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Study of neutrophil to lymphocyte ratio as a prognostic marker in COVID-19 infection-our experience at teritary care hospital

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Abstract---Background: To evaluate the prognostic value of Neutrophil to lymphocyte ratio (NLR) in Covid -19 patients at our district area hospital/ Teritary care center. Methods: It is a prospective study from 1-8-2021 to 30-9-2021. Patients who presented with complaints of

Fever, sore throat, body pains, cough, breathlessness, diarrhoea were evaluated at the triage area of the Hospital. Throat swab was taken and RT-PCR was done and only 200 confirmed cases were included in the study. Patient blood samples were collected and processed in SYSMAX 5 -part, Heamotology analyser in the Hospital Central Laboratory. The patients CBP was processed in the laboratory NLR value calculated and tabulated. Results: Out of 200 cases number of Males were 145(72.5%) more compared to the female were 55(27.5%), with NLR value 1.0-3.9 in74 cases(37%) ,4.0- 6.9 in 63 cases (33%) , 7.0 – 9.9 in 25 cases (12.5%), 10-12.9 in 17 (8.5%) cases , 13-15.9 7 cases(3.5%), 16 -18.9 3 cases(1.5%) ,19-21.9 9 cases(4.5%) ,22-24.9 0 cases, 25-27.9 0 cases , 28-30.9 2 cases (1%). Conclusion: NLR Value more than 3.5 found to be significant and it is correlating with the patients symptoms.

Keywords---neutrophil lymphocyte ratio (NLR), COVID -19, infection-our experience.

Introduction

The Corona virus also known as Severe Acute Respiratory Syndrome - Coronavirus 2 (SARS- Cov-2)is a pandemic disease which swept the globe in 2019 causing corona virus disease 2019 (COVID-19) a predominantly respiratory illness, Most of the patients, around 80% infected by SARS- CoV- 2 may not have any symptoms or may be asyptomatic, 10% develop severe respiratory symptoms that evolve to acute respiratory distress syndrome(ARDS).[1] COVID-19 is an enveloped single – stranded RNA virus which binds to an intrinsic membrane protein with enzymatic activity called ACE-2 receptors, which activates the renin angiotensin – aldosterone system.These ACE-2 receptors are expressed on endothelial cells, pulmonary alveolar cells, heart, kidney cellS. These receptors shows 10 fold more affinity for SARS-Cov -2 virus than the SARS- Cov-1. [2,3,4]

Incubation period for this virus is 1-14 days. Individuals are contagious during this incubation period. Symptomatic patients presents with fever, dry cough, fatigue, sore throat andmayalgia.In severe cases patients presents with acute respiratory distress syndrome(ARDS).In this syndrome virus enters the respiratory system and binds to the alveolar ACE2 receptors and causes extensive alveolar and intestinal inflammation . This severe inflammation activates the hemostatic system leading to activation and damage of the pulmonary vascular endothelial cells. Theese endothelial cells after activation, increases the angiogenesis and triggers the pulmonary thrombosis.[5] Similar to SARS in 2003 Hematological changes in COVID -19 patients includes lymphopenia and thrombocytopenia. Abnormal coagulation is a common complication of COVID-19 and is manifested by pulmonary vascular leakage, intravascular thrombosis, and disseminated intravascular coagulation. Despite administering the standard thromboprophylaxis, incidence of both arterial and venous thrombosis remains more[6]. Three Other viruses which cause the same hypercoagubility state are Severe Acute Respiratory Syndrome Virus –(SARS)and Middle East Respiratory Syndrome (MERS-CoV) [7,8],H1NI.

The neutrophil-to-lymphocyte ratio – NLR

The neutrophil-to-lymphocyte ratio (NLR), as a easily accessible biomarker, and it can be calculated based on a complete blood count. NLR is proposed as an independent predictor of poor survival in various clinical circumstances ranging from oncological patients [9, 10] to patients with cardiovascular diseases [11], presently it is used as a predictor of severity of disease in COVID-19 patients also. In this prospective observational study, we sought to evaluate the potential association of NLR on hospital admitted COVID -19 diagnosed patients with the clinical prognosis.

Materials and Methods

Study Design

This prospective trial recruited consecutive adult patients with confirmed COVID -19 infection admitted to the Government Medical college, Suryapet from August 2021 to October 2021. For each patient with suspected infection, a complete diagnostic work-up was performed. The work-up comprised demographic and clinical characteristics, and important laboratory data including leukocyte counts, blood biochemistry, chest X-ray, and chest computed tomography.

Blood Measurements

Venous blood (3 mL) was collected from patients. The blood was drawn into an EDTA-containing tube (BD Vacutainer) and Complete blood count was determined using the SYSMAX HematologyAnalyzer. NLR was calculated as a ratio of circulating neutrophil and lymphocyte counts. The normal ranges for the leukocyte in our laboratory are 1.4–6.5 × 10^9/L for neutrophil count and 1.2–3.4 × 10^9/L for lymphocyte count.

Statistical Analysis

Statistical analysis was carried out using the Statistical Package for Social Sciences (SPSS) VERSION 21.0. Independent sample t- tests were used for age, white blood cell count, lymphocyte count, neutrophil lymphocyte ratio. A $p<0.05$ was considered significant.

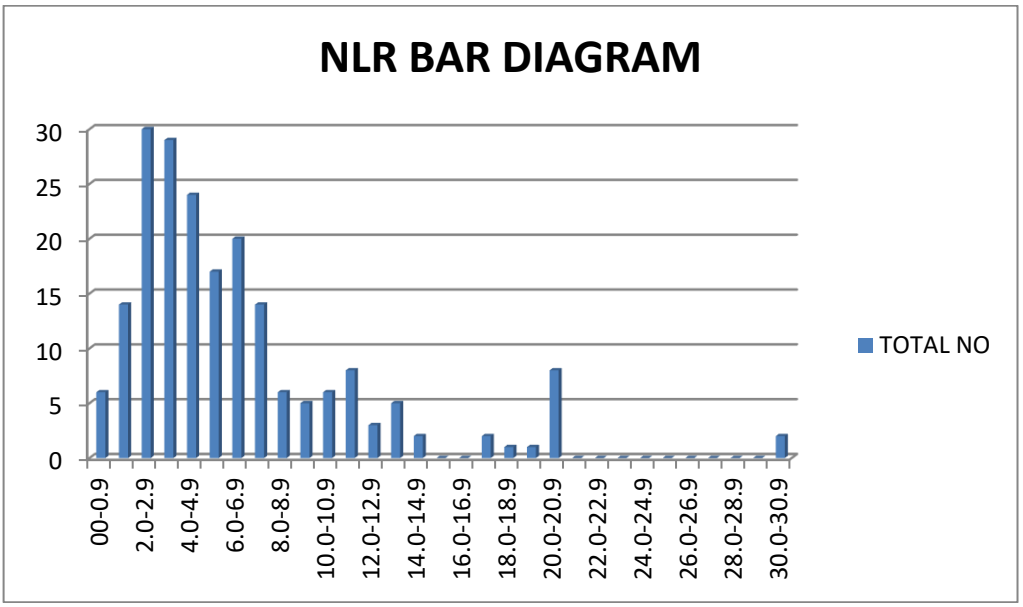
Results

Table 1
Age Distribution

AGE	TOTAL	PERCENTAGE
1-10YRS	00	00
11-19YRS	00	00
20-29YRS	20	10%
30-39 YRS	30	15%
40-49 YRS	32	16%
50-59 YRS	51	25.5%

60-69YRS	40	20%
70-79 YRS	21	10.5%
80-89 YRS	06	3%
TOTAL	200	100%

A total 200 patients were included in the study. Males were 145(72.5%) more compared to the female were 55(27.5%).Age distribution was shown in table 1.Most of the patients belong to50 years age group.(25.5%),60yrs age group(21%).Maximum age was 80 years, minimum age 19 years and mean age was 50 years.



Bar diagram 1. showing the NLR distibution

Normal NLR 1-3.5 in our study less than 3.5 NLR value was seen in 62(31%) and138(69%) patients were showing NLR >3.5. patients distribution shown in the table 2.

Table 2
Showing the NLR value comparision

NLR	<3.5	>3.5	P- VALUE (T test)
NLR			P<0.0001
MEAN	2.3	8.7	
SD	0.79	5.98	
CI	2.3±0.814	8.7±0.99	
AGE			
MEAN	49.5	51	P=0.5018

SD	15.4	14.1	
CI	49.5±3.8	51.5±2.3	
HB			
MEAN	13.0	12.8	P=0.5301
SD	2.01	2.11	
CI	13.0±0.50	12.8 ± 0.35	
WBC			
MEAN	80.0	111.0	P<0.0001
SD	39.6	49,600	
CI	80.0±9.8	111±8.21	
LYMPHOCYTES			
MEAN	2.14	1.38	P<0.0001
SD	1.07	0.75	
CI	2.14±0.2	1.38±0.12	

Table 3
Showing the patients admitted in ICU and required oxygen support

		PERCENTAGE
WITHOUT OXYGEN SUPPORT	40	28.9
HNFC	50	36.5
OXYGEN CONCENTRATORS	20	14.4
C-PAP	28	20.2
TOTAL	138	

NLR VALUE >3.5 was observed in 138(69%) patients these patients had the mean age of presentation to the hospital was 51 years. These patients also had high WBC count compared to the other group and low lymphocyte count with the p-value <0.0001 and needed oxygen support like High Flow Nasal canula, Oxygen concentrators, C-pap.

Discussion

A novel coronavirus (severe acute respiratory syndrome coronavirus 2, SARS-CoV-2) causing coronavirus disease 2019(COVID-19), was identified on 7 January 2020 in Wuhan,China. The COVID-19 pandemic has spread so rapidly around the world with higher incidence of ARDS in patients. The inflammatory response is one which thought to underpin COVID-19 pathogenesis. The sudden clinical deterioration after initial symptom suggests that acute respiratory distress syndrome, severe respiratory failure in COVID-19 is driven by a unique pattern of immune dysfunction and this leads to sustained cytokine production and hyper-inflammation.

In our study patients came with the complaints of fever, cough, shortness of breath, body pains were examined clinical history was taken nasal samples were processed in RT-PCR and those patients samples tested positive were included. In the study a total of 200 patients blood samples were collected and analysed laboratory. NLR neutrophil to lymphocyte ratio, Heamoglobin, Total WBC count these parameter were studied in Covid -19 patients. In Table 4 studies from India shown the various predictors of severity / mortality[23].

Table 4
Comparing various studies related to COVID-19 patients in India

	Author	Study design	Study population	Sample size	Predictors of severity/mortality
1	Soni et al. Chandigarh,[17]	Prospective, observational study	All severity (severe-18 patients)	114	High inflammatory parameters, NLR ratio of ≥3.5, hypalbuminemia, and deranged creatinine.
2	Mahale et al., Pune[20]	Retrospective study	Patients requiring oxygen and on immunomodulators	134	SpO_2, PaO_2/FiO_2 ratio, leukocytosis, lymphopenia, and creatinine
3	Bhadade et al., Mumbai[21]	Prospective observational study	Critically ill COVID-19 patients	373	Comorbidities, hypertension, low SpO_2, low P/F ratio, high levels of blood sugar, LDH, ferritin, D-dimer, IL-6
4	Sharma et al., Jaipur[10]	Prospective observational study	All severity	70	Lymphopenia and higher age
5	Dosi et al., Indore,[22]	Retrospective study	All severity (oxygen requirement-53)	365	Comorbidities, lymphopenia
6	SagarS Maddaniet al[23]	Case control	All sever cases	Cases50,controls142	CRP, C-reactive protein; TLC, total leucocyte count; NLR, neutrophil–lymphocyte ratio; LDH, lactate dehydrogenase, co-morbidites.
7	Present study	Prospective, observational study	All patients	200	NLR,Lymphopenia., Heamoglobin, Total WBC count.

Although several international studies have been published on this subject, it is important to study these parameter in Indian subjects as studies have shown a disparity in outcomes among various races/ethnicities. Patients in our study were (mean age 51 yrs) in north indian study (median age – 33 yr) [12]compared to those in China (median age – 56 yr)[13], New York (median age – 63 yr)[14] or Italy (median age – 63 yr)[15]. Although similar age pattern (mean age of 40.3 yr) was observed in a study done by Gupta *et a*[16] at another tertiary care hospital from northern India, but their sample size was limited. Similar to other published studies, age and male gender were associated with a higher incidence of severe disease our study also correlating with these studies.[17,18] In one study they explained about the age wise hospital stay in hospital in COVID-19 patients. In a study from China, the rate of hospitalization varied between the different age-groups as follows: 1% (20–29 years), 4% (50–59 years), and 18% (>80 years)[19] Indian studies had studied the various parameter to studied about the disease severity in COVID-19 patients shown in the table.

The increase in NLR value means the progressive increase of neutrophils, and/or the decrease of lymphocyte. This increase of neutrophil counts indicates that the patients have bacterial infection and the infection is aggravated and associated decrease of lymphocyte indicates that the immune function is poor. NLR was found to have greater prognostic value than traditional infection markers, such as CRP, white blood cell count and neutrophil count.[24,25] NLR Neutrophil-to-lymphocyte ratio calculated using the absolute neutrophil count divided by absolute lymphocyte count value. NLR value 3.5 was taken as a cut off value, we grouped the patients into two groups. NLR value less than 3.5 and more than 3.5. In our study NLR value less than 3.5 was seen in 62(31%), >3.5 in 138(69%) patients respectively. Neutrophil-to-lymphocyte ratio (NLR) > 3.5 was associated with more disease severity,it is a convenient and quick index of inflammation detection in laboratory examination during routine hematology.

Highest NLR value was 30.6, seen in one patient with absolute lymphocyte count was 0.3, NLR more than 20 was seen in 9 patients most of the patients age group old age group patients, platelet count in these patients was mostly normal except 3 patients one patient present with severe thrombocytopenia and the platelet count was 32,000 and another patient platelet count was 1,25,000, one patient showed the 5lacs.High NLR patients also associated with high WBC counts more than 11,000 except in one patient presented with leucopenia 2,400 WBC count. Clinically also these patients were severly ill requiring oxygen support. In ARDS patients consideration of NLR- as an immune indicators would improve early prediction for disease severity, helps clinicians to give effective respiratory supporting strategies. It is necessary to pay attention to the COVID-19 patients with increased NLR, who may have a poor prognosis, even a risk of death. In ARDS in COVID 19 patients because of the inflammatory strom damage the alveolar epithelium causes the fluid in the elastic air spaces like alveoli in the lugs, which means less oxygen reaches the lungs, patients presents with shortness of breath (SOB),It Usually develops few hours after the infection or injury to lung . Severity of ARDS increases with the age. These patients requires the oxygen supports like High Flow Nasal cannula, Oxygen Concentrators ,C-pap. In our study also patient required the oxygen support for the survival of the

patients. Severity increase with the patients age of the patients and also with the co morbidities.

In INDIA Soni[12] et al studied the NLR in covid -19 patients,NLR in without comorbidities patients median was 1.9 and IQR 0.6-22.5.NLR in comorbidities patients median was 2.3 , IQR was 0.7-47.5, In this study they also divided the patients into mild, moderate, severe patients NLR also studied in these groups . NLR, median (IQR) in asymptomatic patients1.90 (IQR1.15), mild disease 1.79(IQR 1.08), moderate disease 1.43(IQR 0.92), severe disease5.57(IQR 25.5). Sagar s Maddani[23] study from Karnataka India also studied NLR in Covid -19 patients a case –control study. A total of 53 patients with severe Covid-19 disease and studied the NLR. In this they found that median 8.45(IQR5.40- 14.88).

In Aijia Ma et al [26]study Patients diagnosed with severe COVID-19 from 21 hospitals in Sichuan Province between January 16 and March 15 were included in the analysis, totally 81 patients defined as severe COVID-19,44 were diagnosed as ARDS. The baseline characteristics of the non-ARDS group and ARDS group are listed.The cut off value of NLR for moderate-severe ARDS is 11.The high NLR group (NLR > 9.8) showed a higher incidence of ARDS (P= 0.005) and higher rate of non-invasive (P= 0.002) and invasive (P= 0.048)mechanical ventilation. InWenjing Ye1et al study [27]they studied the dynamic changes in NLR in 349 patients at the time of joining in the hospital and few days after the admission they found that association between clinical deterioration and changes in NLR values as follows Initial NLR in survivors 2.88(1.79–6.74), in dead patients it is about 14.96(8.52–26.58) with P- value <0.001. Peak NLR changes as follows in survivors 4.14(2.11–12.32), in dead patients it is about 46.58(27.95–87.29) with p-VALUE <0.001. We also compared the our study with other studies from china and it was tabulated noted the NLR changes in the severely ill patients and non-severely ill patients shown in the table 5 [28]

Table 5
Comparison of various studies showing NLR values

Author	Samples	NLR value	Study design	Study location
Qin et al. 2020[29]	Non-severe: 166 Severe: 286	Non-severe: 3.2 (1.8, 4.9) severe: 5.5 (3.3, 10.0)	Retrospective	Hubei, China
Gong et al. 2020[30]	Non-severe: 161 Severe: 28	Non-severe: 1.9 (1.4, 2.9) Severe: 3.7 (2.0, 6.7)	Retrospective	Guangdong and Hubei, China
Liu et al. 2020[31]	Non-severe: 44 Severe: 17	Non-severe: 2.2 (1.4, 3.1) Severe: 3.6 (2.5, 5.4)	Prospective	Beijing, China
Yang et al.	Non-severe: 69	Non-severe:	Retrospective	Zhejiang, China

2020[32]	Severe: 24	4.8 ± 3.5 Severe: 20.7 ± 24.1		
Zhang et al. 2020[33]	Mild: 84 Severe: 31	Mild: 2.28 ± 1.29 Severe: 7.58 ± 7.04	Retrospective	Hubei, China
Sagar S Maddani et al [23]	Severe 50	8.45 [5.40, 13.88]Cases 2.32 [1.50, 3.48]controls	Case control	Udipi, karnataka
Present study	Non severe 62, severe 138	Non severe mean 2.3(2.3±0.814), severe 8.7(8.7±0.99)	Prospective, observational study	Suryapet,Telangana

In our study we divided the patients into two groups NLR <3.5 and>3.5 we found that patients with NLR < 3.5 were presented with the mild symptoms and mean age also less compared to the that of the patients with the NLR>3.5 these patients presented with moderate to severe symptoms and more mean age, and patients with these patients also required the oxygen support. NLR values correlating with the severity of the patient.

Conclusion

NLR is the easy and quick parameter that can be assed easily in laboratory. NLR is more valuable test to treat patients with the infection of COVID-19, due to higher values of NLR in deceased patients . Further studies are needed to analyse the cause of NLR changes in order to provide potential treatment for the COVID-19 infection and decrease mortality.

References

1. Aijia Ma†, Jiangli Cheng†, Jing Yang†, Meiling Dong, Xuelian Liao and Yan KangNeutrophil-to-lymphocyte ratio as apredictive biomarker for moderate-severeARDS in severe COVID-19 patients Ma et al. Critical Care (2020) 24:288 https://doi.org/10.1186/s13054-020-03007-
2. B. Ayça, F. Akln, O. Celik et al., “Neutrophil to lymphocyte ratio is related to stent thrombosis and high mortality in patients with acute myocardial infarction,” Angiology, vol. 66, no. 6, pp. 545–552, 2015. View at: Publisher Site | Google Scholar
3. Bhadade R, Harde M, deSouza R, Kasbe A, Deshpande C, Dave S, et al. Appraisal of critically ill COVID-19 patients at a dedicated COVID hospital. J Assoc Physicians India. 2020;68(9):14–19. PMID: 32798339. [PubMed] [Google Scholar]
4. Cataudella E, Giraffa CM, Di Marca S, et al. Neutrophil-to-lymphocyte ratio: an emerging marker predicting prognosis in elderly adults with community-

acquired pneumonia. J Am Geriatr Soc. 2017;65(8):1796–1801. doi: 10.1111/jgs.14894. [PubMed] [CrossRef] [Google Scholar]
5. de Jager CP, Wever PC, Gemen EF, et al.The neutrophil-lymphocyte count ratio in patients with community-acquired pneumonia.PLoS One. 2012;7(10):e46561. doi: 10.1371/journal.pone.0046561. [PMC free article] [PubMed] [CrossRef] [Google Scholar].
6. Dosi R, Jain G, Mehta A. Clinical characteristics, comorbidities, and outcome among 365 patients of coronavirus disease 2019 at a tertiary care centre in Central India. J Assoc Physicians India. 2020;68(9):20–23. PMID: 32798340. [PubMed] [Google Scholar]
7. Dynamic changes of D-dimer and neutrophil-lymphocyte count ratio as prognostic biomarkers in COVID-19.Wenjing Ye1†, Guoxi Chen2†, Xiaopan Li3,4†, Xing Lan2†, Chen Ji5†, Min Hou6, Di Zhang7, Guangwang Zeng7,Yaling Wang2, Cheng Xu7, Weiwei Lu8, Ruolin Cui9, Yuyang Cai6*, Hai Huang2*and Ling Yang7*Yeet al. Respiratory Research (2020) 21:169 https://doi.org/10.1186/s12931-020-01428-
8. Giannis D, Ziogas IA, Gianni P. Coagulation disorders in coronavirus infected patients: COVID-19, SARS-CoV-1, MERS-CoV and lessons from the past. J Clin Virol. 2020 Jun;127:104362.
9. Gong J, Ou J, Qiu XP, et al. A tool to early predict severecoronavirusdisease2019(COVID-19): amulticenterstudyusingtherisknomograminWuhanandGuangdong,China.2020. medRxiv.
10. Grasselli G, Zangrillo A, Zanella A, Antonelli M, Cabrini L, Castelli A, et al. Baseline characteristics and outcomes of 1591 patients infected with SARS-CoV-2 admitted to ICUs of the Lombardy Region, Italy. JAMA 2020; 323 : 1574-81.
11. Gupta N, Agrawal S, Ish P, Mishra S, Gaind R, Usha G, et al. Clinical and epidemiologic profile of the initial COVID-19 patients at a tertiary care centre in India. Monaldi Arch Chest Dis 2020; 90 : 193-6
12. Klok FA, Kruip MJ, van der Meer NJ, Arbous MS, Gommers DA, Kant KM, et al. Incidence of thrombotic complications in critically ill ICU patients with COVID-19. Thromb Res. 2020 Jul;191:145–7.
13. Letko M, Marzi A, Munster V. Functional as-sessment of cell entry and receptor usage for SARS-CoV-2 and other lineage B betacorona-viruses. Nat Microbiol. 2020 Apr;5(4):562–9.
14. Liu Y, Du X, Chen J, et al. Neutrophil-to-lymphocyte ratio as an independent risk factor for mortality in hospitalized patients with COVID-19. J Infect. 2020;81(1):e6 e12.https://doi.org/10.1016/j.jinf.2020.04.002.
15. M. H. Kang, S.-I. Go, H.-N. Song et al., “The prognostic impact of the neutrophil-to-lymphocyte ratio in patients with small-cell lung cancer,” British Journal of Cancer, vol. 111, no. 3, pp. 452–460, 2014. View at: Publisher Site | Google Scholar
16. Mahale N, Rajhans P, Godavarthy P, Narasimhan VL, Oak G, Marreddy S, et al. A retrospective observational study of hypoxic COVID-19 patients treated with immunomodulatory drugs in a tertiary care hospital. Indian J Crit Care Med. 2020;24(11):1020–7. doi: 10.5005/jp-journals-10071-23599. DOI: [PMC free article] [PubMed] [CrossRef] [Google Scholar
17. Marietta M, Ageno W, Artoni A, De Candia E, Gresele P, Marchetti M, et al. COVID-19 and haemostasis: a position paper from Ital-ian Society on

Thrombosis and Haemostasis (SISET). Blood Transfus. 2020 May;18(3):167–9.
18. Qin C, Zhou L, Hu Z, et al. Dysregulation of immune response in patients with COVID-19 in Wuhan, China. Clin Infect Dis. 2020;71(15):762–8. https://doi.org/10.1093/cid/ciaa248.
19. R. Zahorec, "Ratio of neutrophil to lymphocyte counts—rapid and simple parameter of systemic inflammation and stress in critically ill," Bratislavske Lekarske Listy, vol. 102, no. 1, pp. 5–14, 2001. View at: Google Scholar.
20. Richardson S, Hirsch JS, Narasimhan M, Crawford JM, McGinn T, Davidson KW, et al. Presenting characteristics, comorbidities, and outcomes among 5700 patients hospitalized with COVID-19 in the New York city area. JAMA 2020; 323 : 2052-9.
21. Sagar S Maddani,1Nitin Gupta,2 Shashikiran Umakanth,3 Sowmya Joylin,4 and Kavitha Saravu 5 Neutrophil–Lymphocyte Ratio in Patients with COVID-19 as a Simple Tool to Predict Requirement of Admission to a Critical Care Unit.Indian J Crit Care Med. 2021 May; 25(5): 535–539. doi: 10.5005/jp-journals-10071-23801.
22. Sharma D, Dayama A, Banerjee S, Bhandhari S, Chatterjee A, Chatterjee D. To study the role of absolute lymphocyte count and RDW in COVID 19 patients and their association with appearance of symptoms and severity. J Assoc Physicians India. 2020;68(8):39–42. PMID: 32738839. [PubMed] [Google Scholar]
23. Shiv Lal Soni[1], Kamal Kajal[1], LN Yaddanapudi[1], Pankaj Malhotra[2], Goverdhan Dutt Puri[1], Ashish Bhalla[2], Mini P Singh[3], Inderpaul Singh Sehgal[4], Vipin Koushal[5], Neelam Varma[6], Manisha Biswal[7], P.V.M. Lakshmi[8], Sadhna Sharma[9], Vikas Suri[2], Z Deepy[9], Sant Ram[9], Jaivinder Yadav[10], Navin Pandey[5], Prashant Sharma[11], Nabhajit Malik[11], Kapil Goyal[3], Aseem Mehra[12], Swapnajeet Sahoo[12], Ritin Mohindra[2], Jijo Francis[1], Mudit Bhargava[2], Karan Singla[1], Preena Babu[1], Amiy Verma[1], Niranjan Shiwaji Khaire[2], RR Guru.Demographic & clinical profile of patients with COVID-19 at a tertiary care hospital in north India. Year : 2021 | Volume : 153 | Issue : 1 | Page : 115-125
24. Soni SL, Kajal K, Yaddanapudi LN, Malhotra P, Puri GD, Bhalla A, et al. Demographic and clinical profile of patients with COVID-19 at a tertiary care hospital in north India. Indian J Med Res. 2020 doi: 10.4103/ijmr.IJMR_2311_20. DOI: [PubMed] [CrossRef] [Google Scholar]
25. Spyropoulos AC, Levy JH, Ageno W, Con-nors JM, Hunt BJ, Iba T, et al.; Subcommittee on Perioperative, Critical Care Thrombosis, Haemostasis of the Scientific, Standardiza-tion Committee of the International Society on Thrombosis and Haemostasis. Scientific and Standardization Committee communica-tion: clinical guidance on the diagnosis, pre-vention, and treatment of venous thrombo-embolism in hospitalized patients with CO-VID-19. J Thromb Haemost. 2020 Aug;18(8):1859–65.
26. Thachil J, Cushman M, Srivastava A. A Pro-posal for Staging COVID-19 Coagulopathy. Res Pract Thromb Haemost. 2020 Jul 6;4(5):731–6.
27. The neutrophil to lymphocyte ratio is an independent predictor for severe COVID-19 Evidence from a multicenter case-control study and meta-analyses Jiangli Cheng, Aijia Ma, Jing Yang, Meiling Dong, Xuelian Liao, and Yan Kang Wien Klin Wochenschr. 2021; 133(17-18): 882–891. Published online 2021 Aug 3. doi: 10.1007/s00508-021-01917-9

28. Vaduganathan M, Vardeny O, Michel T, Mc-Murray JJ, Pfeffer MA, Solomon SD. Renin-Angiotensin-Aldosterone System Inhibitors in Patients with Covid-19. N Engl J Med. 2020 Apr;382(17):1653–9.
29. Verity R, Okell LC, Dorigatti I, Winskill P, Whittaker C, Imai N, et al. Estimates of the severity of coronavirus disease 2019: a model-based analysis. Lancet Infect Dis. 2020;20(6):669–677. doi: 10.1016/S1473-3099(20)30243-7. DOI: [PMC free article] [PubMed] [CrossRef] [Google Scholar]
30. Wrapp D, Wang N, Corbett KS, Goldsmith JA, Hsieh CL, Abiona O, et al. Cryo-EM struc-ture of the 2019-nCoV spike in the prefusion conformation. Science. 2020 Mar;367(6483):
31. YangAP,LiuJP,TaoWQ,LiHM.The diagnostic and predictive role of NLR, d-NLR and PLR in COVID-19 patients. Int Immunopharmacol. 2020;84:106504.
32. Zhang BC, Zhou X, Zhu CL, et al. Immune phenotyping based on neutrophil-to-lymphocyte ratio and IgG predicts disease severity and outcome for patients with COVID-19.2020. MedRxiv.
33. Zhou F, Yu , Du R, Fan G, Liu Y, Liu Z, et al. Clinical course and risk factors for mortality of adult inpatients with COVID-19inWuhan,China: A retrospectivecohortstudy.Lancet2020;395:105462.