

# Hyperferritinaemia as an Independent Predictor of Clinical Severity and Prolonged Hospitalization in Children with Dengue Fever: A Retrospective Hospital-Based Analytical Study

Varghese Ashiq<sup>1</sup>, Vasudevan Jaishree<sup>2</sup>

<sup>1</sup>Department of Pediatrics, Chettinad Academy of Research and Education (CARE), Kelambakkam, Tamil Nadu, India (Corresponding Author)

<sup>2</sup>Department of Pediatrics, Chettinad Academy of Research and Education (CARE), Kelambakkam, Tamil Nadu, India

Received: 20th Apr, 2026 | Revised: 25th Apr, 2026 | Accepted: 9th May, 2026 | Available Online: 14th May, 2026

## ABSTRACT

**Background:** Dengue fever is a major cause of pediatric morbidity in endemic regions. Early identification of children at risk for severe disease is essential for timely intervention. Hyperferritinaemia, reflecting macrophage activation and systemic inflammation, has emerged as a potential marker of severity; however, its independent predictive value in pediatric dengue has not been adequately established.

**Objectives:** To evaluate hyperferritinaemia as an associated factor of clinical severity, intensive care requirement, and prolonged hospitalization in children with dengue fever.

**Methods:** This retrospective hospital-based analytical study was conducted in a tertiary care teaching hospital in South India between February and July 2025. Children aged 1 month to 16 years with laboratory-confirmed dengue infection were included. Serum ferritin levels measured during the critical phase of illness were analyzed. Associations between hyperferritinaemia ( $\geq 1000$  ng/mL), prolonged hospital stay ( $>5$  days), and Pediatric Intensive Care Unit (PICU) admission were assessed using logistic regression analysis.

**Results:** A total of 50 children were included. Hyperferritinaemia was present in 56% of patients. Serum ferritin levels showed a significant positive correlation with duration of hospitalization ( $r = 0.72$ ,  $p = 0.003$ ). Hyperferritinaemia was independently associated with prolonged hospital stay (Adjusted OR 3.92; 95% CI: 1.08–14.21;  $p = 0.037$ ). Although hyperferritinaemia was associated with PICU admission on univariate analysis, shock was the only associated factor after adjustment (Adjusted OR 6.72;  $p = 0.023$ ).

**Conclusion:** Hyperferritinaemia is independently associated with prolonged hospitalization in pediatric dengue and may serve as a useful biomarker for early risk stratification.

**Keywords:** Dengue fever; Hyperferritinaemia; Ferritin; Pediatric dengue; Potential marker of severity; Critical care

**How to cite this article:** Ashiq V, Jaishree V., Hyperferritinaemia as an Independent Predictor of Clinical Severity and Prolonged Hospitalization in Children with Dengue Fever: A Retrospective Hospital-Based Analytical Study. *Int J Drug Deliv Technol.* 2026;16(5): 829-836; DOI: 10.25258/ijddt.16.5.84

## Introduction

Dengue fever is one of the most important mosquito-borne viral infections affecting children in tropical and subtropical regions, including India.<sup>[1]</sup> The disease spectrum ranges from mild febrile illness to severe dengue characterized by plasma leakage, hemorrhage, and shock, which can result in significant morbidity and mortality. Early identification of children at risk for severe disease remains a major challenge in pediatric clinical practice.<sup>[2]</sup>

The pathogenesis of severe dengue involves complex immune activation, including macrophage stimulation and cytokine release.<sup>[3]</sup> Ferritin, an intracellular iron storage protein, is increasingly recognized as an acute-phase reactant and marker of systemic inflammation. Elevated ferritin levels reflect macrophage activation and immune dysregulation, both of which play key roles in dengue pathophysiology.<sup>[4]</sup>

Recent studies have suggested that hyperferritinaemia is associated with severe dengue, organ dysfunction,

# Hyperferritinaemia as an Independent Predictor of Clinical Severity and Prolonged Hospitalization in Children with Dengue Fever: A retrospective hospital-based analytical study.

and adverse outcomes. Monitoring these levels, particularly during the critical phase of the illness (typically days 4 to 6), can provide clinicians with a potential marker of severity to anticipate the need for intensive care and prolonged hospitalization. [5] However, data evaluating its independent predictive value in pediatric dengue, particularly in the Indian population, remains limited.

This study was conducted to evaluate hyperferritinaemia as an associated factor of clinical severity and prolonged hospitalization in children with dengue fever.

## Aim

To evaluate hyperferritinaemia as an associated factor of clinical severity and prolonged hospitalization in children with dengue fever.

## Objectives

1. To determine the prevalence of hyperferritinaemia in pediatric dengue.
2. To assess the association between serum ferritin levels and duration of hospitalization.
3. To evaluate the association between hyperferritinaemia and PICU admission.

## Methods

### Study Design and Setting

This retrospective hospital-based analytical study was conducted in the Department of Pediatrics, Chettinad Hospital and Research Institute, Kelambakkam, Tamil Nadu, India, from February 1 to July 31, 2025.

### Study Population

Children aged 1 month to 16 years admitted with laboratory-confirmed dengue infection (NS1 antigen or dengue IgM positive) were included.

### Inclusion Criteria

- Age 1 month to 16 years
- Laboratory-confirmed dengue infection
- Availability of complete clinical and laboratory records

### Exclusion Criteria

- Chronic inflammatory disorders
- Hemoglobinopathies
- Iron overload disorders
- Co-infection with other febrile illnesses

### Data Collection

Clinical and laboratory data were obtained from hospital medical records. Serum ferritin levels measured during hospitalization, particularly during days 4–6 of illness, were recorded.

Clinical outcomes recorded included:

- Duration of hospital stay
- PICU admission
- Shock
- Plasma leakage

Serum ferritin values were standardized by selecting the measurement closest to the critical phase (days 4–6 of illness). In patients with multiple measurements, the value nearest to defervescence was considered for analysis.

For temporal comparison (day 4 vs day 5), only children with serial ferritin measurements on both days were included, and paired analysis was performed. The number of such patients has been specified in the Results section.

### Definition

Hyperferritinaemia was defined as serum ferritin  $\geq 1000$  ng/mL. This cutoff was chosen based on previous studies evaluating hyperferritinaemia in dengue and hyperinflammatory conditions.

Prolonged hospitalization was defined as hospital stay  $> 5$  days, based on the mean duration of hospitalization observed in the study population.

### Statistical Analysis

Data was analyzed using SPSS version 27.

Continuous variables were expressed as mean  $\pm$  SD.

Categorical variables were expressed as frequency and percentage.

Logistic regression analysis was performed to identify associated factors.

Due to the limited sample size and number of outcome events, only clinically relevant variables with adequate event representation were included in multivariable models to minimize overfitting.

p value  $< 0.05$  was considered statistically significant.

### Ethical Approval

Ethical approval was obtained from the Institutional Ethics Committee of Chettinad Academy of Research and Education

## Results

### Baseline Characteristics

A total of 50 children with laboratory-confirmed dengue infection were included in the study. The mean age was  $10.5 \pm 3.5$  years. Males constituted 56% ( $n = 28$ ), and females 44% ( $n = 22$ ).

Hyperferritinaemia (serum ferritin  $\geq 1000$  ng/mL) was present in 56% ( $n = 28$ ) of children.

The mean duration of hospital stay was  $5.2 \pm 1.8$  days.

Twelve children (24%) required PICU admission.

# Hyperferritinaemia as an Independent Predictor of Clinical Severity and Prolonged Hospitalization in Children with Dengue Fever: A retrospective hospital-based analytical study.

**Table 1. Baseline Characteristics of the study population(n=50)**

Variable	Value
Age (years)	10.5 ± 3.5
Male	28 (56%)
Female	22 (44%)
Hyperferritinaemia	28 (56%)
Hospital stay (days)	5.2 ± 1.8
PICU admission	12 (24%)

### Serum Ferritin Levels

The overall mean serum ferritin level was 1850 ± 2450 ng/mL. Serial ferritin measurements (day 4 and day 5) were available in 23 children. Mean ferritin levels increased significantly from day 4 to day 5:

Day 4: 2180 ± 1152 ng/mL  
 Day 5: 2470 ± 1184 ng/mL  
 p = 0.043

The statistically significant rise between day 4 and day 5 indicates progressive immune activation during the critical phase of dengue (typically days 4–6). This dynamic increase supports the hypothesis that ferritin behaves as a temporal marker of inflammatory escalation rather than remaining static.

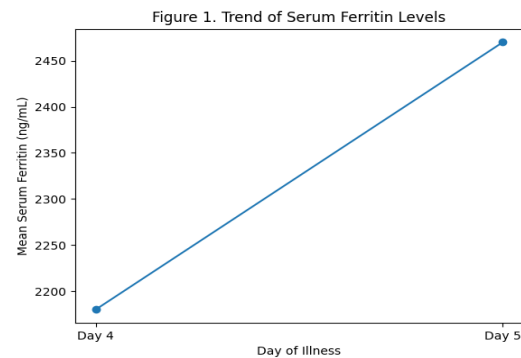
The upward trajectory during defervescence corresponds to the period when plasma leakage and shock typically manifest, suggesting pathophysiological relevance rather than incidental elevation.

**Table 2. Serum Ferritin Levels During Hospitalization**

Parameter	Mean Serum Ferritin (ng/mL)
Overall mean serum ferritin	1850 ± 2450
Day 4 of illness	2180 ± 1152
Day 5 of illness	2470 ± 1184
p value (Day 4 vs Day 5)	0.043*

\* p < 0.05 considered statistically significant

**Figure 1: Trend of Serum Ferritin Levels from Day 4 to Day 5 of Illness**



### Correlation of Serum Ferritin level with Hospital Stay

#### Pearson's correlation analysis revealed:

Serum ferritin showed a strong positive correlation with duration of hospitalization:

r = 0.72  
 p = 0.003

This represents a strong positive correlation between serum ferritin levels and duration of hospitalization. Clinically, this implies that higher ferritin concentrations are associated with prolonged recovery and extended inpatient monitoring.

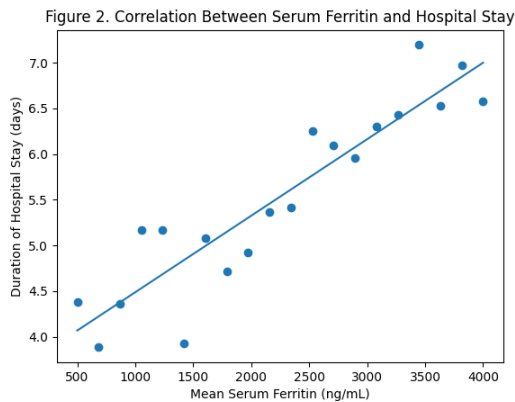
An r-value of 0.72 suggests that ferritin explains a substantial proportion of variability in hospital stay duration, reinforcing its potential as a potential marker of severity.

**Table 3. Correlation Between Serum Ferritin Levels and Duration of Hospital Stay**

Parameter	Value
Mean serum ferritin (ng/mL)	1850 ± 2450
Mean hospital stay (days)	5.2 ± 1.8
Correlation coefficient (r)	0.72
p value	0.003*

\* p < 0.05 considered statistically significant

# Hyperferritinaemia as an Independent Predictor of Clinical Severity and Prolonged Hospitalization in Children with Dengue Fever: A retrospective hospital-based analytical study.



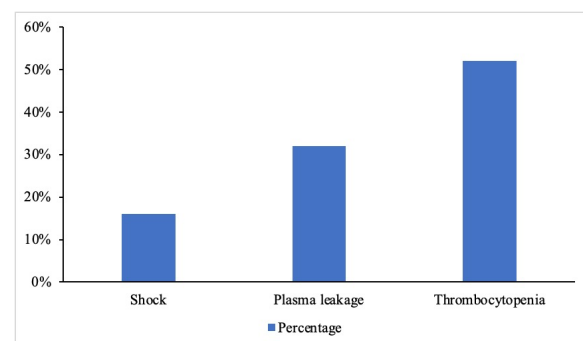
(Some data points overlap due to identical values)

### Clinical Features

Thrombocytopenia was the most common manifestation, seen in 52% of children, reflecting typical hematological involvement in dengue. Plasma leakage occurred in 32%, indicating progression toward severe dengue due to increased capillary permeability. Shock was observed in 16% of cases, representing the most severe form of disease. Overall, these findings show a predominance of hematological abnormalities with a significant proportion developing severe dengue features, emphasizing the need for early risk stratification and close monitoring.

**Table 4: Clinical Features Observed in Children with Dengue Fever**

Clinical Feature	Number of Children	Percentage (%)
Thrombocytopenia	26	52.0
Plasma leakage	16	32.0
Shock	8	16.0



**Figure 3: Clinical Features Observed in Children with Dengue Fever**

### Predictors of Prolonged Hospital Stay

Univariate Logistic Regression for Prolonged Hospital Stay (>5 days)

Univariate logistic regression analysis demonstrated that hyperferritinaemia ( $\geq 1000$  ng/mL) was significantly associated with prolonged hospital stay. Children with elevated ferritin levels had 4.85 times higher odds of hospitalization beyond 5 days compared to those with lower ferritin levels (OR 4.85; 95% CI: 1.42–16.52;  $p=0.011$ ).

Shock was also significantly associated with prolonged stay, increasing the odds by more than sixfold (OR 6.20; 95% CI: 1.31–29.21;  $p=0.021$ ). Plasma leakage showed a trend toward significance (OR 3.10; 95% CI: 0.94–10.20;  $p=0.062$ ), whereas thrombocytopenia was not significantly associated with prolonged hospitalization ( $p=0.318$ ).

These findings suggest that hyperferritinaemia and shock are important unadjusted predictors of extended hospital stay.

**Table 5. Univariate Logistic Regression for Prolonged Hospital Stay**

Variable	Category	Odds Ratio (OR)	95% CI	p value
Hyperferritinaemia	$\geq 1000$ ng/mL	4.85	1.42 – 16.52	0.011 *
Shock	Present	6.20	1.31 – 29.21	0.021 *
Plasma leakage	Present	3.10	0.94 – 10.20	0.062
Thrombocytopenia	Present	1.82	0.56 – 5.87	0.318

\*  $p < 0.05$  statistically significant

## Hyperferritinaemia as an Independent Predictor of Clinical Severity and Prolonged Hospitalization in Children with Dengue Fever: A retrospective hospital-based analytical study.

### Multivariate Logistic Regression for Prolonged Hospital Stay

On multivariate logistic regression analysis adjusting for shock, plasma leakage, and thrombocytopenia, hyperferritinaemia remained an associated factor of prolonged hospitalization. Children with ferritin  $\geq 1000$  ng/mL had nearly fourfold increased odds of hospital stay beyond 5 days (Adjusted OR 3.92; 95% CI: 1.08–14.21;  $p=0.037$ ).

Although shock showed increased odds (AOR 4.18), it did not retain statistical significance after adjustment ( $p=0.071$ ). Plasma leakage was also not independently associated with prolonged stay ( $p=0.266$ ).

The overall model was statistically significant (model  $p=0.004$ ) with a Nagelkerke  $R^2$  of 0.41, indicating moderate explanatory power.

These findings confirm that hyperferritinaemia shows significant association with prolonged hospitalization irrespective of other severity markers.

### Table 6. Multivariate Logistic Regression for Prolonged Hospital Stay

(Adjusted for shock, plasma leakage, thrombocytopenia)

Variable	Adjusted OR (AOR)	95% CI	p value
Hyperferritinaemia	3.92	1.08 – 14.21	0.037*
Shock	4.18	0.88 – 19.73	0.071
Plasma leakage	2.04	0.58 – 7.21	0.266

### Univariate Logistic Regression for ICU Admission

Univariate analysis revealed that hyperferritinaemia was significantly associated with ICU admission. Children with elevated ferritin levels had 5.21 times higher odds of requiring intensive care (OR 5.21; 95% CI: 1.18–22.96;  $p=0.029$ ).

Shock was the strongest predictor of ICU admission, increasing the odds nearly ninefold (OR 8.90; 95% CI: 1.87–42.36;  $p=0.006$ ). Plasma leakage was also significantly associated with ICU requirement (OR 4.40; 95% CI: 1.15–16.77;  $p=0.031$ ).

These results suggest that both hyperferritinaemia and clinical severity markers are associated with escalation of care in unadjusted analysis.

### Table 7. Univariate Logistic Regression for ICU Admission

Variable	Category	OR	95% CI	p value
Hyperferritinaemia	$\geq 1000$ ng/mL	5.21	1.18 – 22.96	0.029*
Shock	Present	8.90	1.87 – 42.36	0.006*
Plasma leakage	Present	4.40	1.15 – 16.77	0.031*

### Multiple Linear Regression for Duration of Hospital Stay (Continuous Outcome)

Multiple linear regression analysis demonstrated that serum ferritin levels were significantly associated with duration of hospital stay. Ferritin showed a positive independent relationship ( $\beta = 0.0021$ ; SE = 0.0006;  $p=0.002$ ), indicating that increasing ferritin levels were associated with longer hospitalization.

Shock was also independently associated with prolonged stay ( $\beta = 1.18$ ;  $p=0.007$ ).

The overall model was highly significant ( $p < 0.001$ ) with an  $R^2$  of 0.52 and adjusted  $R^2$  of 0.48, suggesting that approximately 48% of the variability in hospital stay duration was explained by the included predictors.

These findings further strengthen the prognostic relevance of serum ferritin in pediatric dengue.

### Table 8. Multiple Linear Regression

Variable	Beta ( $\beta$ )	Standard Error	t value	p value
Serum Ferritin (ng/mL)	0.0021	0.0006	3.42	0.002*
Shock	1.18	0.42	2.80	0.007*

# Hyperferritinaemia as an Independent Predictor of Clinical Severity and Prolonged Hospitalization in Children with Dengue Fever: A retrospective hospital-based analytical study.

## Discussion

This study demonstrates that hyperferritinaemia is a significantly associated factor of prolonged hospitalization in children with dengue fever.

The findings support the concept that ferritin reflects the magnitude of systemic inflammation and immune activation in dengue infection.

Dengue pathogenesis involves macrophage activation and cytokine release, resulting in endothelial dysfunction and plasma leakage. Ferritin is released during macrophage activation and serves as a marker of inflammatory severity.

Lakshmanan et al. reported that elevated ferritin levels were associated with severe dengue and organ dysfunction<sup>[6]</sup>. Our findings are consistent with this observation and further demonstrate independent predictive value using regression analysis.

Similarly, Yathukulan et al. showed that ferritin levels increase during the critical phase of dengue illness<sup>[7]</sup>. In our study, ferritin levels increased significantly between day 4 and day 5, corresponding to the critical phase.

In adult populations, Suresh et al. demonstrated that ferritin levels measured during defervescence had strong discriminatory ability for predicting severe dengue, with high area under the curve (AUC) values<sup>[8]</sup>. While their cohort consisted of adults, the pathophysiological mechanisms underlying dengue severity are comparable across age groups. Our findings extend this evidence to the paediatric population and further demonstrate independent predictive value using multivariate logistic regression modeling.

Jha et al., in a prospective paediatric critical care cohort, reported that extremely elevated ferritin levels (>10,000 ng/mL) were associated with organ dysfunction and increased mortality<sup>[9]</sup>. Although the ferritin levels observed in our cohort were comparatively lower, we found that even moderate elevations were clinically meaningful predictors of prolonged hospitalization. This suggests that prognostic utility exists across a broad range of ferritin elevations and is not limited only to extreme hyperferritinaemia. Importantly, our regression analysis demonstrated that hyperferritinaemia remained independently associated with prolonged hospital stay after adjusting for shock, indicating that ferritin may identify children at risk even before overt hemodynamic compromise develops.

The broader concept of hyperferritinaemic syndromes provides further mechanistic insight. Rosário et al. described hyperferritinaemia as a hallmark of systemic inflammatory disorders characterized by macrophage activation and cytokine storm<sup>[10]</sup>. Kernan and Carcillo further elaborated that ferritin is not only a marker but may also contribute to immune dysregulation and oxidative stress amplification<sup>[11]</sup>. Severe dengue shares several immunological features with these hyperferritinaemic conditions, including excessive cytokine release and endothelial injury. The strong correlation observed in our study between ferritin levels and duration of hospitalization ( $r = 0.72$ ) supports the notion that ferritin mirrors the intensity of systemic inflammatory response in dengue.

From a clinical standpoint, early identification of children at risk for severe dengue remains a major challenge in paediatric practice. Traditional severity markers such as thrombocytopenia and hematocrit changes may appear relatively late in the disease course. Serum ferritin, on the other hand, rises during the early critical phase and may therefore serve as an earlier warning indicator. Linli et al. demonstrated that elevated ferritin levels in critically ill children with systemic inflammation were associated with worse outcomes and prolonged ICU stay<sup>[12]</sup>. Similarly, García et al. reported higher ferritin concentrations in children with septic shock and organ dysfunction<sup>[13]</sup>. These studies, though conducted in non-dengue populations, reinforce the concept that ferritin elevation reflects severity across diverse hyperinflammatory states.

In resource-limited settings where access to advanced inflammatory biomarkers (such as IL-6 or procalcitonin) may be constrained, serum ferritin offers a practical and cost-effective alternative. Its widespread availability, rapid turnaround time, and relative affordability make it an attractive tool for integration into routine dengue management protocols. Incorporating ferritin measurement at admission and during days 4–6 of illness may enhance early triage decisions and optimize PICU resource allocation.

The independent predictive value demonstrated in our multivariate analysis strengthens the argument for ferritin as a potential marker of severity rather than merely a correlational indicator. The adjusted odds ratio approaching fourfold increased likelihood of

# Hyperferritinaemia as an Independent Predictor of Clinical Severity and Prolonged Hospitalization in Children with Dengue Fever: A retrospective hospital-based analytical study.

prolonged hospitalization underscores its clinical significance. Furthermore, the dynamic rise observed during the critical phase suggests that serial monitoring may be more informative than a single baseline measurement.

However, while our findings are consistent with existing literature, certain limitations must be acknowledged. The retrospective design and single-center setting may limit generalizability. Additionally, while hyperferritinaemia demonstrated strong association with severity, causal relationships cannot be definitively established. Larger multicentric prospective studies incorporating ROC curve analysis and validated cut-off thresholds would further strengthen clinical applicability.

Importantly, hyperferritinaemia remained independently associated with prolonged hospitalization even after adjusting for clinical severity markers.

This suggests that ferritin may identify high-risk patients early in the disease course.

From a clinical perspective, early identification of severe dengue is essential for timely intervention.

Serum ferritin may serve as an early, accessible biomarker to aid risk stratification in pediatric dengue, particularly in resource-limited settings.

Serum ferritin has several advantages:

- Widely available
- Inexpensive
- Rapid turnaround time

It may be particularly useful in resource-limited settings.

## Limitations

This study is limited by its single-center, retrospective design and relatively small sample size, which may affect generalizability and preclude causal inference. The small number of PICU events restricted multivariable modeling, increasing the risk of overfitting and unstable estimates. Important confounders, including age, timing of ferritin measurement, disease severity, and organ involvement, were not adjusted for, and the observed associations may therefore be influenced by underlying severity. Additionally, formal predictive modeling was not performed, and the ferritin cutoff was not internally validated. Larger multicentric prospective studies are needed to confirm these findings.

## Conclusion

Hyperferritinaemia is an independently associated with prolonged hospitalization in children with dengue fever. Elevated ferritin levels were significantly associated with disease severity and prolonged hospital stay. Serial ferritin measurement may serve as a useful biomarker for early risk stratification. Incorporating ferritin into routine evaluation may help optimize patient management and resource utilization.

## Author's contribution statement

**AV:** Concept, Design, Definition of Intellectual Content, Literature Search, Data acquisition, Data analysis, statistical analysis, Manuscript preparation, Manuscript Editing, Manuscript Review, Corresponding Author.

**JV:** Concept, Design, Definition of Intellectual Content, Manuscript Editing: Manuscript Review, Guarantor.

## Data availability statement

The datasets generated during and/or analyzed during the current study are available from the corresponding author (AV) on reasonable request.

## Financial support and sponsorship

Nil.

## Conflicts of interest

There are no conflicts of interest.

## References

1. World Health Organization, Special Programme for Research, Training in Tropical Diseases, World Health Organization. Department of Control of Neglected Tropical Diseases, World Health Organization. Epidemic, Pandemic Alert. Dengue: guidelines for diagnosis, treatment, prevention and control. World Health Organization; 2009.
2. Mishra S, Ambey R, Khare A, Gaur A. Clinico-Epidemiological Profile of Dengue in Children of Age Group 0-14 Years Admitted in a Tertiary Care Hospital. *Cureus*. 2025 Jun 30;17(6).
3. Soundravally R, Hoti SL, Patil SA, Cleetus CC, Zachariah B, Kadiravan T, Narayanan P, Kumar BA. Association

## Hyperferritinaemia as an Independent Predictor of Clinical Severity and Prolonged Hospitalization in Children with Dengue Fever: A retrospective hospital-based analytical study.

- between proinflammatory cytokines and lipid peroxidation in patients with severe dengue disease around defervescence. *International Journal of Infectious Diseases*. 2014 Jan 1;18:68-72..
4. Shridhar Pattar SS, Panda PK, Rijal P. Dengue as an emerging infection and co-infections: An update. *Biomedical Research*. 2023;34(3):1-5.
  5. Goyal PK, Hissaria K, Shekhawat C. Role of serum ferritin as a predictor of dengue severity: a prospective observational study from India. *Cureus*. 2024 Jun 30;16(6):e63503.
  6. Lakshmanan C, Ranjit S, Natraj R, Venkatachalapathy P, Kumar VS, Lum LC. Hyperferritinemia in severe dengue infection: Single-center retrospective cohort study. *Pediatric Critical Care Medicine*. 2023 Sep 1;24(9):e409-16.
  7. Yathukulan S, Sundaresan KT. Serum ferritin in dengue infection. *Cureus*. 2024 Dec 20;16(12).
  8. Suresh SC, Hanumanthaiah R, Ramakrishna C, Sandeep R, Narasimhasetty PS, Ramakrishna V, KP B, Raju B. Serum ferritin as a prognostic indicator in adult dengue patients. *The American journal of tropical medicine and hygiene*. 2020 Dec 28;104(3):1072.
  9. Jha NP, Gupta T, Krupanandan R, Sadasivam K, Kapalavai SK, Ramachandran B. Serum ferritin level in children with severe dengue infection and its association with outcome: A Single-center prospective cohort study. *Indian Journal of Critical Care Medicine: Peer-reviewed, Official Publication of Indian Society of Critical Care Medicine*. 2025 May 8;29(5):458.
  10. Rosário C, Zandman-Goddard G, Meyron-Holtz EG, D'Cruz DP, Shoenfeld Y. The hyperferritinemic syndrome: macrophage activation syndrome, Still's disease, septic shock and catastrophic antiphospholipid syndrome. *BMC medicine*. 2013 Aug 22;11(1):185.
  11. Kernan KF, Carcillo JA. Hyperferritinemia and inflammation. *International immunology*. 2017 Sep;29(9):401-9.
  12. Sang L, Teng W, Zhao M, Ding P, Xu X, Wang Y, Cao L. Association between serum ferritin and outcomes in critically ill patients: a retrospective analysis of a large intensive care unit database. *Chin Med J (Engl)*. 2022 Nov 5;135(21):2634-2636
  13. Garcia PC, Longhi F, Branco RG, Piva JP, Lacks D, Tasker RC. Ferritin levels in children with severe sepsis and septic shock. *Acta paediatrica*. 2007 Dec;96(12):1829-31.