



CORRELATION BETWEEN WHITE BLOOD CELL COUNT AND INFECTION SEVERITY IN PATIENTS

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ABSTRACT

The infectious diseases are one of the major causes of morbidity and mortality and the severity of infections must be assessed as early as possible to control the situation successfully. The most common and most available hematological parameter in the day to day practice is the count of the white blood cell (WBC) which reflects immune and inflammatory response of the body to infection. The current observational correlational study in the hospital was undertaken to determine the correlation between the number of WBCs and the severity of the infection in the patients. There were one hundred adult patients diagnosed with infections clinically. Clinical and lab parameters were used to assess the severity of the infection which included mild infection, moderate or severe infection. The number of WBC was determined by an automated hematology analyzer and the statistical analysis was done with descriptive statistics and Pearson correlation. The findings obtained showed a gradual rise in the mean WBC count in mild and severe infection with more variability in severe cases. The findings revealed that the number of WBC and the severity of infection had a close and statistically significant positive relationship ($r = 0.68, p < 0.001$). The results suggested that high WBC level is strongly related to the onset of the increasing severity of infections and could be utilized as a simple cost-effective and valid marker to determine and evaluate the severity of clinical infections in the medical practice.

Keywords: *White blood cell count, Infection severity, Leukocytosis, Hematological markers, Clinical assessment*



1. INTRODUCTION

The infectious diseases remain one of the major morbidities and mortality causes in the world and has remained an enormous burden to the health systems and particularly in the developing countries. The early diagnosis and correct evaluation of the level of infection are the key aspects in the commencing of the timely treatment course, avoidance of complications and the better patient treatment outcomes. The white blood cell (WBC) count is one of the most frequently used and readily available hematological tests in the daily clinical practice, among the other clinical and laboratory parameters in the assessment of infections.

White blood cells are the key players in the immune defense mechanism of the body. They play an active role in identifying, reacting and eradicating infectious bacteria, viruses, fungi and parasites. The circulation of leukocytes in the body changes quantitatively and qualitatively in the presence of an infection as a result of stimulation of the immune system. A rise in the number of WBC, leukocytosis, is frequently present in acute infections, inflammatory reactions, but persistently low levels may occur with severe or overwhelming infections, immunosuppression, or bone marrow dysfunction. Therefore, changes in WBC count indicate a physiological reaction of the body to an infectious stress.

Different factors influence the level of infection including type of the pathogen, the immune status of the host, comorbidity, and treatment. Incidentally, the severity of the infection is mild and self-limiting conditions to life-threatening disease states characterized by systemic inflammatory response, organ dysfunction, and sepsis. Proper measurement of the extent of infection is a key to covering clinical decision-making, including whether to hospitalize a patient, admit him to intensive care, and administer antimicrobial treatment intensively. Markers of laboratory, which are related to the severity of infections, thus, can be clinically useful in risk stratification and disease progression as well.

Several studies have linked that an elevation in the count of WBC is ascribed to elevation in severity of infection due to augmentation of inflammatory and immune reaction. The higher the intensity of infection, the more leukocytes are produced in the bone marrow and are released into the bloodstream with a resultant rise in WBC levels. The severity of this reaction between people can however differ with age, underlying health condition, and the competence of the immune system. Although the use of WBC count is common in the clinical scenario, the

correlation between its count on the basis of infection severity needs a systematic assessment in order to enhance its application as a good indicator of the disease severity.

The connection between the number of WBC and the severity of infection is of special interest in the settings with limited resources, where sophisticated diagnostic facilities might not be easily accessible. An easy, cheap, and regularly conducted examination like that of WBC count can assist the clinician to very early detect severe infections and direct the way to manage them. Consequently, investigation of the relationship between the severity of infection and the levels of white blood cells can help in better clinical evaluation, early intervention and patient outcomes.

The contemporary research objectively seeks to determine the existence or otherwise of a relationship between the number of white blood cells and the severity of an infection in patients, thus evaluating the clinical utility of WBC count to depict the severity of an infection and whether it can be used in the routine diagnosis and prognostic assessment of infectious diseases.

2. REVIEW OF LITERATURE

Marik and Stephenson (2020) used a massive data analysis to determine the predictive worth of procalcitonin, lactate, the white blood cell count, and neutrophil/ lymphocyte ratio in predicting bloodstream infection. Their analysis showed that white blood cell count was still a useful and easily accessible indicator in the diagnosis of infectious diseases, even though the predictive capacity of this indicator was greater when combined with other biomarkers, like procalcitonin and lactate. The authors found that high levels of WBC were typically linked to known bloodstream infection, which presented the persistence of clinical importance of hematological parameters in the evaluation of the severity of infection and systemic inflammatory reactions.

Rebulla (2019) reviewed the problems of pathogen elimination in platelets, red blood cells, and whole blood and discussed the consequences of this on the safety and hematology of transfusion. The paper has stressed the importance of infection and inflammatory situations that may affect blood constituents and include changes in the behavior and activity of leukocytes. The results highlighted the significance of comprehending the variations in the hematological changes, including the changes in white blood cell count, when assessing

infection and clinical judgment especially during the transfusion medicine and critical care practice.

Thomas et al. (2020) used the proteomic analysis to study the presence of structural protein damage and membrane lipid remodelling damage in the red blood cells of COVID-19 patients. Their results showed that there were critical changes in the structure of blood cells related to severe infection and systemic inflammation. The study did not focus on red blood cells as its main subject, but the evidence it has given confirms that severe infections cause extensive blood-based changes thus justifying the idea that the state of the white blood cell count provides information of the severity of the infectious and inflammatory situation. The present paper supported the role of hematological parameters in the severity and development of diseases during infectious conditions.

Yoshida, Prudent, and D'Alessandro (2019) researched the problem of lesions of storage of red blood cells, their origin, and potential clinical consequences. The aspects that were emphasized in their review were that the biochemical and structural changes in blood cells have the potential to modify immune and inflammatory responses especially in critical patients. The authors highlighted the importance of infection and systemic inflammation in hematological changes, supporting the topicality of blood-based parameters, such as the leukocyte dynamics, in the clinical outcomes and the severity of the disease.

Zhang et al. (2020) examined phenotypic alterations of morphological and inflammatory characteristics of peripheral blood monocytes in patients with COVID-19. Their investigation showed that infection resulted in significant changes in the morphology and the activated state of monocytes and these changes were closely associated with severity of the disease and patient outcomes. The results indicated that the parameters of the peripheral blood cells are a good indicator of the intensity of immune response and severity of infection, which would justify the increased application of hematological markers to assess the progression of infectious diseases.

Zhu et al. (2021) aimed at determining the relationship between the count of white blood cells at hospital admission and mortality among COVID-19 patients. The research found out that abnormal WBC count, especially high levels of WBC counts were associated with increased mortality rates. The authors made a conclusion that the count of WBC at admission was a

valuable prognostic factor, which showed that there is a strong correlation between the response of leukocytes and the level of infection. This research gave first-hand evidence of the clinical applicability of WBC count with regard to the bedside predictability of unfavourable outcomes in dangerous infectious diseases.

3. RESEARCH METHODOLOGY

The section represents the methodology design that should be applied to conduct the research on the connection between the number of white blood cells and the severity of infections in patients. It provides the research design, setting, population, sampling method, data collection method, and statistical methodology to be used to ensure that there is a systematic process of data collection, reliability of the findings, and that the research adheres to ethical standards in the research process.

3.1. Study Design

The observational correlational research design was used to examine the correlation between the number of white blood cells (WBC) and the level of infection in patients. The design was selected because it enables the evaluation of the extent and the direction of correlation between the hematological parameters and the clinical severity without any intervention as well as manipulation of variables.

3.2. Study Setting

The research was conducted in the Department of Medicine and Clinical Pathology of a teaching hospital of tertiary care. Inclusion of patients in the inpatient and outpatient departments was done in order to get a representation of the different levels of the severity of infection.

3.3. Study Population

The target population was the group of adult patients with a clinical diagnosis of infectious diseases, whose hematological research, including total white blood cell count, was recommended as a part of their diagnosing process.



3.4. Sample Size

The number of patients used in the study was 100. The sample size was calculated using the feasibility, availability of patients at the time of conducting the study, and the necessity to gather statistically significant correlation.

3.5. Sampling Technique

The convenience sampling method was used. All eligible patients who approached the study at the appropriate time and met the exclusion criteria were referred to the study until the necessary sample size was reached.

3.6. Inclusion and Exclusion Criteria

Investigated were patients aged 18 years and above who were diagnosed clinically to have infection and who underwent complete blood count test and gave informed consent to participate in the study. Exclusion was done in patients with known hematological disorders, autoimmune diseases, malignancies, receiving chemotherapy, immunosuppressive drugs, or corticosteroids, and pregnant women to exclude confounding factors on WBC count.

3.7. Variables of the Study

White blood cell count was regarded as the independent variable in this study and infection severity was regarded as the dependent variable. The possible confounding factors like age, sex, kind of infection, and comorbidity were also observed and put into consideration when analyzing.

3.8. Assessment of Infection Severity

The severity of the infection was measured on the basis of the complex of clinical findings and laboratory parameters. Body temperature, systemic signs as tachycardia and hypotension, signs of dysfunction of organs, need of hospitalization or intense care were factored. According to these criteria, patients were classified under mild, moderate or severe infection.

3.9. Data Collection Procedure

Informed consent was obtained in writing and demographic data and clinical data collected by using a structured data collection form. Aseptic blood samples were taken and examined on a

total WBC count by automated hematology analyzer. Clinical examination and medical records evaluation were the methods used by the treating physician to determine the severity of infection.

3.10. Statistical Analysis

Data collected was put in Microsoft Excel and analyzed by use of SPSS software. The characteristics of the patients and lab results were summarized using descriptive statistics such as frequency, mean, standard deviation, and percentage. The number of WBC and the severity of infections were correlated with the Pearson correlation coefficient. Value of P less than 0.05 was considered as a statistically significant value.

3.11. Ethical Considerations

This was done with the permission of the Institutional Ethics Committee. The informed consent of all participants was collected in written form before data collection. The information on the patients was kept confidential and anonymous and all the processes were conducted in compliance with the ethical standards.

4. RESULTS AND DISCUSSION

This section is the summary of the main findings of the research which presents demographic and clinical profile of patients, distribution of the infection severity, changes in the WBC count among the levels of infection severity and the correlation of the WBC count and the infection severity and its clinical meaning.

4.1. Demographic and Clinical Characteristics

The population of the study was predominantly middle-aged adults with a greater representation of male patients. The age and gender distribution mean that the infections were more prevalent among the individuals aged 31 to 50 years and males in the study environment. The demographic profile of the study population of 100 patients is as outlined in Table 1; the age distribution was given under the three groups of 18 years to 30 years, 31 to 50 years and above 50 years and the gender distribution was given in terms of frequency and percentage. Figure 1 presents the percentage distribution of such demographic characteristics graphically

to clearly illustrate the percentage distribution of the sample in each age group and the percentage distribution of male and female patients in the study population.

Table 1: Demographic Characteristics of the Study Population (N = 100)

Variable	Frequency	Percentage (%)
Age 18–30 years	22	22.0
Age 31–50 years	46	46.0
Age >50 years	32	32.0
Male	58	58.0
Female	42	42.0

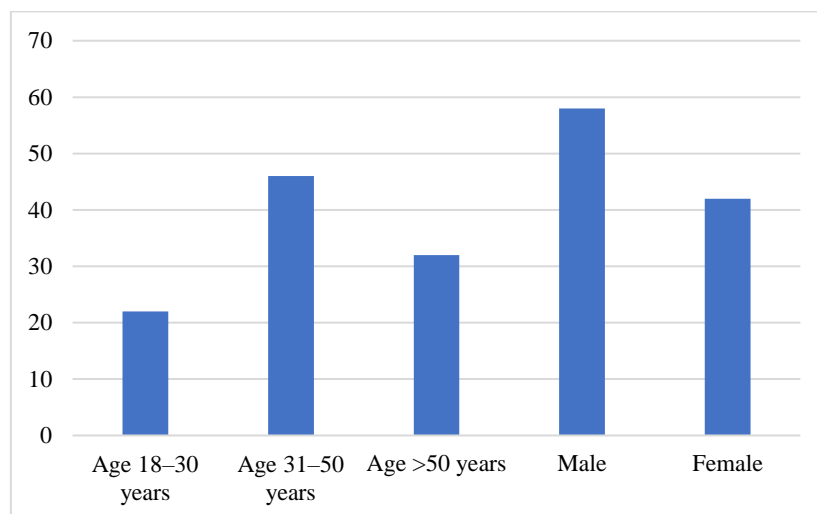


Figure 1: Graphical Representation of Percentage in Demographic Characteristics of the Study Population

The demographic study showed that the greatest percentage of patients was 31 years to 50 years old with 46 percent of total study population. It was then succeeded by the patients who were aged above 50 years (32%), and those in the 18 30 years age range (22%). Regarding the gender representation, the study population was higher among male people (58%), who were compared to females (42%). Figure 1 illustrates the tabulated data as graphically in order to

point out the overwhelming proportion of middle aged and male patients among the study population.

4.2. Distribution of Infection Severity

The majority of the patients were those of the moderate category of infection, and the mild and severe ones were equally spread, which means that there was a balanced representation among the levels of severity. Table 2 shows the distribution of patients based on the severity of the infection and the level of infection is arranged into mild, moderate and severe and the number of patients and interpretation of the percentage against each category. Figure 2 presents a graphical account of percentage distribution of patients with the various severity categories of infection giving a visual comparison of the percent cases in each severity category.

Table 2: Distribution of Patients According to Infection Severity

Infection Severity	Number of Patients	Percentage (%)
Mild	28	28.0
Moderate	44	44.0
Severe	28	28.0

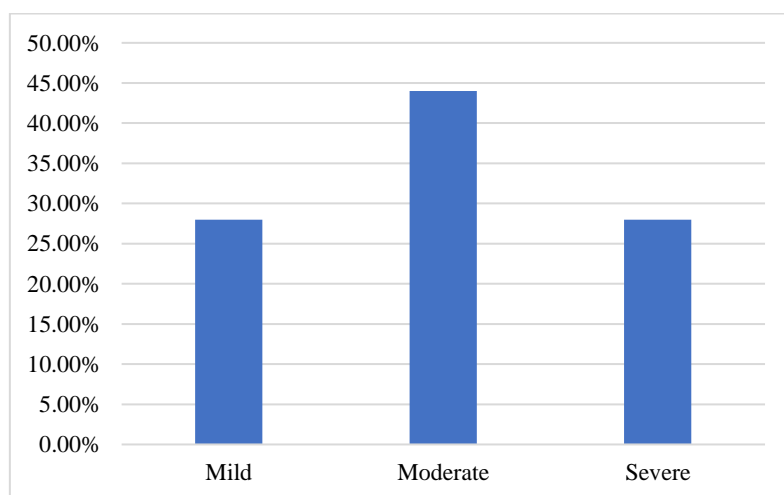


Figure 2: Graphical Representation of Percentage in Distribution of Patients According to Infection Severity

The patients were distributed in terms of the severity of infection and it was established that the largest percentage of patients was in the moderate category of infection and this was 44 percent of the entire population of the study. There were 28% mild and severe groups of infection. This pattern is well depicted in the graphical representation in Figure 2 with moderate infections among the patients that have been included in the study.

4.3. White Blood Cell Count Across Infection Severity

WBC level rises gradually in the range of mild to severe infection with more variation at extreme level of infection, which is a good indicator of the relationship between high WBC level and severity of infection. Table 3 indicates the mean number of white blood cells (WBC) and standard deviation of the number of WBCs of the patients who were categorised according to the severity of the infection i.e. mild, moderate and severe. The table is the summary of the central tendency and variability of the WBC counts in each of the severity groups. Figure 3 shows the graphical representation of the standard deviation of the number of WBC in the different types of infection severity, and graphically provides the level of variability of the values of WBC between the groups.

Table 3: Mean WBC Count According to Infection Severity

Infection Severity	Mean WBC Count (cells/mm ³)	Standard Deviation
Mild	8,450	1,120
Moderate	11,980	1,540
Severe	16,750	2,130

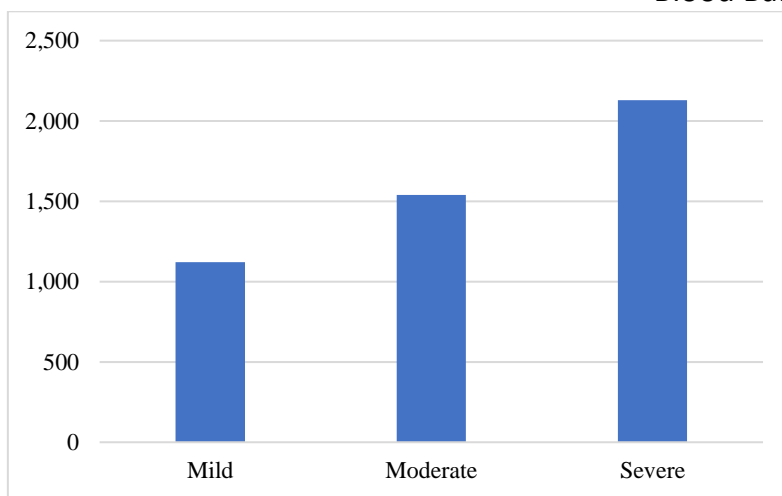


Figure 3: Graphical Representation of Standard Deviation WBC Count According to Infection Severity

These findings depict the unambiguous and progressive rise in the number of white blood cells (WBC) as the severity of infections escalates. The mean WBC count of patients with mild infection was 8,450 cells/mm³ as compared to patients with moderate infection which had higher mean WBC count of 11,980 cells/mm³. Patients of severe infection had the largest average count of WBC of 16,750 cells/mm³. Besides the increase in the mean values, standard deviation also changed to 2,130 in severe cases compared to 1,120 in mild cases indicating the standard deviation was higher in severe infections as compared to mild infections. These results demonstrate that high WBC number is closely linked to the severity of an infection and could be used as a good hematological marker to evaluate the clinical severity of an infectious disease.

4.4. Correlation Between WBC Count and Infection Severity

Correlation analysis indicates that the relationship between the count of WBC and the severity of infection is positive and statistically significant indicating that the higher the degree of infection the higher the degree of the WBC counts. The outcome is worth the clinical relevance of WBC count as an important and reliable data to assess the severity of the infection in a patient. The results of the correlation analysis that was conducted to determine the relationship between the number of the white blood cell (WBC) and the magnitude of infection are presented in Table 4. The table comprises Pearson correlation coefficient (r) and the p-value

that was employed to determine the degree, direction, and statistical significance of the relationship between the two variables.

Table 4: Correlation Analysis Between WBC Count and Infection Severity

Variables	Pearson Correlation (r)	p-value
WBC count vs Infection severity	0.68	<0.001

The correlation has revealed that the number of WBC has a strong positive relation with the severity of infection with a Pearson correlation coefficient of 0.68. The p-value was found to be less than 0.001 and it implies that the correlation found was statistically significant. The outcome indicates that the greater severity the infection, the higher the level of WBC count are and justifies the use of WBC count as a good indicator to determine the level of infection in a patient.

4.5. Discussion of Findings

Demographic results of the given study show that the infection was more prevalent in the middle-aged adult population, especially the age group of 31 to 50 years, and more prevalent in male patients. This trend can be explained by a higher occupational exposure, lifestyle circumstances, and higher healthcare seeking behavior among this age group. The moderate severity rate of infections is indicative of the fact that the majority of patients came to the hospital with clinically significant infections that needed medical care, which is characteristic of a tertiary care institution. The equal number of mild and severe cases also supports the validity of the comparison between comparisons of various severity types.

The results of the study indicate that there is a definite and progressive increment in the number of white blood cells as the severity of infection increases, which indicates the significance of the number of white blood cells as an important indicator of inflammatory response in the body. The positive correlation between the infection severity and the WBC count is high and statistically significant ($r = 0.68$, $p < 0.001$), which proves that high leukocyte counts are strongly correlated with more severe infections. Also, the rise in the range of variability in the number of WBC in severe cases indicates the heterogeneity of immune responses in patients.



In general, the study findings support the clinical usefulness of WBC count as a simple, relatively inexpensive, and readily available hematological value in the measurement and management of the severity of infections in the everyday clinical environment.

5. CONCLUSION

The present research finds that the relationship between the number of white blood cells and the severity of infection among patients is positive and has a significant statistical correlation. The results proved the progressive rise of mean WBC count between mild and severe infections with a higher variation rate among severe cases, which indicates the enhanced and diverse immune response. The high degree of correlation ($r = 0.68$, $p < 0.001$) proves the fact that high WBC count is directly related to the worsening of the infection and promotes it as a good hematological variable to be used in clinical evaluation. Considering its simplicity, low cost, and regular access, WBC count can be successfully used as an initial assessment, risk assessment, and follow-up of an infectious disease patient, especially in a limited health care facility.

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