discharge (p<0.05), there wasn't a substantial distinction among

groups I and II regarding the lymph at days 3 and 5 (p>0.05). While a substantial variation was existed among groups I and III as well as between group II and III with respect to the neutrophil at day5, 7, and discharge (p<0.05), there wasn't a substantial disparity among groups I and II regarding the neutrophil at day5 (p>0.05). Between the study groups, there were substantial variations in the neutrophil count at admission and on day 3 (p<0.05). (Table 2).

Table 2: Comparison between the studies groups regarding TLC, lymphocytes percent and neutrophils percent.

TLC	Mild	Moderate	Severe	P
Admission	7.47 ± 2.33	10.94 ± 6.02	8.62 ± 3.23	0.109
Day 3	7.58 ± 1.92	10.05 ± 5.56	9.06 ± 2.92	0.092
Day 5	7.70 ± 1.93	8.94 ± 4.15	9.88 ± 3.44	0.086
Day 7	7.96 ± 1.79	9.66 ± 3.35	9.65 ± 3.40	0.080
Discharge	8.28 ± 1.55	9.60 ± 2.98	9.70 ± 3.22	0.111
Lymphocytes Admission	25.16 ± 5.43	20.48 ± 4.97	15.40 ± 1.66	<0.001*
Post hoc	p_1=0.018*,p_2<0.001*,p_3=0.001*			
Day 3	25.04 ± 5.37	21.88 ± 5.09	15.56 ± 3.20	<0.001*
Post hoc	p_1=0.117,p_2<0.001*,p_3<0.001*			
Day 5	26.68 ± 5.96	25.04 ± 5.98	16.44 ± 3.73	<0.001*
Post hoc	p_1=0.361,p_2<0.001*,p_3<0.001*			
Day 7	28.60 ± 3.65	25.52 ± 7.54	17.12 ± 3.96	<0.001*
Post hoc	p_1=0.012*,p_2<0.001*,p_3<0.001*			
Discharge	29.4 ± 2.06	26.40 ± 5.79	18.04 ± 3.61	<0.001*
Post hoc	p_1=0.001*,p_2<0.001*,p_3<0.001*			
Neutrophils Admission	70.56 ± 4.45	75.0 ± 5.63	80.16±2.36	<0.001*
Post hoc	p_1=0.002*,p_2<0.001*,p_3<0.001*			
Day 3	70.76 ± 4.19	74.48 ± 6.15	79.84 ± 3.87	<0.001*
Post hoc	p_1=0.022*,p_2<0.001*,p_3=0.001*			
Day 5	69.16 ± 4.91	71.0 ± 6.86	78.92 ± 3.38	<0.001*
Post hoc	p_1=0.434,p_2<0.001*,p_3<0.001*			
Day 7	68.20 ± 3.18	71.08 ± 7.41	79.20 ± 3.76	<0.001*
Post hoc	p_1=0.124,p_2<0.001*,p_3<0.001*			
Discharge	67.88 ± 1.33	70.56 ± 5.94	78.44 ± 3.32	<0.001*
Post hoc	p_1=0.053,p_2<0.001*,p_3<0.001*			

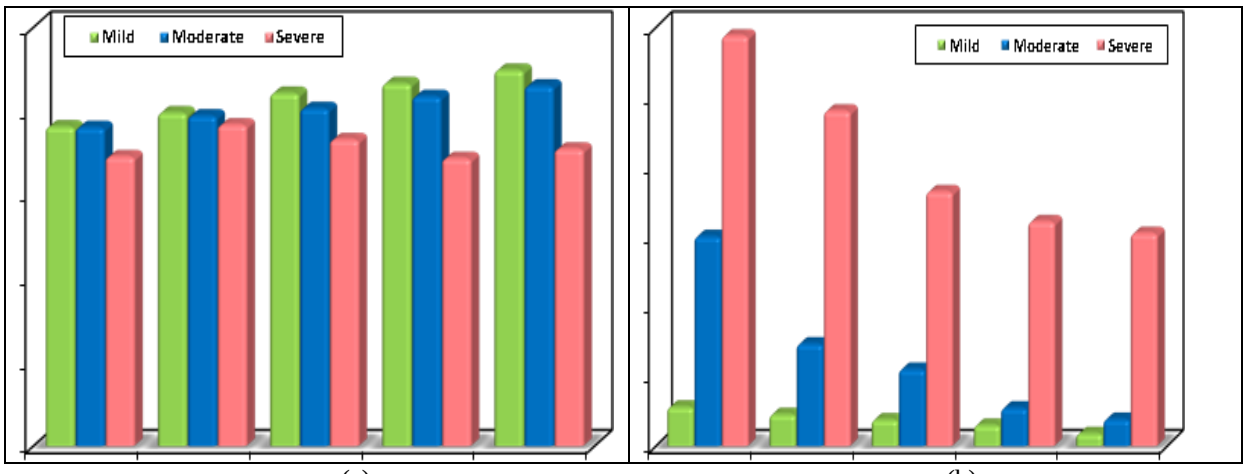
TLC: total leucocyte count, p1: p value for contrasting between mild and moderate p2: p value for contrasting between mild and severe p3: p value for contrasting between mild and severe Statistically significant at p≤ 0.05

The platelets at admission, day 3, and day 5 were not substantially different throughout the study groups (p>0.05). While there was substantial variation between groups I and III, as well as between group II and III, regarding platelets at day 7, and discharge (p<0.05), no substantial distinction was existed between groups I and group II.

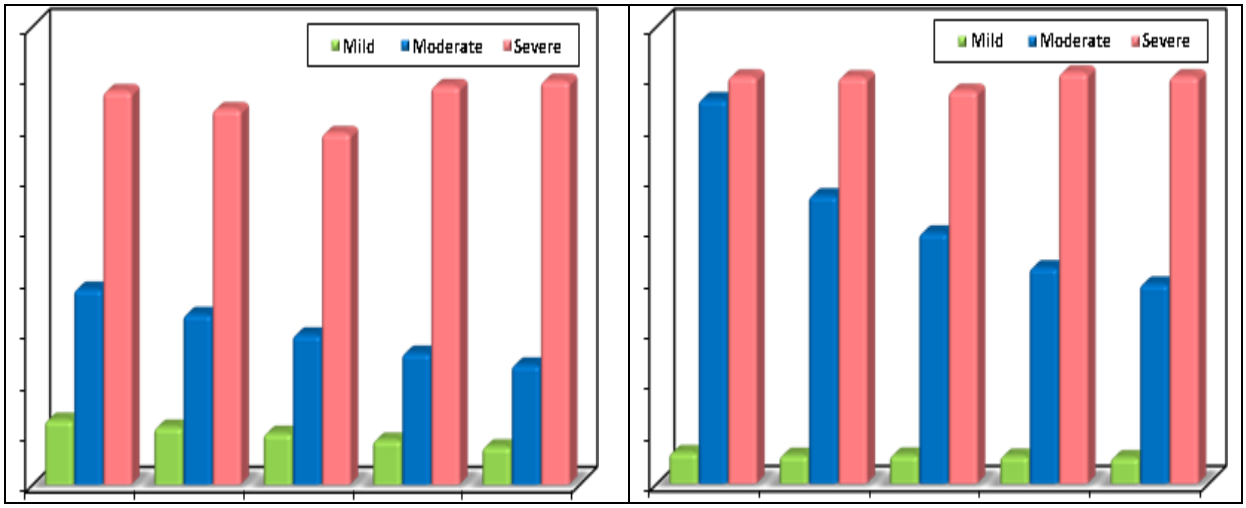
At all measurement periods, there were substantial variations between the examined groups in terms of CRP and D-dimer (p<0.05).

In terms of ferritin at admission and day 3, a marked variance was existed among groups I and II as well as between groups I and III (p<0.05), while no substantial variance was existed among groups II and III (p> 0.05).

Between the study groups, there were substantial variations in ferritin levels at days 5, 7, and discharge (p< 0.05). (Figure 1).



(a) (b)



(c) (d)

Fig 1: Comparison between the studied groups as regard platelet count (a), CRP (b), D-dimer (c), and ferritin (d).

Regarding PCT upon admission, there was substantial variation among groups I and group II as well as among groups I and III ($p< 0.05$). As for PCT at admission, day 3, and day 5, no apparent distinction was existed among groups II and III ($p>0.05$). In terms of PCT at day 7 and discharge, there were substantial variations between the study groups difference between studied groups ($p<0.05$). (Table 3).

Table 3: Comparison between the three studied groups regarding to PCT

PCT	Mild	Moderate	Severe	P
Admission	0.149 ± 0.033	0.280 ± 0.095	0.246 ± 0.057	<0.001*
Post hoc	p_1<0.001*, p_2 <0.001*,p_3=0.564			
Day 3	0.139 ± 0.034	0.253 ± 0.082	0.213 ± 0.057	<0.001*
Post hoc	p_1<0.001*, p_2 <0.001*,p_3=0.199			
Day 5	0.126 ± 0.034	0.230 ± 0.072	0.207 ± 0.038	<0.001*
Post hoc	p_1<0.001*, p_2 <0.001*,p_3=0.704			
Day 7	0.115 ± 0.034	0.200 ± 0.055	0.306 ± 0.120	<0.001*
Post hoc	p_1<0.001*, p_2 < 0.001*,p_3=0.006*			
Discharge	0.099 ± 0.035	0.187 ± 0.053	0.307 ± 0.138	<0.001*
Post hoc	p_1<0.001*, p_2 < 0.001*, p_3=0.007*			

PCT: procalcitonin, p1: p value for contrasting between mild and moderate p2: p value for contrasting between mild and severe p3: p value for contrasting between mild and severe Statistically significant at $p \leq 0.05$

Concerning group I, there was a substantial negative relationship between PCT and TLC at admission, days 3, 5, 7, and discharge, as well as between PCT and platelets at discharge $p<0.05$). However, there was a substantial positive relationship between PCT and neutrophil at admission and day 3, as well as between PCT and ferritin at day 3 and 7 ($p< 0.05$).

In group II, there was a substantial positive relationship between PCT and TLC at day 5 and discharge, as well as between PCT and CRP at admission, day 3, and discharge. However, except at admission ($p< 0.05$), there was a substantial negative association among PCT and lymphocyte at discharge and between pct and platelets as well.

Regarding group III, there was a substantial negative relationship between PCT and d dimer at admission ($p<0.05$), but a positive relationship was established between PCT and CRP at days 5, 7, and discharge ($p<0.05$). (Table 4).

Table 4: Correlation between PCT and different parameters in groups I, II, and III.

	PCT									
	at Admission		Day 3		Day 5		Day 7		Discharge	
	r_s	P	r_s	p	r_s	p	r_s	p	r_s	p
Age (years)	-0.012	0.954	0.053	0.8	0.065	0.757	0.092	0.662	0.146	0.486
TLC	-0.465	0.019*	-0.401	0.047*	-0.468	0.018*	-0.597	0.002*	-0.516	0.008*
Neutrophil	0.415	0.039*	0.404	0.045*	0.261	0.208	0.395	0.051	0.189	0.364
Lymphocytes	-0.110	0.601	0.003	0.989	-0.278	0.178	-0.121	0.563	0.039	0.854
Platelet	-0.046	0.827	-0.208	0.318	-0.131	0.534	-0.371	0.068	-0.486	0.014*
CRP	-0.316	0.124	-0.262	0.206	-0.313	0.127	-0.212	0.310	-0.081	0.699
D dimer	0.202	0.334	0.361	0.076	0.283	0.170	0.178	0.396	0.133	0.526
Ferritin	0.360	0.077	0.419	0.037*	0.312	0.129	0.401	0.047*	0.230	0.269
Age (years)	0.288	0.162	0.340	0.096	0.349	0.088	0.279	0.176	0.308	0.134
TLC	-0.075	0.722	0.331	0.106	0.626	0.001*	0.376	0.064	0.407	0.043*

Lymphocytes	-0.003	0.990	-0.382	0.060	-0.313	0.128	-0.378	0.062	-0.398	0.049*
Platelet	-0.376	0.064	-0.448	0.025*	-0.582	0.002*	-0.618	0.001*	-0.600	0.002*
CRP	0.446	0.025*	0.555	0.004*	0.363	0.075	0.198	0.343	0.410	0.042*
D dimer	0.457	0.022*	0.458	0.021*	0.426	0.034*	0.460	0.021*	0.465	0.019*
Ferritin	0.330	0.107	0.448	0.025*	0.456	0.022*	0.634	0.001*	0.643	0.001*
Age (years)	0.012	0.953	0.076	0.717	-0.114	0.589	0.150	0.474	0.189	0.365
TLC	0.190	0.363	0.145	0.491	0.047	0.825	0.040	0.851	0.048	0.819
Lymphocytes	0.061	0.770	0.190	0.363	0.265	0.201	-0.160	0.446	-0.280	0.175
Platelet	0.273	0.186	0.243	0.241	0.119	0.570	-0.247	0.234	-0.332	0.105
CRP	0.058	0.784	0.197	0.345	0.399	0.048*	0.635	0.001*	0.698	<0.001*
D dimer	-0.433	0.031*	-0.355	0.082	-0.136	0.516	0.301	0.144	0.474	0.017*
Ferritin	-0.388	0.055	-0.242	0.243	-0.289	0.161	0.320	0.118	0.383	0.059

rs: Spearman coefficient, *: Statistically significant at $p \leq 0.05$, TLC: total leucocyte counte, CRP: C-reactive protein

Serum PCT average had 94 %Sensitivity, 84% Specificity 92.2% Positive predictive value and, 87.5 % Negative predictive value to discriminate groups Π, III (moderate + severe) versus group I (mild). (Figure 2).

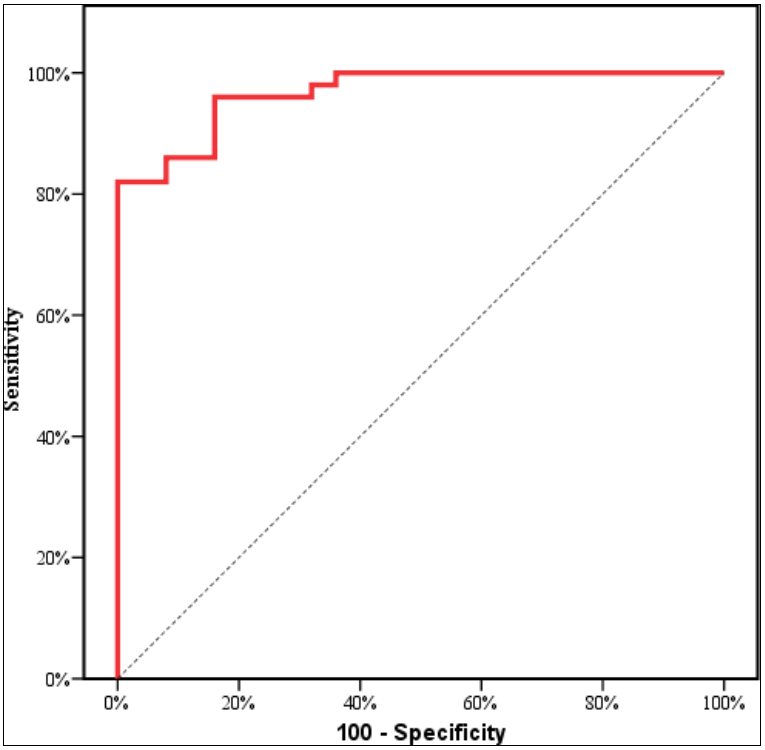


Fig 2: ROC curve for PCT (average) to discriminate patient's moderate + severe group versus mild group

Discussion

Our investigation revealed that there was no discernible variation in the TLC at admission, day 3, day 5, day 7, and at discharge between the analysed groups.

Leukocytes and neutrophils were substantially more abundant in individuals with severe COVID-19 infections contrasting with those with non-severe infections, according to research by Soraya and Ulhaq [6], Yamada *et al* [7], and Zhang *et al.* [8] Additionally, as the COVID-19 disease proceed, the severity groups' leukocyte and neutrophil numbers rose.

In the study, there was a notable rise in neutrophil % between the study groups' admission and day 3. At days 5, 7, and discharge, there was no apparent disparity between groups I and II, but at these same dates, an apparent elevation was existed in group III relative to groups I and II. According to research performed by Yamada *et al.* [7] and Zhang *et al.* [8], the amount of circulating neutrophils progressively increased as COVID-19 advanced. Consequently, neutrophilia has been discovered as a sign of a serious respiratory condition and a bad prognosis.

In this study, a substantial decrease was existed in lymphocyte percentage among the groups evaluated at admission, day 7, and discharge. While no apparent distinction was existed among groups I and II, groups III substantially decreased in comparison to groups I and II on days three and five.

According to the study's findings, there were no significant variations between the tested groups' platelets at admission, day three, and day five. While a substantial reduce was existed in groups III contrasted to I, as well as in group III contrasted to group II at day 7 after discharge, no apparent distinction was existed among groups I and group II.

According to research by Lippi *et al.* [4], and Li *et al.* [9], a low PLT count is associated with a greater death rate and a COVID-19 disease that becomes more severe. individuals with either more extensive illnesses or poor results or even non-survivors had decreased platelet counts than healthy individuals.

In this investigation, there was a discernible upward trend in CRP levels for the three study groups at admission, days 3, 5, and 7 and at discharge. According to our findings, elevated CRP levels were linked to illness severity and a poor prognosis by Huang *et al.* [10], Liu *et al.* [11], Qin *et al.*

[12], and Sahu *et al*. [13]. However, Chen *et al*.'s research [14] found that there was no statistically substantial variance in the mean levels of CRP of the severe and non-severe COVID groups, even though The mean levels of CRP was higher in the severe group.

Regarding D Dimer concentrations at admission, day 3, day 5, day 7, and at discharge, there was a discernible upward trend across the analyzed groups in the current research. D dimer levels fell in groups I and II while remaining high in group III. According to research by Huang *et al*., elevated D Dimer levels were linked to a worse prognosis and a more severe form of the illness. According to Wright *et al*. [15], inflammation brought on by the SARS-Cov-2 infection promotes PAI-1 release from endothelial cells, which in turn inhibits the activity of tissue and urokinase plasminogen activators. By preventing the conversion of plasminogen to plasmin, the breakdown of fibrin is reduced. In venous thrombosis, full breakdown of the intravascular thrombus leads to higher blood levels of intermediate degradation products such D- Dimer.

This study discovered that there was not a substantial distinction between groups II and III at admission or day three, however ferritin concentrations were substantially greater in group II contrasted to group I and in group III contrasted to group I. Regarding ferritin, there was a substantial rise across the study groups; by day 7 and discharge, group III had greater ferritin levels than groups I and II. According to research by Ian Huang *et al*., elevated ferritin levels are linked to severe illness and a bad prognosis. According to research by Lucena *et al*. [16], and Lagadinou *et al*. [17], a shift in ferritin levels is a result of an inflammatory process called an acute-phase response, which is defined by a series of metabolic and physiological alterations that take place right away after tissue injury. The shift in the quantities of certain plasma proteins is one of the various systemic indications of this acute-phase event. The most often utilized indicators in clinical practice include ferritin, CRP, amyloid A, haptoglobin, fibrinogen, and LDH.

This research demonstrated no substantial distinction among groups II and III as regard PCT at admission, day 3, or day 5, but that there was a substantial steady increase in PCT levels in group II contrasted to group I and in group III contrasted to group I.

In this study, a noticeable rise was existed among the groups that were examined in terms of PCT at day 7 and discharge. This is consistent with the conclusions of Huang *et al*. [10], who discovered that total serum PCT levels rose as the disease progressed in serious instances and reduced as the patient recovered.

In this research, from admission to discharge, PCT levels in group I substantially decreased with time. While there was a negative link between PCT and TLC at admission, days 3, 5, 7, and discharge as well as between PCT and platelets at discharge, there was a substantial positive relationship between PCT and neutrophil at admission and day 3, as well as between PCT and ferritin at days 3 and 7. Except upon discharge, no substantial correlation was existed among PCT and age, lymphocyte percentage, CRP, d dimer, or platelets.

PCT and neutrophil levels at days 5, 7, and discharge did not significantly correlate. Neither did PCT and ferritin levels at admission, day 5 or discharge.

In this study, levels of PCT substantially decreased with time in group II from admission to discharge. PCT and TLC at day 5 and discharge showed a strong positive connection, as did PCT and CRP at admission, day 3, and discharge. Except at admission, there was an important positive association between PCT and d-dimer and ferritin, while there was also a substantial negative association between PCT and lymphocyte percentage at discharge and between PCT and platelets. PCT was not significantly associated with age, TLC at admission, days 3 and 7, neutrophil percentage, or lymphocyte percentage at admission, days 3, 5, or 7. PCT and platelets at admission, CRP at days 5, 7, or ferritin at admission did not significantly correlate. In this research, group III, PCT levels were significantly lower on days 3 and 5 compared to admission, whereas they were significantly higher on days 7 and discharge. In contrast to the strong negative association established between PCT and d dimer at admission, there was a significant positive correlation between PCT and CRP at days 5, 7, and discharge as well as between PCT and d dimer at discharge. Age, TLC, Neutrophil, Lymphocyte Percentage, Platelet, Ferritin, CRP, and D-Dimer at Days 3, 5, and 7 of Admission did not significantly correlate with PCT. In this research, there was no substantial association between PCT and age in groups I, II, or III, but a substantial connection was existed among PCT and age at days 5, 7, and discharge in the whole sample.

According to the ROC curve, this study's sensitivity for PCT in the severe and moderate categories against the mild group was 94% and its specificity was 84%.

According to research by Feng *et al*. [18], there was a strong correlation between mortality and the levels of CRP, PCT, platelets, and lymphocyte percentages at the time of consultation. It means that the treating physician may use these variables when deciding whether to admit severe COVID-19 inpatients to the ICU or predict the course of their illness. Studies by Huang *et al*. [10], Tang *et al* [19], and Sarfaraz *et al*. [20] added to the expanding data supporting the usage of PCT in the setting of COVID-19 infection by showing that high PCT was most significantly linked with both mortality and ICU acceptance. Lippi and Plebani as well. [21] Study found that A 5-fold higher incidence of severe infection with COVID-19 was associated with elevated PCT levels. Whereas Del Sole *et al*.'s investigation discovered a connection between severe infection and higher PCT, thrombocytopenia, and D-dimer. In COVID-19, levels of PCT commonly increase, and published research suggests that PCT may be an indicator of disease intensity. As opposed to that, it's been hypothesized that expression of IFN-G in the context of a viral respiratory tract infection reduces PCT production in studies by Gilbert. [22], Delevaux *et al*. [23], and Christ-Crain *et al*. [24]. Indeed, research show that viral pneumonia doesn't increase PCT levels, allowing doctors for using this marker to distinguish between bacterial and viral lung infections and determine how long to provide antibiotics. To assess the blood concentration of PCT and indicate its function in the pathogenesis of COVID-19 and other viral infections, additional studies with a large number of patients and in various age groups should be conducted. In order to get a comprehensive picture of the function of PCT in COVID-19, we want to combine our research with other investigations that were conducted continuously in other countries. It is necessary to do more study to clarify the methods by which elevated PCT is produced and secreted in SARS-CoV-2 patients.

Conclusions

PCT may serve as a marker for the degree of illness and

help assess the severity of patients with covid-19. Serial PCT readings might also be helpful in determining the prognosis.

Financial support and sponsorship: Nil

Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

1. Sohrabi C, Alsafi Z, O'Neill N, Khan M, Kerwan A, Al-Jabir A, *et al*. World Health Organization declares global emergency: A review of the 2019 novel coronavirus (COVID-19). Int J Surg. 2020;76:71-6.
2. Wang L, Duan Y, Zhang W, Liang J, Xu J, Zhang Y, *et al*. Epidemiologic and Clinical Characteristics of 26 Cases of COVID-19 Arising from Patient-to-Patient Transmission in Liaocheng, China. Clin Epidemiol. 2020;12:387-91.
3. Pfortmueller CA, Spinetti T, Urman RD, Luedi MM, Schefold JC. COVID-19-associated acute respiratory distress syndrome (CARDS): Current knowledge on pathophysiology and ICU treatment - A narrative review. Best Pract Res Clin Anaesthesiol. 2021;35:351-68.
4. Lippi G, Plebani M, Henry BM. Thrombocytopenia is associated with severe coronavirus disease 2019 (COVID-19) infections: A meta-analysis. Clin Chim Acta. 2020;506:145-8.
5. Zhang ZL, Hou YL, Li DT, Li FZ. Laboratory findings of COVID-19: a systematic review and meta-analysis. Scand J Clin Lab Invest. 2020;80:441-7.
6. Soraya GV, Ulhaq ZS. Crucial laboratory parameters in COVID-19 diagnosis and prognosis: An updated meta-analysis. Med Clin (Engl Ed). 2020;155:143-51.
7. Yamada T, Wakabayashi M, Yamaji T, Chopra N, Mikami T, Miyashita H, *et al*. Value of leukocytosis and elevated C-reactive protein in predicting severe coronavirus 2019 (COVID-19): A systematic review and meta-analysis. Clin Chim Acta. 2020;509:235-43.
8. Zhang H, Cao X, Kong M, Mao X, Huang L, He P, *et al*. Clinical and hematological characteristics of 88 patients with COVID-19. Int J Lab Hematol. 2020;42:780-7.
9. Li X, Liu C, Mao Z, Xiao M, Wang L, Qi S, *et al*. Predictive values of neutrophil-to-lymphocyte ratio on disease severity and mortality in COVID-19 patients: a systematic review and meta-analysis. Crit Care. 2020;24:647.
10. Huang I, Pranata R, Lim MA, Oehadian A, Alisjahbana B. C-reactive protein, procalcitonin, D-dimer, and ferritin in severe coronavirus disease-2019: a meta-analysis. Ther Adv Respir Dis. 2020;14:1753466620937175.
11. Liu D, Su LX, Guan W, Xiao K, Xie LX. Prognostic value of procalcitonin in pneumonia: A systematic review and meta-analysis. Respirology. 2016;21:280-8.
12. Qin C, Zhou L, Hu Z, Zhang S, Yang S, Tao Y, *et al*. Dysregulation of Immune Response in Patients With Coronavirus 2019 (COVID-19) in Wuhan, China. Clin Infect Dis. 2020;71:762-8.
13. Sahu BR, Kampa RK, Padhi A, Panda AK. C-reactive protein: A promising biomarker for poor prognosis in COVID-19 infection. Clin Chim Acta. 2020;509:91-4.
14. Chen J, Pan Y, Li G, Xu W, Zhang L, Yuan S, *et al*. Distinguishing between COVID-19 and influenza during the early stages by measurement of peripheral blood parameters. J Med Virol. 2021;93:1029-37.
15. Wright FL, Vogler TO, Moore EE, Moore HB, Wohlauer MV, Urban S, *et al*. Fibrinolysis Shutdown Correlation with Thromboembolic Events in Severe COVID-19 Infection. J Am Coll Surg. 2020;231:193-203.e1.
16. de Lucena TMC, da Silva Santos AF, de Lima BR, de Albuquerque Borborema ME, de Azevêdo Silva J. Mechanism of inflammatory response in associated comorbidities in COVID-19. Diabetes Metab Syndr. 2020;14:597-600.
17. Lagadinou M, Salomou EE, Zareifopoulos N, Marangos M, Gogos C, Velissaris D. Prognosis of COVID-19: Changes in laboratory parameters. Infez Med. 2020;28:89-95.
18. Feng T, James A, Doumlele K, White S, Twardzik W, Zahid K, *et al*. Procalcitonin Levels in COVID-19 Patients Are Strongly Associated with Mortality and ICU Acceptance in an Underserved, Inner City Population. Medicina (Kaunas). 2021;57.
19. Tang J, Lin J, Zhang E, Zhong M, Luo Y, Fu Y, *et al*. Serum IL-6 and procalcitonin are two promising novel biomarkers for evaluating the severity of COVID-19 patients. Medicine (Baltimore). 2021;100:e26131.
20. Sarfaraz S, Shaikh Q, Saleem SG, Rahim A, Herekar FF, Junejo S, *et al*. Determinants of in-hospital mortality in COVID-19; a prospective cohort study from Pakistan. PLoS One. 2021;16:e0251754.
21. Lippi G, Plebani M. Procalcitonin in patients with severe coronavirus disease 2019 (COVID-19): A meta-analysis. Clin Chim Acta. 2020;505:190-1.
22. Gilbert DN. Procalcitonin as a biomarker in respiratory tract infection. Clin Infect Dis. 2011;52 Suppl 4:S346-50.
23. Delèvaux I, André M, Colombier M, Albuisson E, Meylheuc F, Bègue RJ, *et al*. Can procalcitonin measurement help in differentiating between bacterial infection and other kinds of inflammatory processes? Ann Rheum Dis. 2003;62:337-40.
24. Christ-Crain M, Jaccard-Stolz D, Bingisser R, Gencay MM, Huber PR, Tamm M, *et al*. Effect of procalcitonin-guided treatment on antibiotic use and outcome in lower respiratory tract infections: cluster-randomised, single-blinded intervention trial. Lancet. 2004;363:600-7.

How to Cite This Article

Goma GAAA, Hantera MS, Soliman GAA, Hammoudah SAF. Procalcitonin levels in COVID-19 patients recruited from Tanta University Hospitals. International Journal of Advanced Research in Medicine. 2023;5(3):31-37.