

Association between inverted neutrophil-to-lymphocyte ratio and laboratory-confirmed dengue among febrile patients in an endemic area of northern Peru

Gustavo Adolfo Vásquez-Tirado^{1,*}, Rosángela Judithi Fuentes-Muñoz², Edinson Dante Meregildo-Rodríguez³, Claudia Vanessa Quispe-Castañeda⁴

Abstract

Introduction: Dengue, a virus of the genus *Flavivirus* and family *Flaviviridae*, is an infectious disease that presents a clinical spectrum ranging from asymptomatic infection or febrile syndrome without alarm signs to severe dengue with critical alarm signs. This study aimed to determine whether the inversion of the neutrophil/lymphocyte ratio (INLR) is associated with dengue in adults with febrile syndrome in a reference hospital in northern Peru.

Materials and methods: A retrospective case-control study enrolled 150 patients aged > 15 years, who were admitted to the JAMO II-2 Tumbes Hospital, Peru, diagnosed with febrile syndrome, and treated between January 2018 and January 2022. We evaluated whether the INLR is associated with dengue diagnosis in patients admitted with febrile syndrome in an endemic area for the disease in northern Peru.

Results: Among the patients without dengue, four (8.0%) had INLR, while among those with dengue, 46 (92.0%) showed INLR, a significant risk factor for dengue according to multivariate analysis (OR 607.6; 95% CI 92.9 – 1023.9; $p < 0.001$). The pre-test probability was 30%, and the post-test probability was 96% (LR +: 49).

Discussion: INLR is associated with dengue in adult patients with febrile syndrome at a reference hospital in northern Peru.

Keywords: Dengue; neutrophil/lymphocyte ratio; associated factor; febrile syndrome

Asociación entre la inversión del ratio neutrófilo-linfocito y dengue confirmado por laboratorio en pacientes febriles de una zona endémica del norte del Perú.

Resumen

Introducción: El dengue, un virus del género *Flavivirus* y de la familia *Flaviviridae*, es una enfermedad infecciosa que presenta un espectro clínico que abarca desde la infección asintomática o el síndrome febril sin signos de alarma hasta el dengue grave con signos de alarma críticos. El objetivo de este estudio fue determinar si la inversión de la relación neutrófilos/linfocitos (INRL) es un factor asociado al dengue en adultos con síndrome febril, en un hospital de referencia del norte del Perú.

Materiales y métodos: Se realizó un estudio retrospectivo de casos y controles que incluyó a 150 pacientes mayores de 15 años, admitidos en el Hospital JAMO II-2 de Tumbes, Perú, con diagnóstico de síndrome febril y atendidos entre enero de 2018 y enero de 2022. Se evaluó si la INRL estaba asociada con el diagnóstico de dengue en pacientes admitidos con síndrome febril en una zona endémica de la enfermedad en el norte del Perú.

Resultados: Entre los pacientes sin dengue, 2 (2.0%) presentaron INRL, mientras que entre aquellos con dengue, 46 (92.0%) mostraron INRL. El análisis multivariado identificó a la INRL como un factor significativamente asociado al dengue (OR 607.6; IC 95%: 92.9–1023.9; $p < 0.001$). La probabilidad preprueba fue de 30% y la probabilidad posprueba de 96%, con una razón de verosimilitud positiva (LR+) de 49.

Discusión: La INRL es un factor asociado al dengue en pacientes adultos con síndrome febril en un hospital de referencia del norte del Perú.

Palabras clave: Dengue; relación neutrófilos/linfocitos; factor asociado; síndrome febril

1 Facultad de Medicina, Universidad Privada Antenor Orrego, Trujillo, Perú. <https://orcid.org/0000-0002-2109-6430>

2 Facultad de Medicina, Universidad Privada Antenor Orrego, Trujillo, Perú. <https://orcid.org/0000-0002-4315-7396>

3 Universidad Peruana Cayetano Heredia, Lima, Perú. <https://orcid.org/0000-0003-1814-5593>

4 Facultad de Medicina, Universidad Privada Antenor Orrego, Trujillo, Perú. <https://orcid.org/0000-0003-1522-9409>

* Autor para correspondencia:

Correo electrónico: gavt13@gmail.com

Recibido: 22/04/2026; Aceptado: 29/06/2026

Cómo citar este artículo: G.A. Vásquez-Tirado, *et al.* Association between inverted neutrophil-to-lymphocyte ratio and laboratory-confirmed dengue among febrile patients in an endemic area of northern Peru. *Infectio* 2026; 30(3): 247-252

Introduction

Dengue, a virus of the genus *Flavivirus* and family *Flaviviridae*, is an infectious disease that presents a clinical spectrum ranging from asymptomatic infection or febrile syndrome without alarm signs to severe dengue with critical alarm signs¹.

Globally, the incidence of dengue has increased. The World Health Organization (WHO) estimates 390 million dengue cases annually, with 96 million exhibiting clinical manifestations². In the Americas, dengue is the arboviral infection with the highest reported cases in 2023, totaling over 4.1 million new infections, with the highest cumulative incidence rates in the Southern Cone, with 1,049 cases per 100,000 inhabitants. Brazil reported the highest number of cases (2,909,404), followed by Peru (269,603)³.

Four serotypes have been identified, differing in genome structure, with variations between 25% and 40%. The virus enters the body through cutaneous exposure via the bite of an infected female *Aedes aegypti* mosquito. The virion immediately interacts with dermal cells, dendritic cells, macrophages, and mast cells, with the latter migrating to lymph nodes to activate the adaptive immune response within the first three days of symptoms, during which viremia peaks are the highest⁴.

The most commonly used diagnostic tests for dengue include viral genetic material detection, specific IgG and IgM antibody identification, and viral antigen detection such as the non-structural protein (NS1)^{5,6}.

Hematological parameters are essential for diagnosing and prognosticating the disease, with notable markers being reduced platelet levels and increased hematocrit levels. Additionally, leukopenia, resulting from bone marrow suppression, reduces neutrophil levels, whereas lymphocytosis becomes predominant from the onset of the disease and increases as the patient's condition progresses⁷.

The inversion of the neutrophil/lymphocyte ratio (NLR) is a hematological parameter that has shown significant predictive accuracy for differentiating and diagnosing dengue in the context of febrile syndrome with a high suspicion of the disease⁸⁻¹⁰.

Studies have noted INLR between days 3-5, preceding changes in hematocrit and platelets in most patients with dengue, marking the end of the febrile phase and the beginning of the critical phase (19,20). Higher NLR values are correlated with worse prognosis and possibly higher severity⁹.

This study aimed to evaluate INLR's role as an associated factor in predicting dengue diagnosis in patients with febrile syndrome, considering that in third-world countries, serological diagnostic tests for dengue are limited or scarce, and dengue remains endemic. This parameter could aid in differentiating between multiple infections presenting with febrile symptoms and numerous differential diagnoses.

Materials and methods

Study Design and Population

A retrospective case-control study was conducted by reviewing the medical records of patients from the José Alfredo Mendoza Olavarria Regional Hospital (JAMO-II), Tumbes, Peru. This hospital is a referral center in a city with a high rate of dengue diagnoses, considered an endemic area with an annual incidence rate (TIA) of 2.46 per 1,000 inhabitants in 2023. Data were collected from January 2018 to January 2022, and the manuscript was drafted following the STROBE guidelines.

Study Population and Sample

Inclusion criteria included patients over 15 years of age, of both sexes, with a diagnosis of febrile syndrome, admitted through the emergency department of JAMO-II Hospital in Tumbes, Peru. Based on the clinical symptoms and evaluation, laboratory and serological tests for dengue were ordered. Patients who tested serologically positive for dengue (NS1, IgM) formed the case group, while those who tested negative comprised the control group. Control patients underwent serological testing for other endemic diseases (malaria, leptospirosis, bartonellosis, Zika, and chikungunya). Complete blood counts, hematocrit, transaminases, glucose, creatinine, and urea tests were performed for all patients, with follow-ups as required. The sampling method was non-probabilistic. The sample size was calculated using the single-proportion formula, considering an expected dengue prevalence of 15.5% among patients with acute febrile illness in Tumbes, Peru¹¹. With a 95% confidence level, 5% absolute precision, and a Z-value of 1.96, the minimum sample size was 150 patients.

Data and Variables

A database was created with information from the medical records of patients in the emergency and internal medicine services of JAMO-II who met the inclusion criteria and were admitted between January 2018 and July 2022. Clinical and biochemical variables were collected, including NLR values from days 6-9 of symptom onset.

Exposure Variable

In this study, INLR was defined as a neutrophil-to-lymphocyte ratio <1 ⁹. Complete blood count results used to calculate the INLR were selected based on the number of days from symptom onset, restricting the analysis to samples collected between the 6 and 9 of illness. Complete blood count was processed using an automated hematology analyzer⁹.

Outcome Variable

Dengue infection confirmed by serological tests for NS1 and IgM antigens, regardless of severity¹².

Covariables

Clinical variables, such as age, sex, and comorbidities (type 2 diabetes mellitus -T2DM-, hypertension, and chronic kidney disease), as established in the medical record); demographic variables, such as residence in the main districts of Tumbes, Peru; and laboratory variables, including complete

blood count, platelet count, hematocrit, creatinine, glucose, and transaminases (TGO and TGP).

Statistical Analysis

Variables were compiled into an Excel spreadsheet and subsequently analyzed using R Studio v. 4.2. Frequencies and percentages were calculated for categorical variables, and central tendency measures (median and interquartile range) were calculated for numerical variables lacking a normal distribution (Kolmogorov-Smirnov test). Bivariate analysis was performed between the collected variables (exposure and intervention) and the outcome (dengue diagnosis in febrile patients) using OR calculations and 95% CI, with p-values <0.05 considered significant. Multivariate analysis for dengue diagnosis was conducted using logistic regression on significant bivariate variables, with preconditions such as the absence of multicollinearity (VIF<10) and no interaction. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), positive likelihood ratio (LR+), and negative likelihood ratio (LR-) were calculated. Pre- and post-test probabilities were computed using Fagan's nomogram to evaluate the INLR as a strong predictive variable for dengue diagnosis in febrile patients with >10% disease prevalence.

Ethical Aspects

The ethical principles of the Declaration of Helsinki were observed. This study was approved by the Ethics Committee of the Universidad Privada Antenor Orrego (UPAO) and the Ethics Committee of JAMO-II Hospital. Owing to the nature of the study, no consent document was required for data collection.

Results

A total of 175 medical records were reviewed for adult patients admitted to the emergency department of JAMO-II Hospital with febrile syndrome. Of these, 25 did not meet the inclusion or exclusion criteria. Convenience sampling continued until 50 patients with febrile syndrome tested positive for dengue serology (cases), and 100 patients with negative dengue serology formed the control group. The evaluation period included patients who were treated between January 2018 and January 2022.

General Characteristics of the Population

Of the total patients with febrile syndrome, those diagnosed with dengue had a lower median age than those without (27.5; 95% CI 15 – 95 vs. 51.0; 95% CI 18 – 80; $p<0.05$). Females predominated in the non-dengue group (53%, $n=53$) compared to the dengue group (50 %, $n = 25$), with no significant differences ($p>0.05$). Most febrile patients diagnosed with dengue originated from the Tumbes district, representing 80% ($n=40$) of the dengue cases and 81% ($n=81$) of the non-dengue cases, with no significant differences in geographical origin related to dengue diagnosis ($p>0.05$). Concerning comorbidities, T2DM, hypertension, and CKD were more frequent in non-dengue patients, at 53%, 32%, and 17%, respectively, compared to 4%, 3%, and 0% in dengue patients, with statistically significant differences ($p<0.05$). Biochemical variables such as hematocrit, creatinine, AST, and ALT levels

were higher in dengue patients than in non-dengue patients, with statistically significant differences ($p<0.05$). See Table 1.

Bivariate and Multivariate Analysis

Upon evaluating INLR presence around the sixth day after symptom onset, 92% ($n=46$) of serologically positive dengue patients showed INLR compared to only 2% ($n=2$) in non-dengue patients, indicating a highly significant association in bivariate analysis (crude OR 563.5; $p<0.001$), which was maintained in multivariate analysis (OR 607.6; $p<0.001$). Regarding comorbidities, dengue patients had a lower frequency of these conditions. The crude OR for T2DM was 0.07 (95% CI 0.02 – 0.21; $p<0.001$) and for HTN, 0.13 (95% CI 0.03 – 0.41; $p<0.01$), suggesting that comorbidities such as T2DM, hypertension, and CKD reduce the likelihood of dengue diagnosis in febrile patients; however, these associations lost significance in the multivariate analysis ($p>0.05$). Biochemical variables, such as AST and ALT, had higher median values in dengue cases than in controls, with AST levels significantly associated with dengue in the crude analysis (OR 1.006; 95% CI 1.002 – 1.01; $p<0.01$), though losing significance in mul-

Table 1. General characteristics of adult febrile syndrome patients in a reference hospital in northern Peru by dengue status

Variable	Dengue	
	Yes (n = 50)	No (n = 100)
Age (años)	27,5 (15 – 95)	51,0 (18 – 80)
Sex		
Female	25 (50,0%)	53 (53,0%)
Male	25 (50,0%)	47 (47,0%)
Origin		
Tumbes	40 (80,0%)	81 (81,0%)
Zarumilla	10 (20,0%)	16 (16,0%)
Contralmirante Villar	0 (0,0%)	2 (2,0%)
Pampa Grande	0 (0,0%)	1 (1,0%)
T2DM		
Sí	4 (8,0%)	53 (53,0%)
No	46 (92,0%)	47 (47,0%)
Hypertension		
Yes	3 (6,0%)	32 (32,0%)
No	47 (94,0%)	68 (68,0%)
CKD		
Sí	0 (0,0%)	17 (17,0%)
No	50 (100,0%)	83 (83,0%)
Hematocrito	34.0 (27.4 – 40.2)	40.5 (35.0 – 44.0)
Creatinin	1.1 (0.7 – 2.05)	0.8 (0.7 – 1.07)
TGO	62 (20.5 – 134.2)	53.5 (22.0 – 51.0)
TGP	31.0 (19.5 – 106.5)	40.0 (29.0 – 64.25)
INLR		
No	4 (8,0%)	98 (98,0%)
Yes	46 (92,0%)	2 (2,0%)

Numerical variables: median (P25-P75), Mann-Whitney U test, p-value <0.05 significant. Categorical variables: cOR (crude OR), p-value <0.05 significant.

tivariate analysis ($p > 0.05$). Hematocrit and creatinine levels also showed differences between the dengue and non-dengue groups but lacked statistical significance in the multivariate analysis. See Table 2.

INLR as a Predictor of Dengue in Febrile Patients

Multivariate analysis demonstrated a high association (OR 607.6; $p < 0.001$) for INLR as a dengue predictor in febrile patients. The pretest probability was 30% and the posttest probability was 96%, with a positive likelihood ratio (LR+) of 46 (95% CI 12–182) and posterior odds of 96% (95% CI 86%–99%). Without INLR, the negative likelihood ratio (LR-) was 0.08 (95% CI 0.03 – 0.21), and the posterior odds were 4% (95% CI 1%–10%). See Table 3 and Figure 1.

Discussion

This study aimed to determine whether INLR, as a hematological parameter, is associated with dengue in febrile patients at a reference hospital in northern Peru, where dengue is highly prevalent. The results show that INLR is indeed a significant predictor of dengue diagnosis (OR 607.6; $p < 0.001$; LR+ 49), aligning with the findings of Chaloeuwong et al.⁹, where neutrophil to lymphocyte ratios in dengue patients inverted between days six and nine, matching our observed timeframe. In their study, 154 patients were evaluated, with 30% ($n=46$) testing positive for the NS1 antigen. Among positive cases, hematocrit levels were elevated from days 3 to 10 compared to those in dengue-negative controls. The case group showed a lower leukocyte count, with decreasing neutrophils and increasing lymphocytes from day 6-9, displaying

INLR during this period.

Hematological parameters derived from the complete blood count, an accessible test in most healthcare facilities, may be useful for distinguishing dengue from other acute infections^{3,7,13}. Among these parameters, the neutrophil-to-lymphocyte ratio has been proposed as a complementary marker for differentiating infectious diseases, as it may reflect the temporal dynamics of the host immune response, with an initial neutrophil-predominant phase followed by relative lymphocyte predominance in later stages^{4,5,12,14,15}. Early neutrophil elevation may result from delayed neutrophil apoptosis and rapid mobilization from the bone marrow, whereas lymphocyte reduction may be related to redistribution toward sites of infection and immune activation, as well as increased lymphocyte apoptosis^{8,11,16,17}.

Although the neutrophil-to-lymphocyte ratio (NLR) has been associated with hematological alterations in several arboviral infections, including Zika, chikungunya, and dengue, its inversion (INLR) appears to be a more specific pattern in dengue than in other arboviral infections, as shown by previous studies and our results. Furthermore, NLR has been reported as a prognostic marker of dengue severity^{9,10,18,19}.

In endemic areas such as Tumbes, Peru, the initial clinical diagnosis of dengue represents a challenge because of the coexistence of multiple causes of acute febrile syndrome, including other arboviral infections and leptospirosis^{1,11,16,17}. Therefore, complete blood count-derived parameters may be useful as low-cost complementary tools to guide diagnosis.

Table 2. Bivariate analysis of variables associated with dengue presence.

Variable	Outcome: Dengue			
	cOR (IC 95%)	p	OR (IC 95%)	p
Age (years)	0.95 (0.93 – 0.97)	< 0,001	0.96 (0.91 – 1.03)	> 0.05
Gender				
Male	1,13 (0,57 – 2,22)	0,73	-	-
Femlae	Ref.	-	-	-
Origin				
Tumbes	1,07 (0,45 – 2,50)	0,88	-	-
Zarumilla	Ref.	-	-	-
Contralmirante Villar				
Pampa Grande				
T2DM				
Yes	0.07 (0.02 – 0.21)	< 0,001	0.22 (0.02 – 2.03)	> 0.05
No				
Hypertension				
Yes	0.13 (0.03 – 0.41)	< 0,01	7.9 (0.36 – 219.9)	> 0.05
No				
Hematocrit	1.11 (1.05 – 1.17)	< 0,001	0.96 (0.84 – 1.10)	> 0.05
Creatinin	0.36 (0.16 – 0.66)	< 0,01	0.44 (0.07 – 1.10)	> 0.05
TGO	1.006 (1.002 – 1.01)	< 0,01	1.004 (0.99 – 1.01)	> 0.05
TGP	1.003 (0.99 – 1.007)	> 0.05	-	-
INLR				
Si	563,5 (123,2 – 4404,1)	0,001	607.6 (92.9 – 1023.9)	< 0.001
No	Ref.	-	Ref.	-

Table 3. Validity indices of INLR as a predictor for dengue in febrile patients.

Neutrophil/ lymphocyte ratio (NLR)	Dengue		Total
	Positivo	Negativo	
Inverted	46	2	48
No Inverted	4	98	102
Total	50	100	150

Sensitivity: 92,0% (IC 95%: 80.77 - 97.78%)

Specificity: 98,0% (IC 95%: 92.96 - 99.76%)

Positive Predictive Value (PPV): 96,0% (IC 95%: 85.32 - 98.91%)

Negative Predictive Value (NPV): 96,0% (IC 95%: 90.55 - 98.43%)

tic suspicion at the primary care level. Among these parameters, inversion of the neutrophil-to-lymphocyte ratio, defined as an N/L ratio <1 , is biologically plausible in dengue, since the disease is associated with leukopenia, progressive neutrophil reduction, relative lymphocyte predominance, and appearance of atypical lymphocytes during the febrile and critical phases. Chaloeuwong et al.⁹ showed that in patients with acute fever, the neutrophil-to-lymphocyte ratio became inverted between days 6 and 9 in confirmed dengue cases, whereas it remained >1 among non-dengue febrile controls.

In this context, evaluating the association between inversion of the neutrophil-to-lymphocyte ratio and confirmed dengue among febrile patients in Tumbes is relevant because this region has active transmission, continuous epidemiological surveillance, and outbreaks reported by health authorities. The potential utility of this marker does not lie in replacing confirmatory tests such as NS1, RT-PCR, or IgM, but rather in providing an accessible hematological criterion to prioritize the suspicion of dengue over other febrile etiologies in endemic areas^{3,9,19}.

Significant comorbidities associated with INLR in dengue patients included T2DM, hypertension, and CKD, although they lost statistical significance in the multivariate analysis. In contrast, Issop et al.²⁰ noted higher INLR values in patients with diabetes and dengue. Hyperglycemia differentially affects neutrophils and lymphocytes, with elevated lymphocyte apoptosis and increased DNA oxidative damage reported in T2DM patients. Conversely, hyperglycemia reduces neutrophil apoptosis, thereby prolonging inflammation in diabetic mice. Elevated neutrophil counts could mediate insulin resistance through heightened inflammation, as evidenced by persistent neutrophil activation and increased neutrophil protease release in T2DM patients^{2,4,5,8}.

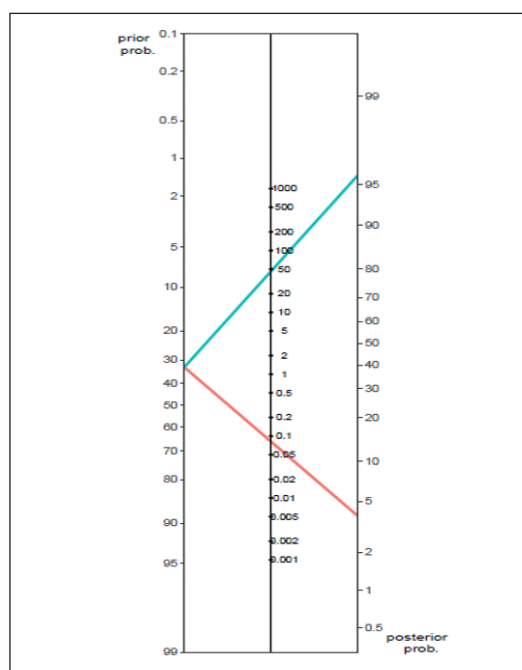
The NLR is associated with poor outcomes in various diseases, including hypertension, possibly reflecting vascular inflammation in patients with hypertension. Neutrophils release mediators such as elastase, myeloperoxidase, free oxygen radicals, and hydrolase enzymes, which are linked to tissue damage and plaque disruption, increasing hypertension risk²¹. Neutrophils may also release reactive oxygen species, contributing to oxidative stress, which plays a role in the pathogenesis of hypertension by inducing vasoconstriction and causing sodium and water retention in the kidneys^{2,11}.

For CKD, as an inflammatory condition, INLR reflects inflammation and independently predicts CKD progression. Neutrophils release chemotactic substances (e.g., interleukin-8), promoting neutrophil migration to the kidney, causing glomerular injury and ultimately glomerulosclerosis and reduced renal function. CD4+CD28 null T lymphocytes, indicative of systemic inflammation, are associated with an increased cardiovascular risk in CKD²².

Laboratory parameters such as hematocrit, creatinine, and AST levels were significantly associated with INLR in patients with dengue. Elevated hematocrit levels were found in only 30% of dengue patients, whereas 92% of them exhibited neutrophil/lymphocyte inversion. This finding aligns with that of Ishake et al., where the INLR preceded hematocrit and platelet changes¹⁶. Given the early INLR change in febrile dengue patients in endemic areas, this parameter may serve as a critical predictor of dengue diagnosis.

Higher serum creatinine levels in dengue patients mirrors the findings of Masset et al.²³, suggesting that dengue infection may involve a direct viral effect on the glomerular basement membrane, with cytokine release causing endothelial dysfunction and increased vascular permeability, elevating renal serum parameters such as creatinine. Further studies are needed to explore the renal effects of dengue on short- and long-term outcomes.

The association between TGO and NLR remains unclear in the literature; however, liver damage from dengue's inflammatory response releases AST into the bloodstream. Hepatic injury from dengue infection likely involves innate immune responses, with B, T, and NK cells contributing to viral control¹⁶.

**Figure 1.** Fagan nomogram showing pre-test probability of 30% and post-test probability of 96% for febrile patients with INLR.

Limitations

This study had some limitations. First, we were unable to evaluate the role of the INLR in predicting dengue severity because of the limited number of severe cases. Second, because this was a single-center study conducted in an endemic area, extrapolation of our findings to other settings, particularly non-endemic regions, should be performed with caution. Third, we did not perform analyses according to dengue serotype or severity grade; such analyses would have been informative in better characterizing the behavior of INLR across different virological and clinical subgroups. Finally, we did not report the specific etiologies of dengue-negative patients with acute febrile syndrome, as this information was not consistently available in the reviewed medical records. Therefore, some control patients may have had other arboviral infections or alternative infectious etiologies that could not be systematically identified in this study.

In conclusion, in endemic regions with limited diagnostic resources, the INLR serves as a strong predictive marker for dengue in febrile patients, supporting early diagnosis in areas where standard diagnostic tests are scarce or delayed.

Ethical considerations

Protection of persons and animals. The authors declare that no experiments were performed on humans or animals for the preparation of this case report.

Protection of vulnerable populations. Not applicable.

Confidentiality. The authors declare that institutional protocols regarding the management of clinical information and scientific publication were followed.

Privacy. The patient's identity was strictly protected; no names, initials, medical record numbers, or images enabling identification were included. Informed consent for publication of the case was obtained from the patient's relatives. In addition, approval from the institutional ethics committee was obtained, when applicable.

Financing. Own resources.

Conflict of interests. The authors have no conflict of interest to declare

Acknowledgments. None.

Statement on the use of artificial intelligence. The authors declare that no artificial intelligence tools were used in the preparation, writing, or editing of this manuscript.

Authors' contribution. Conceptualization, Methodology, Investigation, Writing – original draft: GAVT, RJFM, EDMR, CVQC. Writing – review & editing: GAVT, RJFM, CVQC. All authors contributed to read and approved the version of the submitted manuscript.

References

- Harapan H, Michie A, Sasmono RT, Imrie A. Dengue: A Minireview. *Viruses*. 2020;12(8):829. doi:10.3390/v12080829
- Pourzangiabadi M, Najafi H, Fallah A, Goudarzi A, Pouladi I. Dengue virus: Etiology, epidemiology, pathobiology, and developments in diagnosis and control - A comprehensive review. *Infect Genet Evol*. 2025;127:105710. doi:10.1016/j.meegid.2024.105710
- Ferede G, Tiruneh M, Abate E, et al. A study of clinical, hematological, and biochemical profiles of patients with dengue viral infections in Northwest Ethiopia: implications for patient management. *BMC Infect Dis*. 2018;18(1):616. doi:10.1186/s12879-018-3557-z
- Khan MB, Yang ZS, Lin CY, et al. Dengue overview: An updated systemic review. *J Infect Public Health*. 2023;16(10):1625-1642. doi:10.1016/j.jiph.2023.08.001
- Witte P, Venturini S, Meyer H, Zeller A, Christ M. Dengue Fever—Diagnosis, Risk Stratification, and Treatment. *Dtsch Arztebl Int*. 2024;121(23):773-778. doi:10.3238/arztebl.m2024.0175
- Uriol-Mantilla CL, Vasquez-Tirado GA. Ventilación espontánea en decubito prono en pacientes con infección por SARS Cov-2 sin ventilación mecánica invasiva. *Revista del Cuerpo Médico Hospital Nacional Almanzor Aguinaga Asenjo*. 2020;13(4):446-456. doi:10.35434/rcmhnaaa.2020.134.781
- da Costa VG, Marques-Silva AC, Moreli ML. A meta-analysis of the diagnostic accuracy of two commercial NS1 antigen ELISA tests for early dengue virus detection. *PLoS One*. 2014;9(4):e94655. doi:10.1371/journal.pone.0094655
- Kocyigit I, Eroglu E, Unal A, et al. Role of neutrophil/lymphocyte ratio in prediction of disease progression in patients with stage-4 chronic kidney disease. *J Nephrol*. 2013;26(2):358-365. doi:10.5301/jn.5000152
- Chaloemwong J, Tantiworawit A, Rattanathammethee T, et al. Useful clinical features and hematological parameters for the diagnosis of dengue infection in patients with acute febrile illness: a retrospective study. *BMC Hematol*. 2018;18(1):20. doi:10.1186/s12878-018-0116-1
- Ishaque N, Siddique MU, Imran A, Malik NA. Utilization of Neutrophil to Lymphocyte Ratio to Assess Recovery in Patients with Dengue. *Journal of Haematology and Stem Cell Research*. 2022;2(2):77-80.
- Tripul VG, Castro RLS, Castro ES, Aguilera RA. Factores demográficos y estacionales asociados a dengue, chikungunya y leptospirosis en pacientes con síndrome febril agudo en Tumbes, Perú: Predisposing factors associated with dengue, chikungunya and leptospirosis in patients with febrile syndrome in the department of Tumbes, Peru. *RICSA*. 2026;3(1):20-26. doi:10.57188/ricsa.2026.004
- Muller DA, Depelsenaire ACI, Young PR. Clinical and Laboratory Diagnosis of Dengue Virus Infection. *J Infect Dis*. 2017;215(suppl_2):S89-S95. doi:10.1093/infdis/jiw649
- Shiny A, Bibin YS, Shanthirani CS, et al. Association of neutrophil-lymphocyte ratio with glucose intolerance: an indicator of systemic inflammation in patients with type 2 diabetes. *Diabetes Technol Ther*. 2014;16(8):524-530. doi:10.1089/dia.2013.0264
- Issop A, Bertolotti A, Diarra YM, et al. Dengue clinical features and harbingers of severity in the diabetic patient: A retrospective cohort study on Reunion island, 2019. *Travel Med Infect Dis*. 2023;54:102586. doi:10.1016/j.tmaid.2023.102586
- Uno N, Ross TM. Dengue virus and the host innate immune response. *Emerg Microbes Infect*. 2018;7(1):167. doi:10.1038/s41426-018-0168-0
- Wang XJ, Wei HX, Jiang SC, He C, Xu XJ, Peng HJ. Evaluation of aminotransferase abnormality in dengue patients: A meta analysis. *Acta Trop*. 2016;156:130-136. doi:10.1016/j.actatropica.2015.12.013
- Kadadavar SS, Lokapur V, Nadig D, M PH, Masur D. Hematological parameters in dengue fever: A study in tertiary care hospital. Published online July 26, 2025. doi:10.18231/j.ijpo.2020.042
- Jayadas TTP, Kumanan T, Arasaratnam V, Gajapathy K, Surendran SN. The clinical profile, hematological parameters and liver transaminases of dengue NS1 Ag positive patients admitted to Jaffna Teaching Hospital, Sri Lanka. *BMC Res Notes*. 2019;12(1):604. doi:10.1186/s13104-019-4655-8
- Osuna-Ramos JF, Reyes-Ruiz JM, Ochoa-Ramírez LA, et al. The Usefulness of Peripheral Blood Cell Counts to Distinguish COVID-19 from Dengue during Acute Infection. *Trop Med Infect Dis*. 2022;7(2):20. doi:10.3390/tropicalmed7020020
- Issop A, Bertolotti A, Diarra YM, et al. Dengue clinical features and harbingers of severity in the diabetic patient: A retrospective cohort study on Reunion island, 2019. *Travel Med Infect Dis*. 2023;54:102586. doi:10.1016/j.tmaid.2023.102586
- Zhu T, Xiao X, Zhu X, Wang X. Hospitalised Dengue Patients and Risk of Hypertension: A Systematic Review and Meta-Analysis. *Rev Med Virol*. 2025;35(1):e70013. doi:10.1002/rmv.70013
- Lee IK, Lee NY, Huang WC, et al. In-hospital mortality predictors among hospitalized adults and those with chronic kidney disease with dengue. *Journal of Microbiology, Immunology and Infection*. 2023;56(5):996-1006. doi:10.1016/j.jmii.2023.08.004
- Masset C, Le Turnier P, Bressollette-Bodin C, Renaudin K, Raffi F, Dantal J. Virus-Associated Nephropathies: A Narrative Review. *International Journal of Molecular Sciences*. 2022;23(19):12014. doi:10.3390/ijms231912014