

Research Article

Utilization of Scatter gram Patterns in the Mindray BC-6800 Hematology Analyzer for Early Diagnosis of Dengue Infection: A Novel Automated Analyzer-Based Study

Dr. Tanusha Ethamakula^{1*}, Dr Shreni Vipparthi², Dr Srikanth Reddy Kamireddy³, Dr. Sai Sudha M.⁴

^{1*,2,3}Assistant Professor, Department of Pathology, Rangaraya Medical College, Kakinada, Andhra Pradesh, India.

⁴Associate Professor, Department of Pathology, Sree Balaji Medical College and Hospital, Bharath Institute of Higher Education and Research (BIHER), Chennai, Tamil Nadu, India.

Corresponding Author: Dr. Tanusha Ethamakula

Assistant Professor, Department of Pathology, Rangaraya Medical College, Kakinada, Andhra Pradesh, India.

Email: drtanusha.ethamakula@gmail.com

Received: 22.05.26, Revised: 26.06.26, Accepted: 31.07.26

ABSTRACT

Background: Dengue is a rapidly emerging mosquito-borne viral infection that poses a major public health challenge in tropical countries. Early diagnosis is crucial for timely supportive management and prevention of complications. Automated hematology analyzers provide scatter gram patterns that may serve as valuable adjuncts for the early identification of dengue infection. This study aimed to evaluate lymphocyte scatterogram patterns generated by the Mindray BC-6800 hematology analyzer in laboratory-confirmed dengue cases and assess their association with severe thrombocytopenia.

Methods: This retrospective observational study was conducted at Sree Balaji Medical College and Hospital, Chennai, India. Patients presenting with acute febrile illness between September and November 2021 with laboratory-confirmed dengue infection by NS1 antigen and/or anti-dengue IgM/IgG serology were included. Hematological parameters, including platelet count, and lymphocyte scatter gram patterns obtained from the Mindray BC-6800 automated hematology analyzer were analyzed.

Results: A total of 102 patients with confirmed dengue infection were included. Eighty (78.4%) patients demonstrated atypical lymphocytosis with varying degrees of thrombocytopenia. A characteristic figure-of-eight lymphocyte scatter gram pattern was consistently observed in patients with atypical lymphocytosis and severe thrombocytopenia. This distinctive pattern was absent in patients without significant hematological abnormalities and served as an early indicator of severe dengue-related changes.

Conclusion: The figure-of-eight scatter gram pattern identified on the Mindray BC-6800 analyzer is a promising laboratory marker associated with atypical lymphocytosis and severe thrombocytopenia in dengue infection. Recognition of this characteristic pattern may facilitate early clinical suspicion, expedite confirmatory testing, and support timely initiation of appropriate patient management. Further prospective multicentre studies are warranted to validate its diagnostic and prognostic utility.

Keywords: Dengue, Scatter Gram, Mindray Bc-6800, Atypical Lymphocytes, Thrombocytopenia, Automated Hematology Analyzer.

INTRODUCTION

Dengue fever is caused by the dengue virus, a member of the *Flaviviridae* family, and is an endemic disease in India, particularly in the southern states.¹ The virus is transmitted primarily through the bites of infected *Aedes aegypti* and *Aedes albopictus* (tiger mosquito).¹ Based on the infecting serotype and host

immune response, dengue virus infection is classified into four serotypes (DENV-1 to DENV-4), which can manifest as dengue fever, dengue hemorrhagic fever (DHF), or dengue shock syndrome (DSS).² Conventional laboratory diagnosis of dengue includes viral isolation in cell culture, serological assays, detection of NS1 antigen, and viral RNA

amplification using reverse transcriptase-polymerase chain reaction (RT-PCR).³

In Tamil Nadu, India, dengue cases increase predominantly during the monsoon and post-monsoon seasons, particularly between June and September, with a marked rise in the number of reported cases during the 2021 outbreak.⁴ Early diagnosis is essential for timely clinical management and prevention of severe complications associated with dengue infection. Peripheral blood smear examination and dengue serology, together with automated hematological analysis, play an important role in the diagnosis and monitoring of dengue infection. Hematological abnormalities such as thrombocytopenia, leukopenia, and atypical lymphocytosis are commonly observed in affected patients. Reactive (atypical) lymphocytes are characteristic of several viral infections, particularly infectious mononucleosis and dengue, and their increased numbers have been associated with disease severity.^{5, 6}

Automated hematology analyzers provide valuable information beyond routine blood cell counts by generating white blood cell (WBC) scatter grams that reflect changes in leukocyte morphology and distribution. Correlation of platelet count, WBC parameters, and scatter gram findings may facilitate the early identification of dengue infection. Therefore, the present study aimed to evaluate the scatter gram patterns generated by the Mindray BC-6800 automated hematology analyzer and investigate their association with atypical lymphocytosis and severe thrombocytopenia in laboratory-confirmed dengue patients.

MATERIALS AND METHODS

Study Design and Setting

This retrospective observational study was conducted in the Department of Pathology, Sree Balaji Medical College and Hospital, Chennai, Tamil Nadu, India. The study included patients presenting with acute febrile illness between September 2021 and November 2021 who were subsequently diagnosed with laboratory-confirmed dengue infection. A total of 102 patients were enrolled during the study period.

Study Population

Patients with laboratory confirmed dengue infection diagnosed by NS1 antigen and/or anti-dengue IgM/IgG serological tests were included. Demographic details, including age and sex, along with clinical findings, serological

reports, hematological parameters, platelet counts, and white blood cell (WBC) scatter gram images, were retrieved retrospectively from hospital records.

Inclusion and Exclusion Criteria

Only laboratory-confirmed dengue cases with severe thrombocytopenia (platelet count $<50,000/\mu\text{L}$) and complete hematological data were included in the study. Patients with chronic kidney disease, chronic liver disease, autoimmune disorders, hematological or solid organ malignancies, those recovering from dengue infection, and dengue-positive patients with platelet counts $>50,000/\mu\text{L}$ were excluded to minimize potential confounding factors affecting hematological parameters and scattergram patterns.

Hematological and Scatter gram Analysis

Complete blood count analysis was performed using the Mindray BC-6800 automated hematology analyzer. The instrument underwent routine internal quality control and periodic calibration every six months according to the manufacturer's recommendations. Hematological parameters, particularly platelet count, total leukocyte count, and lymphocyte characteristics, were recorded. White blood cell scatter grams were carefully reviewed to identify abnormalities associated with atypical lymphocytosis. Particular emphasis was placed on the presence of the characteristic figure-of-eight scatter gram pattern observed in patients with severe thrombocytopenia. The scatter gram findings were correlated with hematological parameters to evaluate their potential role as an early laboratory marker for severe dengue infection.

Statistical Analysis

Data were entered into Microsoft Excel and analyzed using IBM SPSS Statistics version 25.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean $\pm$ standard deviation or median (interquartile range), while categorical variables were presented as frequencies and percentages. Associations between scatter gram patterns and hematological parameters were assessed using appropriate statistical tests, with a p-value <0.05 considered statistically significant.

RESULTS

Patient Characteristics

A total of 102 laboratory-confirmed dengue patients were included in the study. All cases

were positive for dengue serology (NS1 antigen and/or anti-dengue IgM/IgG). The majority of patients (96/102; 94.1%) were younger than 40 years, while 6/102 (5.9%) were aged 40 years or above. There was a male predominance, with 62 (60.8%) males and 40 (39.2%) females.

Hematological Findings

All included patients had severe thrombocytopenia (platelet count <50,000/ μ L) and demonstrated atypical lymphocytosis on peripheral blood smear examination. Scatterogram analysis generated by the Mindray BC-6800 automated hematology analyzer was performed for all cases. A characteristic figure-of-eight lymphocyte scatterogram pattern was consistently observed in patients with atypical lymphocytosis and severe thrombocytopenia.

Platelet Count Distribution

Among the 102 patients, 94 (92.2%) had platelet counts ranging from 20,000 to 50,000/ μ L, while 8 (7.8%) had platelet counts

<20,000/ μ L. notably, all patients in both platelet count groups demonstrated the characteristic figure-of-eight scatterogram pattern. Of the eight patients with platelet counts below 20,000/ μ L, four (50%) also exhibited leukopenia, indicating more severe hematological involvement.

Peripheral Smear and Scatter gram Findings

Peripheral blood smear examination revealed reactive (atypical) lymphocytosis in all cases. Patients with platelet counts of approximately 30,000/ μ L and 20,000/ μ L showed prominent atypical lymphocytes with deeply basophilic cytoplasm, consistent with viral infection. Corresponding scatter grams generated by the Mindray BC-6800 analyzer demonstrated a distinctive figure-of-eight configuration in the lymphocyte region, which was consistently associated with atypical lymphocytosis and severe thrombocytopenia. This pattern was observed across all laboratory-confirmed dengue cases included in the study.

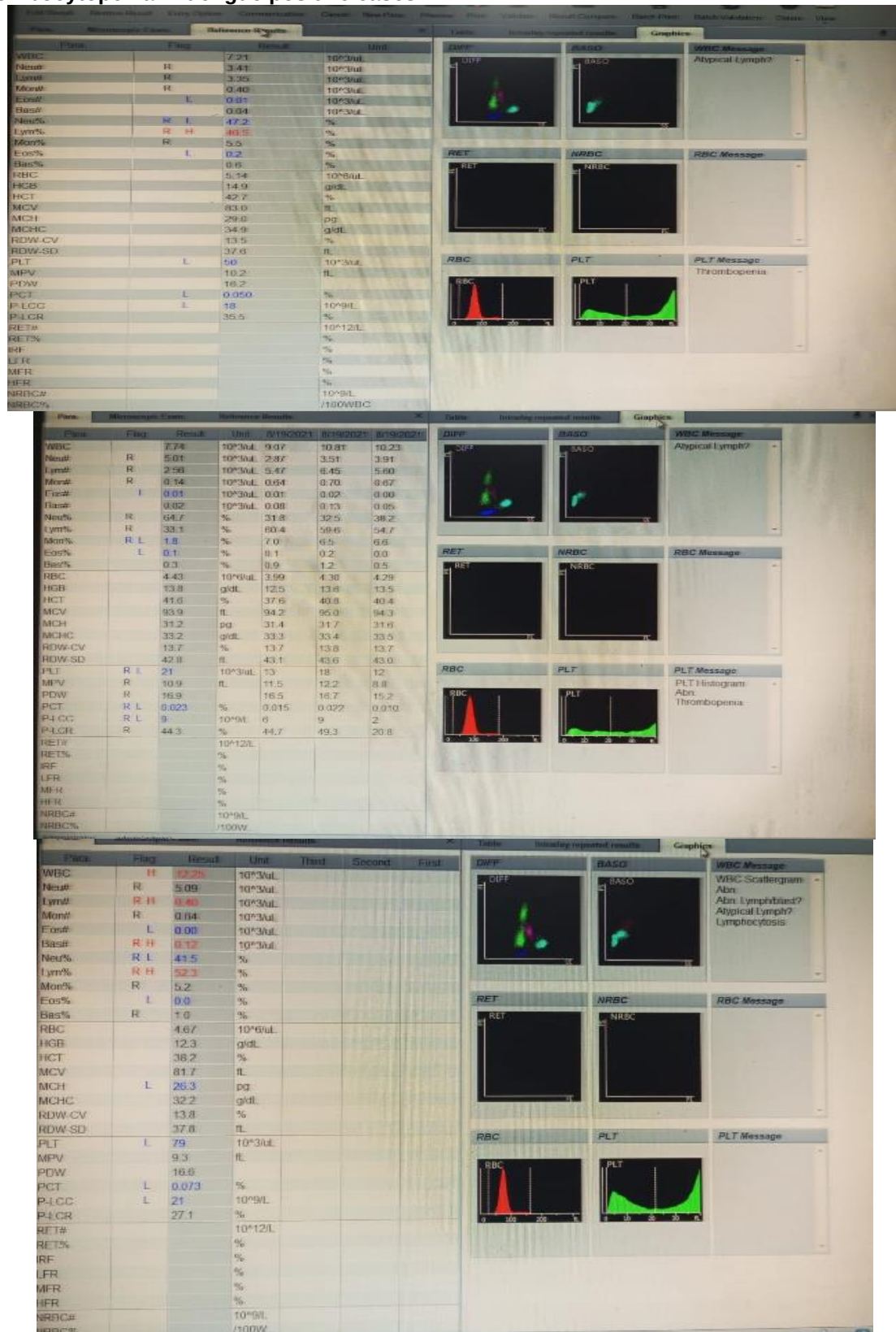
Table 1. Demographic Characteristics of the Study Population

Characteristic	Number of Cases (n=102)	Percentage (%)
Age <40 years	96	94.1
Age $\geq$ 40 years	6	5.9
Male	62	60.8
Female	40	39.2

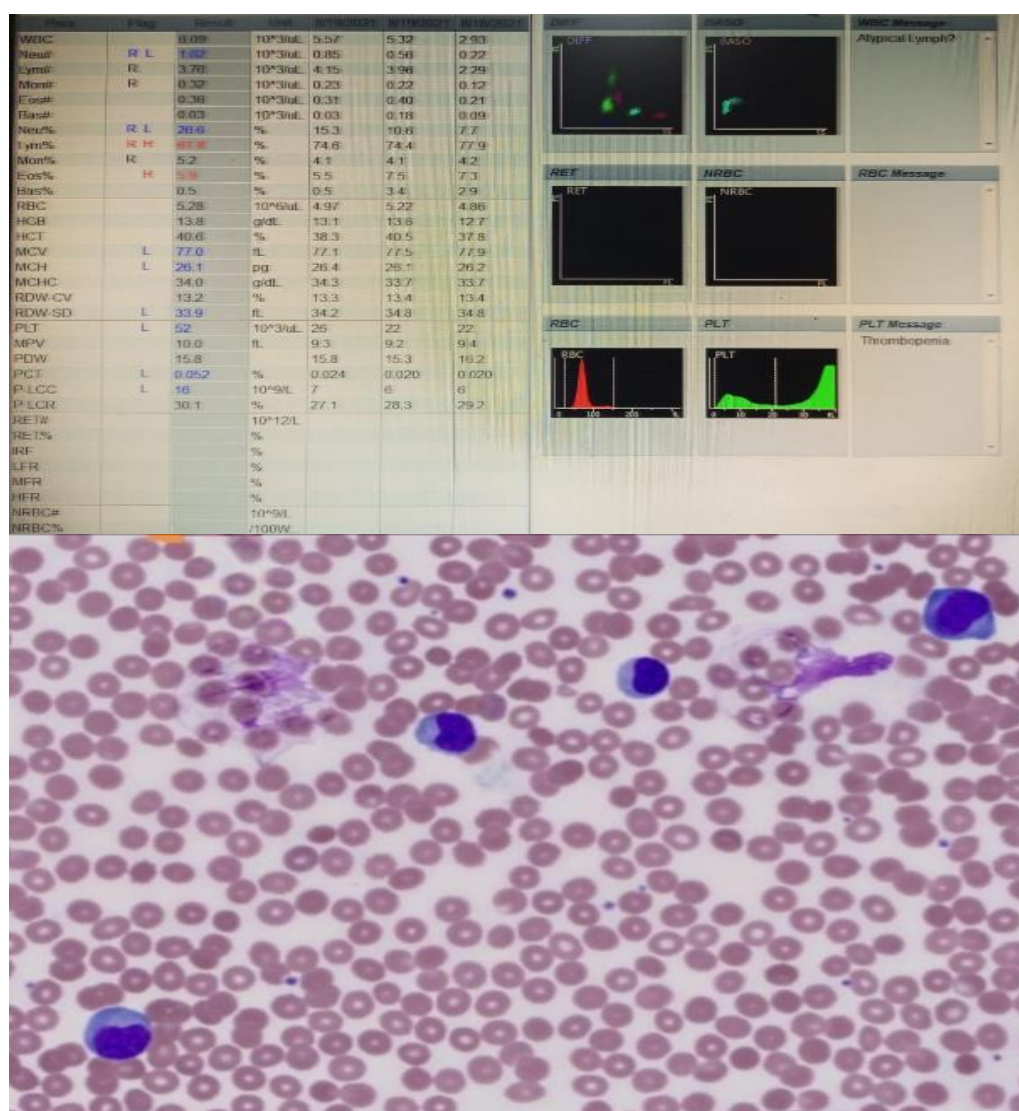
Table 2. Platelet Count Distribution and Scatterogram Findings

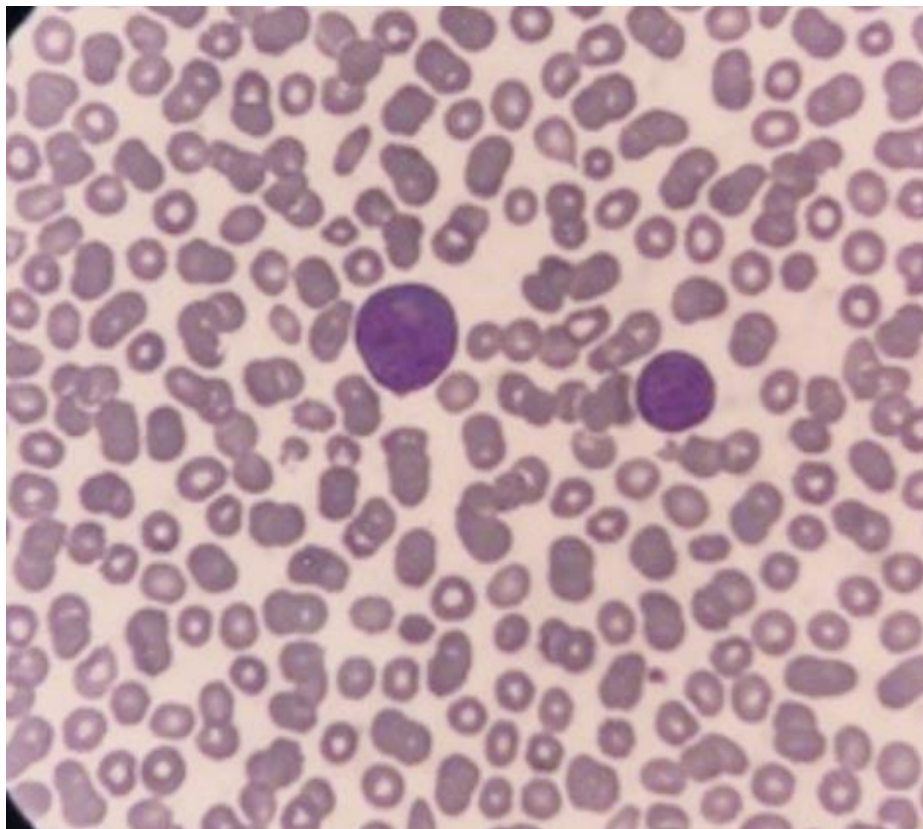
Platelet Count	Number of Cases	Figure-of-Eight Scatterogram	Additional Finding
20,000–50,000/ μ L	94	94 (100%)	Atypical lymphocytosis
<20,000/ μ L	8	8 (100%)	Four cases also had leukopenia

Scatter gram pictures associated with high atypical lymphocyte count and severe thrombocytopenia in dengue positive cases



Dr. Tanusha Ethamakula et al / Utilization of Scatter gram Patterns in the Mindray BC-6800 Hematology Analyzer for Early Diagnosis of Dengue Infection: A Novel Automated Analyzer-Based Study





DISCUSSION

Early identification of dengue infection is essential because its clinical presentation frequently overlaps with other acute febrile illnesses such as malaria, scrub typhus, leptospirosis, and coronavirus disease (COVID-19). Early recognition enables prompt supportive management and reduces the risk of severe complications. In the present study, a characteristic figure-of-eight scatter gram pattern generated by the Mindray BC-6800 automated hematology analyzer was consistently observed in laboratory-confirmed dengue patients with atypical lymphocytosis and severe thrombocytopenia ($<50,000/\mu\text{L}$), suggesting that scatter gram analysis may serve as a useful adjunctive laboratory marker for early detection of severe dengue.

Atypical (reactive) lymphocytosis is a well-recognized hematological feature of viral infections, particularly dengue, and reflects activation of the host immune response. Previous studies have demonstrated that reactive lymphocytes increase during the acute phase of dengue infection and gradually decline during recovery, making them a useful indicator of disease activity. Examination of buffy coat smears and peripheral blood films has also shown a significant association between atypical lymphocyte counts and dengue

infection.⁵⁻⁸ In the present study, all patients demonstrated atypical lymphocytosis on peripheral smear, which corresponded with the characteristic figure-of-eight scatter gram pattern. The prominence of this pattern increased with the degree of atypical lymphocytosis, suggesting that alterations in lymphocyte morphology contribute to the observed scatter gram changes.

Most patients in the present study were younger than 40 years, with a predominance of male patients. Similar demographic findings have been reported in previous epidemiological studies from India, where dengue predominantly affects young adults during seasonal outbreaks.^{1,4} The majority of patients were diagnosed during the acute phase of illness with positive NS1 antigen, either alone or in combination with anti-dengue IgM antibodies, reflecting the high diagnostic utility of these serological markers.³

Besides thrombocytopenia, several patients also demonstrated leukopenia, neutropenia, lymphocytosis, and elevated hematocrit. These hematological abnormalities have been extensively described in dengue infection and are considered important indicators of disease severity. Plasma leakage resulting from endothelial dysfunction and cytokine-mediated vascular permeability contributes to

hemoconcentration and elevated hematocrit observed in severe dengue.^{2,9}

Oehadian et al. reported that high fluorescent lymphocyte count (HFLC), atypical lymphocyte percentage (AL%), immature granulocyte count, and immature platelet fraction (IPF) are useful parameters for differentiating dengue from leptospirosis and enteric fever.⁹ Similarly, studies have shown that IPF can predict platelet recovery in dengue-associated thrombocytopenia.¹⁰ Our findings complement these observations by demonstrating that a distinctive figure-of-eight scatter gram pattern is consistently associated with atypical lymphocytosis and severe thrombocytopenia. Since scatter grams are generated automatically during routine complete blood count analysis, recognition of this pattern requires no additional laboratory procedures or cost and may provide an early alert to clinicians while awaiting confirmatory serological results. The present study has certain limitations. It was conducted at a single tertiary care center using a retrospective design with a relatively small sample size. Furthermore, patients with other causes of acute febrile illness were not included for comparison, limiting assessment of the specificity of the observed scatter gram pattern. Future prospective multicentre studies involving larger cohorts and comparative analysis with other viral and bacterial infections are required to validate the diagnostic and prognostic significance of the figure-of-eight scatter gram pattern.

REFERENCES

1. World Health Organization. Comprehensive guidelines for prevention and control of dengue and dengue haemorrhagic fever. Revised and expanded edition. New Delhi: WHO Regional Office for South-East Asia; 2011. Available from: http://apps.searo.who.int/pds_docs/B4751.pdf. Accessed December 7, 2019.
2. Back AT, Lundkvist Å. Dengue viruses—An overview. *Infect Ecol Epidemiol*. 2013;3:19839. doi:10.3402/iee.v3i0.19839.
3. Parkash O, Shueb RH. Diagnosis of dengue infection using conventional and biosensor-based techniques. *Viruses*. 2015;7(10):5410-5427. doi:10.3390/v7102877.
4. Lopez D, Sharma A, Murugesan V. Deep learning model to predict the outbreak of dengue in Tamil Nadu based on human mobility. *Int J Infect Dis*. 2020. doi:10.1016/j.ijid.2020.09.948.
5. Jampangern W, Vongthoung K, Jittmittraphap A, et al. Characterization of atypical lymphocytes and immunophenotypes of lymphocytes in patients with dengue virus infection. *Asian Pac J Allergy Immunol*. 2007;25(1):27-36.
6. Mehta RC, Goswami HM, Katara RK, et al. Importance of complete blood count and peripheral smear examination in early diagnosis of dengue patients. *J Infect Dis Lett*. 2013;2:22-26.
7. Thisyakorn U, Nimmannitya S, Ningsanond V, Soogarun S. Atypical lymphocytes in dengue hemorrhagic fever: Their value in diagnosis. *Southeast Asian J Trop Med Public Health*. 1984;15(1):32-36.
8. Jayaram A, Mathew NS, Nair SC. High fluorescent lymphocyte cell count and scattergram patterns on the Sysmex XN series cell counters: Novel parameters in early and reliable diagnosis of dengue on a background of acute febrile illness. *Int J Lab Hematol*. 2021;43(5):e214-e217.
9. Oehadian A, Michels M, de Mast Q, et al. New parameters available on Sysmex XE-5000 hematology analyzers contribute to differentiating dengue from leptospirosis and enteric fever. *Int J Lab Hematol*. 2015;37(6):861-868.
10. Dadu T, Sehgal K, Joshi M, Khodaiji S. Evaluation of the immature platelet fraction as an indicator of platelet recovery in dengue. *Int J Lab Hematol*. 2014;36(5):499-504.