

## COMPARISON OF HEMATOLOGICAL AND INFLAMMATORY MARKERS TO PREDICT OUTCOME IN COVID-19 IN 1<sup>ST</sup> AND 4<sup>TH</sup> WAVE

Khalid Khan<sup>1</sup>, Hamzullah Khan<sup>2</sup>, Shahtaj Khan<sup>3</sup>, Mohammad Fawad Khan<sup>4</sup>, Mohammad Ali<sup>5</sup>, Mohammad Usman<sup>6</sup>

### **ABSTRACT**

#### **OBJECTIVES**

To compare the values of the hematological and inflammatory markers in 1<sup>st</sup> and 4<sup>th</sup> waves to predict the outcome of COVID-19 in a hospital-based study.

#### **METHODOLOGY**

This comparative study was conducted in the Department of Hematology, Hayatabad Medical Complex Peshawar, from April 2020 to 20 August 2021. Tests of significance (Independent t-test/Mann Whitney U test) and Chi-square test were used. Relevant information was recorded on a pre-designed proforma prepared following the study's objectives.

#### **RESULTS**

A total of 178 patients, 71 from (the 1<sup>st</sup> wave) and 107 from (the 4<sup>th</sup> wave) with known outcomes, were studied. A statistically significant difference exists between the groups (1st vs 4<sup>th</sup> wave) regarding hematological markers; neutrophil to lymphocyte ratio (NLR) ( $p=0.02$ ), Absolute Neutrophilic count (ANC) ( $p=0.01$ ) and platelet count ( $p=0.001$ ). Similarly, significantly higher inflammatory markers values were recorded in the 1st wave compared with the 4<sup>th</sup> wave regarding inflammatory markers; CRP ( $p=0.002$ ) and D-dimer ( $p=0.001$ ). During the 1st wave, Total Leukocyte Count (TLC), ANC and d-dimer were the leading prognostic indicators to predict mortality/worst outcome in COVID-19 with an Area Under Curve (AUC) of 0.74, 0.70 and 0.7 on receiver operating characteristics (ROC) respectively. In 4<sup>th</sup>, the Area under the curve (AUC) of d-dimer was 0.84 to predict mortality.

#### **CONCLUSION**

TLC, ANC, NLR, and low platelet count were the worst hematological markers in COVID-19 in the first wave, while d-dimer and CRP were the primary prognostic inflammatory markers. Unlikely in the 4<sup>th</sup> wave, the prognostic values of hematological markers were merely significant. The d-dimer values in both the waves proved to be reliable for predicting the severity and mortality of COVID-19.

**KEYWORDS:** COVID-19 Hematological Markers, Inflammatory Mediators, Mortality

#### **How to cite this article:**

Khan K, Khan H, Khan S, Khan MF, Ali M, Usman M. Comparison of Hematological and Inflammatory Markers to Predict Outcome in Covid-19 in 1st and 4th Wave. J Gandhara Med Dent Sci. 2022;9(3): 44-50  
<https://doi.org/10.37762/jgm.9-3.308>

**Correspondence**

<sup>2</sup>Hamzullah Khan, Professor of Hematology, Department of Pathology, Nowshera Medical College Nowshera, Pakistan  
 ☎: +92-334-4802902

✉: [hamzakmc@gmail.com](mailto:hamzakmc@gmail.com)

<sup>1</sup>Professor and Chairman, Department of Hematology, MTI Hayatabad Medical Complex, Peshawar

<sup>3</sup>Professor, Department of Hematology, MTI Hayatabad Medical Complex, Peshawar & Chairperson Provincial Passive Immunization Committee, Peshawar

<sup>4</sup>Resident Hematology, MTI Hayatabad Medical Complex, Peshawar

<sup>5</sup>Resident Hematology, MTI Hayatabad Medical Complex, Peshawar

<sup>6</sup>Resident Hematology, MTI Hayatabad Medical Complex, Peshawar

**INTRODUCTION**

Covid-19 is a respiratory disease reported to the World Health Organization in Dec 2019 from Wuhan, China. The World Health Organization (WHO) declared a global emergency due to the rapid rise in cases of COVID-19 in China and nearby countries by the mid of February 2020.<sup>1</sup> According to the World Health Organization, globally, confirmed covid cases have reached 426,624,859 with 5,899,578 deaths. By 20 February 2022, 10,407,359,583 vaccine doses have been administered worldwide.<sup>2</sup> By 24 February 2022, the number of laboratory-confirmed cases reached 1505,000 in Pakistan, with 30114 deaths and 62000 active cases. Khyber Pakhtunkhwa province is reported with a total number of COVID-19 cases of 215588 and 6228 deaths.<sup>3</sup> In the first wave, laboratory investigations like hematological indices are used mainly to assess the impact of the COVID-19 on hematopoietic system and homeostasis, which significantly suffer in this deadly disease. As per our first wave experience, we observed that Neutrophilic to lymphocyte ratio (NLR) was the main prognostic factor in COVID-19 to predict mortality/worst outcome in COVID-19, with an Area Under curve on ROC of 0.68, followed by absolute neutrophilic count (ANC) with an AUC value of 0.6.<sup>4</sup> Not a significant difference was noted for other hematological indices like TLC, Hemoglobin and platelet levels. Similarly, inflammatory markers like Ferritin levels, d-dimers, and CRP have been reported to predict mortality and severity in covid-19. A study from the metropolitan city of Wuhan, China, reported hyperferritinemia as a predictor of the disease's mortality and severity of the disease.<sup>5,6</sup> A literature review of the first wave confirms AUC for plasma CRP levels (0.896) on the ROC curve, which was significantly higher than hematological

markers like ANC (0.820) and platelet count (0.677) in outcome prediction with (Sensitivity of 90%, specificity 77%).<sup>7</sup> Some of the authors have reportedly compared the difference in the severity of the different waves. In India, a study showed comparing the first wave with 2nd wave that they received admission to ICU during the two waves were of the similar age, but there was a significant rise in deaths in the females, and more patients had co-morbidities during the second wave. They reported a higher mortality rate in ICU patients in the second wave.<sup>8</sup> However, the United States, with its previous experience from the first wave, with the use of steroids, remdesivir and convalescent plasma in the second wave, reported a lower mortality in the second wave compared to the first wave.<sup>9</sup> After the emergence of the covid-19, By 24 September 2020, several vaccines (more than 200 types) were started in preclinical development. Of those, only 43 entered clinical trials. Vaccines have been widely considered the only modality to eradicate the Pandemic and reduce mortality and morbidity, thus helping resume routine working, schooling, and social activities.<sup>10</sup> In Pakistan, we experienced the 4<sup>th</sup> wave in the third quarter of 2021. The infection spread faster than in the first and second waves, but fewer causalities were reported due to herd immunity. Since very scanty information is available to compare the severity of the 4<sup>th</sup> wave with the first wave, therefore present study was conducted to compare the values of the hematological and inflammatory markers in the 1<sup>st</sup> and 4<sup>th</sup> wave to predict the outcome of COVID-19 in a hospital-based study, to help the clinicians to identify the more clinically significant markers to predict mortality.

**METHODOLOGY**

This comparative study was conducted in the department of hematology, Hayatabad Medical Complex Peshawar, from April 2020 to 20 August 2021. 71 cases of wave 1<sup>st</sup> with known outcomes were compared with 107 cases in the 4<sup>th</sup> wave. This study was conducted in line with the research guidelines, followed sound medical practice, redetected human rights, and within the principles of the declaration of Helsinki of the World Medical Association. Ethical approval was granted from the institutional ethical review board of Post-Graduate Medical Institute, Hayatabad Medical Complex under notification No (316/HEC/B & PSC/2020, Dated 15 May 2020) and notification No (346/HEC/B & PSC/2020, Dated 10 December 2020). Patients hospitalized with COVID-19 in HMC were included. Patients where all

hematological and inflammatory mediators were advised, like CBC, d-dimers, ferritin, and CRP by the consultants, were enrolled, irrespective of age and gender. Similarly those patients were further followed for disease outcomes in terms of satisfactory discharge or death due to COVID-19. COVID-19 patients where deficient hematological and inflammatory mediator readings were available on the chart of patients or those who expired before being thoroughly investigated were excluded from the study. Similarly, all patients, irrespective of symptoms/signs, that came to the emergency or outdoor patients department were also excluded. For COVID confirmation, PCR results of the nasopharyngeal swab duly reported in the Public health research laboratory of the Hayatabad Medical Complex or Khyber medical University only were considered. Data was entered in SPSS, version 25 and descriptive and correlation statistics were applied. Numerical variables like age of patients, Hb%, TLC, ANC, Platelets, serum ferritin, d-dimer, CRP, age and hospital stay were presented with Mean and SD in case of normal distribution and with median and range where the data was not normally distributed. The normality of data was assessed using Shapiro-Wilk Test. Independent t-test/ Mann Whitney U test was used to determine the difference of the numerical variables (Hb%(g/dl), TLC (x10.e3/ul), ANC (x10.e3/ul), ALC (x10.e3/ul), NLR and Platelet count, Ferritin, d-dimer and CRP) in groups (discharged satisfactory vs expired). The receiver operating characteristics (ROC) curve was used to determine the relationship between clinical sensitivity and specificity of different hematological, demographic and inflammatory markers to predict the worst outcome in COVID-19. Chi-square test was used to determine the association of the age and gender and

peripheral hematological & inflammatory markers with disease outcomes in COVID-19 in the 1<sup>st</sup> and 4<sup>th</sup> wave.

## RESULTS

A total of 178 patients, 71 from (the 1<sup>st</sup> wave) and 107 from (the 4<sup>th</sup> wave) with known outcomes, were studied. The patient's mean age in the 1<sup>st</sup> wave was not significantly different from the patient admitted in the 4<sup>th</sup> wave of covid-19 ( $p=0.571$ ). The mean age of patients with SD in the first wave was 54 +12 years, while in the 4<sup>th</sup> wave, 56+16years for hospitalized patients. A lower Median Platelet readings were recorded in the 4<sup>th</sup> wave compared to the first wave. A higher median TLC>16000/cmm3 was recorded in both waves. A statistically significant difference exists between the groups (1<sup>st</sup> vs 4<sup>th</sup> wave) regarding hematological markers; neutrophil to lymphocyte ratio (NLR) ( $p=0.02$ ), Absolute Neutrophilic count (ANC) ( $p=0.01$ ) and platelet count ( $p=0.001$ ). Similarly, a significant difference exists between the groups (1<sup>st</sup> vs 4<sup>th</sup> wave) regarding inflammatory markers; CRP ( $p=0.002$ ) and D-dimer ( $p=0.001$ ). (Table :1) During the 1<sup>st</sup> wave, TLC and ANC were the leading prognostic hematological indicators to predict mortality/worst outcome in COVID-19, with an Area Under Curve (AUC) of 0.74 and 0.70 on ROC, respectively. Likewise, d-dimer was a matchless prognostic inflammatory indicator to predict mortality with an AUC of 0.73 in 1<sup>st</sup> wave. (Table 2), Fig 1 baseline (0.5 to 0.54) while the AUC of d-dimer was 0.84 to predict mortality. (Table 3), Fig 2 We could not find a statistically significant association with the mortality due to covid-19 in both the waves with an insignificant  $p>0.05$ . (Table 4).

**Table 1: Differences in Demographic, Hematological and Inflammatory Markers in the 1<sup>st</sup> and 4<sup>th</sup> Waves of Covid-19**

Parameters	Phase	Number of Patients	Mean/Median	Std. Deviation	Sig.	Test Performed
Age	First wave	71	54.73	12.32	0.571	Independent T-test
	4 <sup>th</sup> Wave	107	55.94	14.91		
Hb%	First wave	71	13.00	2.24	0.019	Independent T-test
	4 <sup>th</sup> Wave	107	12.17	2.32		
TLC (Median)	First wave	71	16819		0.974	Mann Whitney U test
	4 <sup>th</sup> Wave	107	16710			
PLT (Median)	First wave	68	348864		0.001	Mann Whitney U test
	4 <sup>th</sup> Wave	107	158572			
NLR	First wave	71	13.77	8.30	0.028	Independent T-test
	4 <sup>th</sup> Wave	107	5.78	6.37		
ANC (Median)	First wave	71	11616		0.016	Mann Whitney U test
	4 <sup>th</sup> Wave	107	14679			
ALC (Median)	First wave	71	1796		0.793	Mann Whitney U test
	4 <sup>th</sup> Wave	107	2031			
CRP	First wave	67	15.81	11.47	0.002	Independent T-test
	4 <sup>th</sup> Wave	107	10.54	10.69		
Ferritin (Median)	First wave	68	1461		0.369	Mann Whitney U test
	4 <sup>th</sup> Wave	107	1302			
D_DIMER	First wave	68	28.05	8.40	0.001	Independent T-test
	4 <sup>th</sup> Wave	107	5.11	3.73		

**Table 2: Area under the Curve of Different Hematological and Inflammatory Markers in the 1<sup>st</sup> Wave Covid-19 Pandemic**

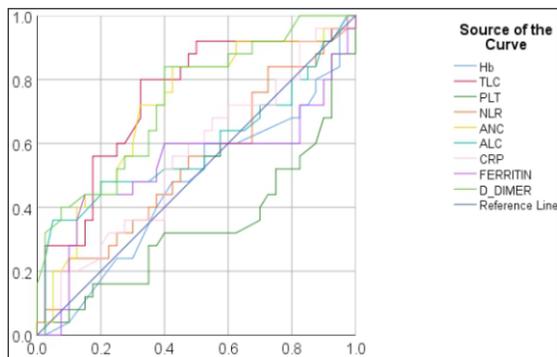
Test Result Variable(s)	Area	Std. Error	Asymptotic Significance	Asymptotic 95% Confidence Interval	
				Lower Bound	Upper Bound
Hb	0.466	0.075	0.647	0.319	0.613
TLC	0.741	0.065	0.001	0.614	0.868
PLT	0.34	0.073	0.03	0.196	0.483
NLR	0.534	0.075	0.647	0.386	0.682
ANC	0.708	0.067	0.005	0.576	0.84
ALC	0.587	0.079	0.243	0.431	0.742
CRP	0.551	0.074	0.492	0.406	0.696
Ferritin	0.532	0.082	0.666	0.371	0.693
D_Dimer	0.735	0.063	0.002	0.611	0.859

**Table 3: Area under the Curve of Different Hematological and Inflammatory Markers In the 4<sup>th</sup> Wave of the Covid-19 Pandemic**

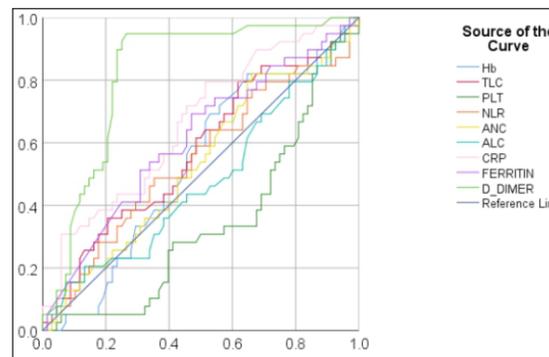
Test Result Variable(s)	Area	Std. Error	Asymptotic Significance	Asymptotic 95% Confidence Interval	
				Lower Bound	Upper Bound
Hb	0.529	0.057	0.62	0.417	0.641
TLC	0.572	0.058	0.218	0.458	0.686
PLT	0.34	0.054	0.006	0.234	0.445
NLR	0.545	0.059	0.441	0.429	0.661
ANC	0.53	0.058	0.605	0.416	0.644
ALC	0.476	0.059	0.681	0.36	0.592
CRP	0.66	0.054	0.006	0.554	0.767
Ferritin	0.61	0.057	0.06	0.498	0.721
D-Dimer	0.822	0.042	0	0.739	0.905

**Table 4: Comparing Outcomes in 1<sup>st</sup> and 4<sup>th</sup> Wave of Covid-19**

Phase/Wave	Outcome		Total	Sig (Chi-Square Test)
	Discharged/Satisfactoril	Expired		
First Wave	46	25	71	0.866
	68	39		
4 <sup>th</sup> Wave	68	39	107	
Total	114	64	178	



**Figure 1: Roc Curve Showing The Predictive Values of Hematological and Inflammatory Markers To Predict the Outcome In 1<sup>st</sup> Wave Of Covid-19**



**Figure 2: Roc Curve Showing the Diagnostic Role of Haematological and Inflammatory Markers to Predict the Outcome in the 4<sup>th</sup> Wave of Covid-19 Pandemic**

**DISCUSSION**

Early detection of the disease and understanding the prognostic values of the simple tests available even at primary and secondary care centres can help assess the severity of the disease and predict mortality. Thus, the clinician can take remedial actions well in time to save precious lives. In the present study, we took the help of our previous experience in the first wave to compare the severity of the disease after attaining much herd immunity due to the vaccination of the citizen against the deadly disease. We observed that the mean age of

patients with SD in the first wave was 54 +12 years, and in the 4th wave, 56+16 years was not significantly different in both phases for hospitalized patients ( $p=0.571$ ). As per our previous experience, we had reported that 35 (49.3%) of the patients had age >55 years and 25 (35.2%) among the ICU patients hospitalized due to COVID-19.<sup>11</sup> However, a study from India comparing the 1<sup>st</sup> wave with the 2<sup>nd</sup> wave reported the younger age group was affected more in the second wave.<sup>12</sup> A study from Karachi reported ICU admission due to Covid-19 with increased age and hospital stay

during the first wave.<sup>13</sup> Regarding the hematological markers, a statistically significant difference exists between the groups (1<sup>st</sup> vs 4<sup>th</sup> wave) regarding; higher neutrophil to lymphocyte ratio (NLR) ( $p=0.02$ ), Absolute Neutrophilic count (ANC) ( $p=0.01$ ) and platelet count ( $p=0.001$ ) were noted in the first wave. While most of these hematological markers predicting severity in the first wave were less remarkable in the 4<sup>th</sup> wave. Similar findings have been reported by Asghar MS et al.<sup>13</sup> comparing the first and second waves. Another study in Spain reported the predictive accuracy of severity and mortality for 6 hematological markers ( NLR, CRP, LDH and ferritin, d-dimer and interleukin 6) in the first wave was 84% with an Area under the curve of 0.84. when the signature was validated for the 2<sup>nd</sup> and third waves, the accuracy was 83%, with an AUC of 0.78.<sup>14</sup> A significant difference in 1<sup>st</sup> wave TLC and ANC counts proved to be of prognostic values to predict mortality/worst outcome in COVID-19 with an Area Under Curve (AUC) of 0.74 and 0.70 on ROC, respectively, as compared to 0.5 in the 4th wave( $p < 0.05$ ). Likewise, a significant difference exists between the groups (1<sup>st</sup> vs 4<sup>th</sup> wave) regarding inflammatory markers; CRP ( $p=0.002$ ) and D-dimer ( $p=0.001$ ). We observed a significantly reduced inflammatory response in the 4th wave, attributed to the widespread use of immunomodulatory therapies and steroids. D-dimer was the main prognostic factor that predicted severity and mortality in both the waves and is less affected by the use of immune modulators and steroids. Ferritin levels were also higher but not statistically different in both waves. Our findings concordance with a trial reported from the united kingdom where they compared the first wave with the second wave.<sup>15</sup> Gao Y et al.<sup>16</sup> have reported that the Area under curved for deranged d-dimers is 0.840, similar to what we observed in 4th wave findings and further confers the higher clinical impact of deranged d-dimers as the worst outcome in COVID-19. The abnormally high serum ferritin levels predict the worst outcome and have been reported to be high and non stoppable in hospitalized patients with COVID-19. A study reported an increase in the ferritin levels exceeding the upper limit of detection, increasing hospital stay and mortality in critically ill ICU patients<sup>17</sup>. Regarding the peripheral hematological markers, as per our previous experience in AUC, the absolute neutrophilic count (ANC) was 0.6 and was significantly higher in a group with case fatality. Therefore ANC can also be used as a prognostic marker in COVID-19.<sup>4</sup> Notably, a study published

in the American Journal of Hematology reported a high leukocyte count in COVID-19 ICU patients with severe complications with a median peak ANC of 11600/cmm<sup>3</sup> as compared to non-ICU patients without complications ( $p<0.001$ ).<sup>18</sup> D-dimer as an inflammatory marker carry higher prognostic values, and its raised levels in both the waves strongly predict mortality in covid-19. The ferritin values were higher in both waves, but the impact on outcome was less specific than d-dimer. High D-dimer values can be observed in severe disease after a long time, while the values of the ferritin and d-dimer decreased with an increase in the disease duration.<sup>19,20</sup>

## CONCLUSION

Most of the hematological and inflammatory markers behaved/presented similarly in both waves in 2020 vs 2021. However, using the ROC curve to determine the clinical sensitivity of these markers in both waves showed that some parameters associated with a poor prognosis (TLC, ANC, NLR, ferritin) were not found in 4th wave., which may indicate a different or stage of presentation for hospitalization with the same disease. However, few markers like NLR and d-dimer possess the same clinical significance as biomarkers for indicating the severity of the disease. These biomarkers constitute a helpful tool to classify patient's prognosis on presentation to hospital emergency.

## LIMITATION

This study had a small sample size. Studies executed with larger sample sizes in both groups (discharged as complication-free) and patients discharged on death summary in COVID-19 will better portray the importance of different hematological and inflammatory markers from peripheral blood count.

**CONFLICT OF INTEREST:** None

**FUNDING SOURCES:** None

## REFERENCES

1. Shrivastava SR, Shrivastava PS. 2019-nCoV Outbreak Declared as Public Health Emergency of International Concern: What Next? International journal of preventive medicine. 2020 5 June;11:65–65.
2. Usman S. Descriptive Analysis of Health Screening for Covid19 at Points of Entry of

- Pakistan according to CDC Guidelines, February 2020 -March 2021 (Preprint) [Internet]. JMIR Publications Inc.; 2022.
3. Cumulative confirmed cases of COVID-19 in Emerging Asia, January 2020 to March 2022 [Internet]. Organization for Economic Co-Operation and Development (OECD); 2022.
  4. Khan H, Khan S. Potential Diagnostic and Prognostic Values of Hematological Biomarkers in COVID-19. *Afro-Egyptian Journal of Infectious and Endemic Diseases*. 2021 Mar 14;0(0):0–0.
  5. Gómez-Pastora J, Weigand M, Kim J, Wu X, Strayer J, Palmer AF, et al. Hyperferritinemia in critically ill COVID-19 patients - Is ferritin the product of inflammation or a pathogenic mediator? *Clinica chimica acta; international journal of clinical chemistry*. 2020 Oct;509:249–51.
  6. Chen G, Wu D, Guo W, Cao Y, Huang D, Wang H, et al. Clinical and immunological features of severe and moderate coronavirus disease 2019. *The Journal of clinical investigation*. 2020 1 May;130(5):2620–9.
  7. Luo X, Zhou W, Yan X, Guo T, Wang B, Xia H, et al. Prognostic Value of C-Reactive Protein in Patients With Coronavirus 2019. *Clinical infectious diseases: an official publication of the Infectious Diseases Society of America*. 2020 Nov 19;71(16):2174–9.
  8. Zirpe KG, Dixit S, Kulkarni AP, Pandit RA, Ranganathan P, Prasad S, et al. The Second- vs First-wave COVID-19: More of the Same or a Lot Worse? A Comparison of Mortality between the Two Waves in Patients Admitted to Intensive Care Units in Nine Hospitals in Western Maharashtra. *Indian journal of critical care medicine: peer-reviewed, official publication of Indian Society of Critical Care Medicine*. 2021 Dec;25(12):1343–8.
  9. Oladunjoye O, Gallagher M, Wasser T, Oladunjoye A, Paladugu S, Donato A. Mortality due to COVID-19 infection: A comparison of first and second waves. *Journal of community hospital internal medicine perspectives*. 2021 Nov 15;11(6):747–52.
  10. Martínez-Rodríguez D, Gonzalez-Parra G, Villanueva R-J. Analysis of Key Factors of a SARS-CoV-2 Vaccination Program: A Mathematical Modeling Approach. *Epidemiologia*. 2021 Jun;2(2):140–61.
  11. Khan H, Khan S, Riaz H, Khattak AR. Prognostic Factors and Association of Inflammatory Biomarkers with Severity and Mortality in COVID-19. *Journal of Bahria University Medical and Dental College*. 2021 29 December;12(01):25–30.
  12. Hada V, Rath RS, Mohanty A, Sahai R, Kumar K, Kumar S, et al. Comparison of Positivity Rates of Rapid Antigen Testing and Real-Time Polymerase Chain Reaction for COVID-19 During the First and Second Waves of the Pandemic in Eastern Uttar Pradesh, India. *Cureus*. 2021 Jul 6;13(7):e16206–e16206.
  13. Asghar MS, Yasmin F, Haris A, Nadeem A, Taweeseed PT, Surani S. Comparison of first and second waves of COVID-19 through severity markers in ICU patients of a developing country. *Journal of community hospital internal medicine perspectives*. 2021 20 September;11(5):576–84.
  14. Mollinedo-Gajate I, Villar-Álvarez F, Zambrano-Chacón M de LÁ, Núñez-García L, de la Dueña-Muñoz L, López-Chang C, et al. First and Second Waves of Coronavirus Disease 2019 in Madrid, Spain: Clinical Characteristics and Hematological Risk Factors Associated With Critical/Fatal Illness. *Critical care explorations*. 2021 Feb 22;3(2):e0346–e0346.
  15. Szakmany T, Tuckwell W, Harte E, Wetherall N, Ramachandran S, Price S, et al. Differences in Inflammatory Marker Kinetics between the First and Second Wave of COVID-19 Patients Admitted to the ICU: A Retrospective, Single-Center Study. *Journal of clinical medicine*. 2021 26 July;10(15):3290.
  16. Gao Y, Li T, Han M, Li X, Wu D, Xu Y, et al. Diagnostic utility of clinical laboratory data determinations for patients with the severe COVID-19. *Journal of medical virology*. 2020 Jul;92(7):791–6.
  17. Ullah W, Thalambedu N, Haq S, Saeed R, Khanal S, Tariq S, et al. Predictability of CRP and D-Dimer levels for in-hospital outcomes and mortality of COVID-19. *Journal of community hospital internal medicine perspectives*. 2020 3 September;10(5):402–8.
  18. Fan BE, Chong VCL, Chan SSW, Lim GH, Lim KGE, Tan GB, et al. Hematologic parameters in patients with COVID-19 infection. *American Journal of Hematology*

- [Internet]. 2020 19 March;95(6).
19. Zeng F, Huang Y, Guo Y, Yin M, Chen X, Xiao L, et al. Association of inflammatory markers with the severity of COVID-19: A meta-analysis. *International journal of infectious diseases : IJID : official publication of the International Society for*
  20. Infectious Diseases. 2020 Jul;96:467–74.
  20. Stebbing J, Phelan A, Griffin I, Tucker C, Oechsle O, Smith D, et al. COVID-19: combining antiviral and anti-inflammatory treatments. *The Lancet Infectious diseases.* 2020 Apr;20(4):400–2.

### CONTRIBUTORS

1. **Khalid Khan** - Concept & Design; Drafting Manuscript; Critical Revision; Supervision; Final Approval
2. **Hamzullah Khan** - Concept & Design; Data Aquisition; Data Analysis/Interpretation; Drafting Manuscript; Critical Revision; Supervision; Final Approval
3. **Shahtaj Khan** - Drafting Manuscript; Critical Revision; Supervision; Final Approval
4. **Mohammad Fawad Khan** - Concept & Design; Data Aquisition; Data Analysis/Interpretation
5. **Mohammad Ali** - Concept & Design; Data Aquisition; Data Analysis/Interpretation
6. **Mohammad Usman** - Concept & Design; Data Aquisition; Data Analysis/Interpretation



LICENSE: JGMDS publishes its articles under a Creative Commons Attribution Non-Commercial Share-Alike license (CC-BY-NC-SA 4.0).  
 COPYRIGHTS: Authors retain the rights without any restrictions to freely download, print, share and disseminate the article for any lawful purpose. It includes scholarly networks such as Research Gate, Google Scholar, LinkedIn, Academia.edu, Twitter, and other academic or professional networking sites.