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Correlating RDW, hematocrit, and neutrophil to lymphocyte ratio with patient outcomes in dengue: A retrospective hospital-based study

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Abstract

Introduction: Dengue is a major public health problem worldwide, with clinical presentations ranging from mild fever to severe hemorrhagic manifestations. Early detection and monitoring of hematological parameters can play a crucial role in patient management and outcome prediction. This study aimed to explore the correlations between Red Cell Distribution Width (RDW), Hematocrit, and Neutrophil Lymphocyte Ratio (NLR) with the clinical outcomes of dengue to identify potential predictive biomarkers.

Material and Methods: The retrospective analysis was conducted with 150 dengue patients admitted to Saveetha Medical College. Data collected included demographic information, clinical symptoms, laboratory results at admission (RDW, Hematocrit, NLR), and patient outcomes (recovery, complications, mortality). Statistical analyses utilized Pearson's correlation coefficient to evaluate the relationship between laboratory parameters and clinical outcomes.

Results: The study found significant correlations between the laboratory parameters and patient outcomes. Elevated RDW and Hematocrit were associated with lower recovery rates and higher complication and mortality rates. Similarly, increased NLR correlated negatively with recovery and positively with both complications and mortality. These findings suggest that RDW, Hematocrit, and NLR can serve as important prognostic markers in dengue.

Conclusions: The correlations between these hematological parameters and patient outcomes underscore their potential utility in predicting the severity of dengue. Such insights could help in early risk stratification and targeted management of patients with severe dengue.

Keywords: Dengue, red cell distribution width, ns1 antigen, hematocrit, neutrophil to lymphocyte ratio

Introduction

Dengue infection remains a substantial health burden globally, particularly in tropical and subtropical regions. As one of the most prevalent mosquito-borne viral diseases, dengue presents in a wide spectrum of severity, ranging from mild flu-like symptoms to severe forms such as dengue hemorrhagic fever (DHF) and dengue shock syndrome (DSS), both of which can lead to significant morbidity and mortality ^[1]. Early diagnosis and prompt clinical assessment are vital for effective management and mitigation of severe outcomes. Blood biomarkers play a pivotal role in the clinical management of dengue ^[2]. Parameters like Red Cell Distribution Width (RDW), Hematocrit, and the Neutrophil to Lymphocyte Ratio (NLR) are crucial. RDW, which measures the size variability of red blood cells, can indicate inflammation and stress in the bone marrow. An elevated RDW in dengue can suggest a worse prognosis or alert to the onset of complications such as capillary leakage, which is a hallmark of severe dengue. Hematocrit levels are equally critical; a rapid rise often precedes dengue shock, serving as a warning sign for immediate intervention. Meanwhile, NLR is an emerging marker of systemic inflammation, and its elevation could indicate a severe immune response, potentially correlating with worse outcomes in dengue patients ^[3].

Despite the acknowledged importance of these markers, there remains a significant gap in the literature specifically correlating these parameters with patient outcomes in the context of dengue. Most existing studies have been confined to general infectious or inflammatory

conditions, with less focus on dengue [4]. This gap highlights a critical need for focused research to validate and quantify the prognostic value of RDW, Hematocrit, and NLR specifically in dengue patients. Such research could lead to better predictive models and risk stratification tools that can be used in routine clinical practice to anticipate disease progression and tailor interventions accordingly [5].

Earlier studies have provided a foundation for this research; for instance, Sahassananda *et al.* (2021) demonstrated the utility of Hematocrit in predicting mortality in critical care settings [6], while Koundinya *et al.* (2021) examined NLR as a marker for dengue infection severity [7]. By extending these insights to dengue, this study hopes to add valuable knowledge to the field, addressing the current research gap and potentially improving outcomes for dengue patients worldwide.

The aim of this study is, therefore, to investigate these correlations in a retrospective hospital-based setting, examining historical data to assess the predictive value of these blood markers for dengue outcomes. By understanding these relationships, the study could significantly contribute to the clinical management of dengue, aiding in the early identification of patients at risk for severe manifestations and guiding therapeutic decisions.

Materials and Methods

Study Design and Setting

This retrospective study was conducted at the Department of Microbiology, Saveetha Medical College. A total of 150 patient records were analyzed in this study. The study aimed to correlate key hematological parameters (RDW, Hematocrit, and NLR) with patient outcomes in individuals diagnosed with dengue. The study was approved by the Institutional Review Board (IRB) of Saveetha Medical College.

Inclusion criteria included confirmed dengue infection by NS1 antigen and/or IgM antibody tests, age 18 years and above, and complete available laboratory data at admission and throughout hospitalization.

Data Collection

Data included demographic information (age, gender), clinical

symptoms at admission, laboratory test results (including RDW, Hematocrit levels, and NLR), treatment details, and outcomes (recovery, complications, mortality).

Laboratory Methods

Red Cell Distribution Width (RDW), Hematocrit, and Neutrophil to Lymphocyte Ratio (NLR) were measured as part of routine hematological assessments conducted upon patient admission and monitored throughout their hospital stay. These tests were performed using standard automated hematological analyzers within the hospital's microbiology department laboratory.

Statistical Analysis

Statistical analysis was carried out using SPSS software (version 25.0). Descriptive statistics were used to summarize the demographic and clinical characteristics of the study population. The correlations between RDW, Hematocrit, NLR, and patient outcomes were assessed using Pearson's correlation coefficient for continuous variables and chi-square tests for categorical variables. A p-value of less than 0.05 was considered statistically significant.

Results

Table 1: Results of NS1 Antigen and IgM Antibody Tests

| Test | Positive | Negative | Positive Frequency (%) |
|-------------------|----------|----------|------------------------|
| NS1 Antigen Test | 100 | 50 | 66.7% |
| IgM Antibody Test | 85 | 65 | 56.7% |

Table 1 shows that out of 150 patients with NS1 Antigen tested, 100 tested positive for the NS1 antigen, which is generally detectable during the acute phase of the infection. This indicates that a significant portion of the cohort was tested during the early stages of the disease. Whereas, the IgM antibody test had 85 positive results, suggesting that these patients were likely in a later stage of infection or had a secondary infection. IgM antibodies typically appear within 3-5 days after the onset of illness and can last for about 30 to 90 days.

Table 2: Demographic Characteristics of Study Participants

| Demographic Parameter | Value | Description |
|--------------------------|----------|--|
| Number of Patients | 150 | Total number of patients in the study |
| Mean Age | 35 years | Average age of the study participants |
| Standard Deviation (Age) | 12 years | Variability in age among participants |
| Gender: Male | 90 (60%) | Number and percentage of male participants |
| Gender: Female | 60 (40%) | Number and percentage of female participants |

Table 2 presents the demographic characteristics of the 150 patients included in the study. The average age of the study participants is 35 years, with a standard deviation of 12 years, indicating a relatively wide age range among the patients. This variability suggests the study encompasses a diverse group of adults, which could help in understanding how dengue affects different age groups. Regarding gender distribution, the study cohort consists of 90 male patients and 60 female patients, representing 60% and 40% of the total study population, respectively. This male predominance might reflect the specific demographics of the area where the study was conducted or possibly differential exposure to dengue vectors. Overall, the demographic data provide a foundation

for analyzing the impact of age and gender on dengue infection outcomes within this specific population.

Table 3: Clinical Symptoms at Admission of Study Participants

| Clinical Symptom | Mean (SD) or Frequency (%) |
|------------------------|----------------------------|
| Fever Temperature (°C) | 38.5 (±0.8) |
| Headache | 120 (80%) |
| Muscle Pain | 110 (73.3%) |
| Joint Pain | 105 (70%) |
| Rash | 45 (30%) |
| Vomiting | 75 (50%) |

Table 3 outlines the clinical symptoms observed at admission among the 150 study participants, providing both quantitative and percentage data for each symptom. The average body temperature recorded at admission was 38.5 °C, with a standard deviation of 0.8 °C, indicating a typical fever range associated with dengue infection and moderate variability among patients. A significant majority of the patients reported experiencing headaches (80%), muscle pain (73.3%), and joint pain (70%), reflecting some of the most common symptoms of dengue, which include severe aches that are often referred to as "break-bone" pain due to their intensity. Additionally, 50% of the patients experienced vomiting, another symptom that can accompany dengue as part of the gastrointestinal impact of the virus. Rash, which is another symptomatic manifestation of dengue, was reported in 30% of the cases. This lower incidence of rash compared to other symptoms might be due to its occurrence in specific phases of the disease or its less frequent documentation.

Table 4: Laboratory Test Results at Admission of Study Participants

| Laboratory Parameter | Mean | Standard Deviation (SD) |
|----------------------|-------|-------------------------|
| RDW | 14.8% | 0.9% |
| Hematocrit | 45% | 5% |
| NLR | 3.2 | 1.1 |

Table 4 provides a summary of key laboratory test results at the time of admission for the 150 study participants, detailing the mean values and standard deviations for each parameter. The Red Cell Distribution Width (RDW) recorded an average of 14.8% with a standard deviation of 0.9%. RDW is a measure of the variation in size among red blood cells; a higher RDW can indicate greater diversity in cell size, which is often associated with various types of anemia and systemic inflammation. In the context of dengue, an elevated RDW may suggest a disruption in hematopoiesis or increased inflammation.

The Hematocrit value, which measures the proportion of blood volume occupied by red blood cells, averaged at 45% with a standard deviation of 5%. In dengue patients, hematocrit is a crucial indicator to monitor as an increase can signal hemoconcentration, a common complication of severe dengue that can lead to dengue hemorrhagic fever or shock if not appropriately managed.

The Neutrophil to Lymphocyte Ratio (NLR), with a mean of 3.2 and a standard deviation of 1.1, is used as a marker of systemic inflammation. In dengue, an elevated NLR may indicate a more severe inflammatory response, potentially correlating with more severe disease manifestations or complications.

Table 5: Treatment Details and Patient Outcomes

| Treatment/Outcome Parameter | Mean (SD) or Frequency (%) |
|-----------------------------|----------------------------|
| Intravenous Fluids (liters) | 3.0 (±1.5) |
| Hospital Stay (days) | 6.5 (±2.3) |
| Analgesics Usage | 135 (90%) |
| Antipyretics Usage | 140 (93.3%) |
| Recovery | 140 (93.3%) |
| Complications | 10 (6.7%) |
| Mortality | 3 (2%) |

Table 5 summarizes the treatment details and outcomes for 150 dengue patients, highlighting treatment practices and effectiveness. Patients received an average of 3.0 liters of

intravenous fluids, reflecting significant fluid therapy essential for managing dengue dehydration and circulatory stability. The average hospital stay was 6.5 days, indicating variability possibly tied to disease severity. High percentages of patients received analgesics (90%) and antipyretics (93.3%), crucial for managing pain and fever. Recovery rate stood at 93.3%, showcasing effective treatment outcomes for most patients. However, complications occurred in 6.7% of cases, and mortality was 2%, underscoring the potential severity of dengue and highlighting areas for potential clinical improvement. This data offers valuable insights into current treatment efficacy and patient recovery in dengue care.

Table 6: Correlation between Laboratory Parameters and Patient Outcomes

| Laboratory Parameter | Correlation with Recovery | Correlation with Complications | Correlation with Mortality |
|----------------------|---------------------------|--------------------------------|----------------------------|
| RDW | -0.45 | 0.30 | 0.25 |
| Hematocrit | -0.35 | 0.55 | 0.50 |
| NLR | -0.50 | 0.65 | 0.60 |
| NS1 Antigen | 0.10 | 0.20 | 0.15 |
| IgM Antibody | -0.05 | 0.25 | 0.20 |

Table 6 analyzes the correlations between various laboratory parameters and clinical outcomes in dengue patients. RDW, Hematocrit, and NLR all show significant correlations with recovery, complications, and mortality, indicating their utility in predicting disease severity. Higher RDW and Hematocrit are associated with lower recovery rates and higher rates of complications and mortality, suggesting their involvement in severe systemic inflammation and hemoconcentration, common in serious dengue cases. NLR, also negatively correlated with recovery and positively with complications and mortality, highlights its role as a marker of systemic inflammation. In contrast, NS1 Antigen and IgM Antibody, while essential for confirming dengue infection, show weaker correlations with clinical outcomes, suggesting that while they are reliable for diagnosis, they are less predictive of disease progression and severity. This information underscores the importance of these parameters in clinical assessments, potentially guiding more targeted interventions for patients at risk of severe outcomes.

Discussion

Dengue fever, caused by the dengue virus (DENV), is a mosquito-borne disease that has become a major global public health concern. According to the World Health Organization (WHO), there are approximately 390 million dengue infections each year, with about 96 million manifesting clinically [8].

The present study provides a detailed overview of the demographic characteristics, clinical symptoms, laboratory results, treatment details, and outcomes of dengue patients, as well as the correlations between laboratory parameters and clinical outcomes. Each data yields important insights into the epidemiology, clinical management, and potential prognostic markers for dengue, which are discussed in depth below, compared with findings from earlier studies. The demographic data with a mean age of 35 years and a slight male predominance reflects findings from studies like those by Kosasih *et al.*, who observed a similar age distribution and a higher incidence of dengue in males, potentially due to greater exposure or behavioral factors (9). The clinical

symptoms reported at admission including high fever, severe headache, muscle and joint pain, which are characteristic of dengue as noted by Htun *et al.*, underline the typical presentation of the disease. This data is crucial for clinicians to promptly recognize and diagnose dengue, reducing the risk of severe complications through early intervention^[10].

The laboratory results highlight RDW, Hematocrit, and NLR as significant indicators of disease severity. High RDW and Hematocrit levels have been associated with increased severity and risk of mortality in dengue, corroborating with the findings by Sahassananda *et al.*^[6]. These markers indicate hemoconcentration and potential complications such as dengue hemorrhagic fever, as suggested by the correlations with patient outcomes. Moreover, NLR's strong negative correlation with recovery and positive correlations with complications and mortality align with its established role as an inflammation marker in viral infections, including dengue, as found in the research by Koundinya *et al.*^[7].

The treatment details reflect standard dengue management protocols, emphasizing fluid replacement and symptom management with analgesics and antipyretics, which align with WHO guidelines^[11]. The high recovery rate of 93.3% illustrates effective clinical management, although the presence of complications and a mortality rate of 2% highlight the potential for severe outcomes, consistent with the global dengue burden reported by Guzman and Harris^[12].

The correlation analysis provides a deeper understanding of how specific laboratory parameters can guide clinical decisions. The negative correlations of RDW, Hematocrit, and NLR with recovery and their positive correlations with complications and mortality suggest these could serve as early indicators of adverse outcomes, aiding in the stratification of patients based on risk. This is supported by similar studies, such as those by Jyothi *et al.*, which have emphasized the prognostic value of these parameters in managing dengue^[13].

Comparatively, our findings reinforce and expand upon earlier research by quantitatively demonstrating the utility of specific hematological markers in predicting the clinical course of dengue^[14]. The consistency of these results with prior studies not only validates our methods but also suggests potential areas for further research, particularly in refining treatment protocols and developing predictive models for dengue severity based on readily available laboratory results.

Conclusion

This study emphasizes the crucial role of early and precise diagnostics, particularly NS1 antigen and IgM antibody tests, in dengue management. Laboratory findings such as elevated RDW, Hematocrit, and Neutrophil to Lymphocyte Ratio (NLR) were significantly correlated with patient outcomes, highlighting their value in predicting disease severity. These markers are particularly effective in identifying patients at risk of severe complications and mortality, underscoring the need for their integration into routine clinical assessments. Additionally, expanding the demographic scope to include pediatric and older populations could provide insights into age-specific responses to dengue infection and treatment, further refining patient care strategies across all age groups.

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