

Original Article,

## High Serum Ferritin Level to Predict the Severity of Dengue Viral Infection

Hossain MM<sup>1</sup>, Mondal NT<sup>2</sup>, Hasan MQ<sup>3</sup>, Khan MM<sup>4</sup>

<sup>1</sup>Associate Professor, Medicine, Enam Medical College, Savar, Dhaka, Bangladesh

<sup>2</sup>Associate Professor Medicine, Enam Medical College & Hospital, Savar, Dhaka, Bangladesh.

<sup>3</sup>Associate professor, Gastroenterology, Enam Medical College and Hospital, Savar, Dhaka, Bangladesh.

<sup>4</sup>Associate Professor, Department of Neurology, Enam Medical College & Hospital, Savar, Dhaka, Bangladesh.

---

### **Abstract:**

This study aims to identify common opportunistic infections and their prevalence among people living with HIV in Osogbo, Osun state, who are receiving treatments for the HIV virus, which has spread widely. A mixed study design was employed, including a hospital-based retrospective study and a Key Informant Interview. The retrospective study involved 280 HIV patients at State Specialists Hospital Asubiaro SSHA Osogbo, Nigeria, and collected socio-demographic, opportunistic infection diagnosis, and viral load test results. The study also included a Key Informant Interview with six health workers in the HIV care unit. Quantitative data was analyzed using descriptive statistics and Chi-square tests, while qualitative data was analyzed using a thematic approach. The study reveals that the majority of People Living with HIV are females (77.1%), with 69% unemployed and 28.6% employed. Most are married (82.5%). In 2020, 58.2% achieved viral suppression, while in 2021, 65.7% and 69% achieved it. Common opportunistic infections include tuberculosis, pruritus, oral candidiasis, and herpes zoster. The prevalence of opportunistic infections decreased from 9.0% to 7.6% between January 2020 and May 2022. The prevalence of opportunistic infections in the study was low, which is due to the high preventive measures employed by the health workers in the hospital. Hence adherence to HAART (Highly Active Antiretroviral Therapy) medications helps to maintain healthy living for People living with HIV

---

**Keywords:** Serum Ferritin Level, Predictor, Dengue Infection

### **Introduction:-**

Dengue epidemics are known to have occurred over the last three centuries in tropical, subtropical and temperate areas of the world <sup>[1]</sup>. The first epidemic of dengue was recorded in 1635<sup>[1]</sup> in the French West Indies, although a disease compatible with dengue had been reported in China as early as 1992 AD <sup>[2]</sup>. During the 18th, 19th and early 20th centuries, epidemics of dengue-like diseases were described globally in the tropics as well as in some temperate regions. The World Health Organization (WHO) estimated that approximately 2.5 billion people living in dengue-endemic countries <sup>[3]</sup>. The virus serotypes are closely related but antigenically distinct <sup>[4]</sup>. In the last 50 years, incidence has increased 30-fold with increasing geographic expansion to new countries <sup>[5]</sup>. Annually a 100 million cases of Dengue fever and half a million cases of Dengue hemorrhagic fever (DHF) occur in the world with a case fatality in Asian countries of 0.5%–3.5% <sup>[6]</sup>. In Bangladesh, dengue fever was first reported in 1964 but became a disease of public health significance from 2000 onwards. <sup>[7]</sup>. Bangladesh had a lower dengue prevalence than most Southeast Asian states, but recently has sustained an upsurge in dengue outbreaks; from 2769 cases in 2017 to 10,148 cases in 2018 <sup>[4]</sup>. Dhaka, the capital and most populated city in Bangladesh, had the highest number of dengue cases between 2012 and 2019. <sup>[8]</sup>. In 2019, the Directorate General of Health Services (DGHS) recorded 101,354 cases with 179 deaths, a 10-fold increase in the incidence rate of dengue from the

previous year.<sup>[9]</sup> Although in 2020, Bangladesh had reported only three confirmed dengue-related deaths and 1,193 dengue cases, the scenario is different in 2021 and 2022. Bangladesh has witnessed 28,429 dengue cases and 105 deaths in 2021<sup>[10]</sup>. In 2022 and 2023, cases and fatality has increased sharply.

Dengue is caused by dengue virus (DENV) serotypes 1-4 and transmitted to human beings by the bite of Aedes mosquitoes<sup>[11]</sup>. BCSIR in its genome sequencing found the presence of the DENV-3. People were becoming increasingly infected with the new dengue variant and a higher death rate was found from dengue in 2021 compared to the dengue epidemic in 2019 in Bangladesh<sup>[12]</sup>. The clinical spectrum of dengue infection is variable from mild fever to severe forms of dengue manifesting as severe thrombocytopenia with major bleeding, plasma leakage resulting in fluid accumulation, respiratory distress, shock and multi-organ dysfunction. In clinical practice, patients with dengue infection are grouped as 1) those without warning signs 2) those with warning signs and 3) severe dengue. Around the time of defervescence, when the temperature drops to 37.5-38°C or less and remains below this level, an increase in capillary permeability in parallel with increasing hematocrit levels may occur. In addition, severe organ impairment such as severe hepatitis, encephalitis or myocarditis and/or severe bleeding may also develop without obvious plasma leakage or shock. Those who improve after defervescence are said to have non-severe dengue. During recovery phase patient's general well-being improves, appetite returns, gastrointestinal symptoms abate, hemodynamic status stabilizes and diuresis ensues. The hematocrit stabilizes or may be lower due to dilutional effect of reabsorbed fluid, white blood cells count and platelet count begin to rise<sup>[13]</sup>. Severe dengue results from interplay between virus related virulence factors and host factors which include inflammatory response of the host to infection with exuberant T and B cell activation, release of cytokines (cytokine storm), altered endothelial function with increased vascular permeability and nutritional status of the host<sup>[14]</sup>.

## **Materials And Methods:-**

Study Design: Prospective Observational Study

Place of Study: Enam Medical College.

Period of Study: August and September 2024

Study population: Patients admitted in the medicine ward of Enam Medical College during the study period with confirmed Dengue infection and who were willing to participate in the study were included in this study.

Population: Total 151 patients who fulfilled the criteria were included in this study.

Inclusion Criteria

- Age  $\geq$  18 of both genders.
- Confirmed dengue cases diagnosed by positive NS1 antigen and/or dengue IgM antibody.
- Who were willing to participate.

Exclusion Criteria

- Patients presenting with severe dengue.
- History of multiple blood transfusions.

Procedure: Each of the participants was explained about the aim, importance and purpose of the study. A written consent was taken and data were collected using a structured questionnaire. Serum ferritin level of all the patients was measured on the day of admission and the patients were grouped in two groups: Group A: Adults with the diagnosis of dengue fever with normal serum ferritin level and Group B: Adults with the diagnosis of dengue fever with increased serum ferritin level.

Other necessary investigations like complete blood count, serum creatinine, serum electrolytes, ALT, AST, Chest X-ray, ultrasound of abdomen, were done according to hospital protocol. Patients were then followed up regularly during their hospital stay and necessary investigations were repeated as required. Every patient was managed according to the National Guideline for Clinical Management of Dengue Syndrome. Discharge from the hospital without complications or death during the hospital stay was the end point of study. The data analysis finally was done using SPSS (Statistical Package for Social Science) windows program version 24.

**Result: -**

Out of 151 patients most of the patients are in the younger age group and having male predominance; 43 percent patients are in the age group of 18 to 30 years and more than 72 patients are male. Table 1 and Table 2 show the distribution of patients by age group and sex respectively.

**Table 1: Distribution of patients by age**

Age group	Number	Percentage
18 to 30 years	65	43.05
31 to 40 years	37	24.50
41 to 50 years	25	16.56
51 to 60 years	17	11.26
>60 years	7	4.64
	151	100

**Table 2: Distribution of patients by sex**

	Male	Female	Total
Number of Patients	109	42	151
Percentage	72.19	27.81	

Almost all patients (over 97%) presented with fever, other major presentations were retro-orbital pain (91.39%) and muscle & joint pain (83.44%). Table 3 shows various complaints the patients presented with.

**Table 3: Distribution of patients by various presentation.**

Clinical presentations	Frequency (n)	Percentage (%)
Fever	147	97.35
Retro-orbital pain	138	91.39
Muscle or joint pain	126	83.44
Headache	120	79.47
Anorexia	108	71.52
Nausea& vomiting	96	63.58
Diarrhea	60	39.74
Skin erythema/rash	48	31.79
Photophobia	39	25.83
Constipation	18	11.92

Patients were grouped into two groups based on very high serum ferritin level (value of >1500); group A patients having low ferritin and group B patients having very serum ferritin level. Table 4, shows the distribution of patients with their ferritin level.

**Table 4, distribution of patients with their ferritin level**

	Frequency (n)	Percentage (%)
Group A (Normal)	97	64.24
Group B (High)	54	35.76

**Table 5, distribution of patients with their ferritin level and warning sings**

Warnings signs	Group A		Group B		Total		*P value
	N=97	Percentage	N=54	Percentage	N=151	Percentage	
Abdominal pain	47	48.45	38	70.37	85	56.29	0.127
Persistent vomiting	38	39.18	26	48.15	64	42.38	0.414
Lethargy	41	42.27	23	42.59	64	42.38	0.781

Mucosal bleed	6	6.19	49	90.74	55	36.42	<0.001
Increased hematocrit with rapid decrease in platelet count	32	32.99	20	37.04	52	34.44	0.758
Liver enlargement (>2cm)	9	9.28	41	75.93	50	33.11	<0.001
Clinical fluid accumulation	12	12.37	35	64.81	47	31.13	<0.001
Respiratory distress	6	6.19	3	5.56	9	5.96	0.984

According to warning signs of the dengue patient, highly significant association was reported among mucosal bleed (36.42%), clinical fluid accumulation (31.13.0%) & liver enlargement (33.11%) with ferritin level ( $p<0.001$ ), these findings were more prominent among the dengue patients who had higher ferritin level. Abdominal pain was the most common warning sign found among 56.29.0% dengue patients, 42.39% respondents had both persistent vomiting & lethargy as warning sign, 34.44% respondents had increase hematocrit with rapid decrease in platelet count& only 6.0% dengue patients had respiratory distress.

**Table 6: Association between serum ferritin level of the respondents & duration of hospital stay**

Hospital stays (Day)	Group A		Group B		Total		*P-value
	(n=32)	Percentage	(n=18)	Percentage	n=50	Percentage	
3 to 5 days	48	49.48%	12	22.22%	60	39.74%	0.015
6 to 8 days	36	37.11%	12	22.22%	48	31.79%	0.308
>8	12	13.40%	31	55.56%	43	28.48%	<0.001
	97		54		151		

The patients who have high ferritin level also stayed more days in the hospital. Among the patients who had high ferritin level 55.56% stayed more than 8 days in hospital in-stead 13.40% stayed more than 8 days who had low ferritin level; this difference is statistically significant ( $P=<0.001$ ).

**Table 7: Association of serum ferritin level with Blood Pressure**

Clinical variables	Group A(n=97) Mean ±SD	Group B(n=54) Mean ±SD	*P value
<b>Systolic Blood Pressure</b>			
• On admission	90.15 ± 0.82	79.67 ± 0.58	<0.001
• After 3 days	96.15 ± 1.04	86.76 ± 1.18	<0.001
• After 5 days	104.39 ± 1.18	98.86 ± 1.01	0.277
• On discharge	120.10 ± 0.58	119.29 ± 0.46	0.268
<b>Diastolic Blood Pressure</b>			
• On admission	62.10 ± 1.18	60.48 ± 0.87	<0.001
• After 3 days	68.68 ± 0.65	63.71 ± 0.46	0.036
• After 5 days	72.46 ± 0.81	70.86 ± 1.11	0.053
• On discharge	80.02 ± 0.35	79.9 ± 0.30	0.365
<b>Pulse pressure</b>			
• On admission	28.05 ± 1.30	19.19 ± 0.98	<0.001
• After 3 days	27.46 ± 1.23	23.05 ± 1.24	0.822
• After 5 days	31.93 ± 1.54	28.00 ± 1.67	0.466
• On discharge	40.07 ± 0.68	39.38 ± 0.59	0.196

We observed statistically significant differences in systolic & diastolic blood pressures along with the pulse pressure on the day of admission in two groups of patients; patients with very high ferritin and low ferritin level. There after during treatment the pressure shows differences but that are not significant enough.

**Table 8: Correlation of serum ferritin level with hematocrit, platelet, WBC and neutrophil & lymphocyte ratio.**

Laboratory findings	Group A (n=97) Mean ±SD	Group B (n=54) Mean ±SD	*P value
<b>Hematocrit (%)</b>			
On admission	52.02 ± 3.18	67.57±7.04	<0.001
After 3 days	52.55 ± 2.98	64.00 ± 4.54	<0.001
After 5 days	42.19 ± 0.61	45.63 ± 0.52	0.642
On discharge	36.63 ± 1.13	38.14 ± 0.85	0.064
<b>Platelet (x109)/L</b>			
On admission	35.66 ± 4.26	22.0 ± 4.64	<0.001
After 3 days	36.56 ± 5.11	22.24 ± 4.21	<0.001
After 5 days	57.59 ± 6.98	44.05 ± 3.11	<0.001
On discharge	97.76 ± 1.66	92.33 ± 0.58	<0.001
<b>WBC (x109)/L</b>			
On admission	4.39 ± 0.86	4.83 ± 0.95	0.064
After 3 days	6.18 ± 0.76	6.22 ± 0.86	0.848
After 5 days	9.48 ± 0.99	9.76 ± 1.16	0.337
On discharge	11.24 ± 1.61	11.43 ± 0.99	0.621
<b>Neutrophil &amp; lymphocyte ratio (%)</b>			
On admission	6.71 ± 2.08	7.58 ± 1.34	0.088
After 3 days	6.49 ± 0.93	6.97 ± 1.11	0.08
After 5 days	4.47 ± 1.59	4.13 ± 1.48	0.417
On discharge	2.11 ± 0.63	2.14 ± 0.54	0.834

Hematocrit (%) level found significant difference among the two groups on the day of admission & 3 days after admitted to the hospital ( $p<0.05$ ). Platelet (x109)/L level also found significant differences ( $p<0.05$ ) among two groups on admission day, after 3 days & 5 days and on discharge from the hospital. WBC(x109)/L & Neutrophil/lymphocyte ratio (%) did not show significant difference between two groups ( $p>0.05$ ).

**Table 9: Comparison of serum ferritin level with severity of dengue**

Severity of dengue	Group A		Group B		Total		*P value
	Number (n=97)	Percentage	Number (n=54)	Percentage	Number (n=151)	Percentage	
Without warning sign	53	54.64	6	11.11	54	35.76	<0.001
With warning sign	36	37.11	9	16.67	45	29.80	0.156
Shock syndrome	8	8.25	39	72.22	52	34.44	<0.001
	<b>97</b>		<b>54</b>		<b>151</b>		

A significant association was found between serum ferritin level with dengue severity (shock syndrome) and serum ferritin level without the warning signs of dengue ( $<0.001$ ).

### **Discussion:-**

The aim of this study was to evaluate the serum ferritin level as a predictor of disease severity in patients with dengue infection. In India, a retrospective study by Chaudhury et al., similarly documented ferritin as a surrogate marker for dengue infection [11] Suresh et al., also reported serum ferritin level as a “good” predictor of diagnosis of severe dengue cases [12]. Most of the respondents (43.0%) belonged to the age group of 18-30 years. 64.24% respondents were in group A & 35.76% in group B.

Regarding the symptoms of the dengue patients, almost all respondents of current study had fever (97.35%) & (91.39%) had retro-orbital pain. A study conducted in India revealed similar findings that, the most common clinical presentation of their respondents was fever in 57 (100%) [15].

According to warning signs of the dengue patient in present study, highly significant association was reported among mucosal bleed (36.42%), clinical fluid accumulation (33.11%) & liver enlargement (31.13%) with ferritin level ( $p < 0.001$ ) & the results were more prominent among the dengue patients who had higher ferritin level. A retrospective study included 669 dengue patients, where a significantly higher incidence of mucosal bleeding was revealed in patients with severe dengue [16]. In a study of Rathore et al., they revealed serum chymase levels was associated with narrow pulse pressure and clinical warning signs such as fluid accumulation which correlate with severe dengue infection, similar to present study [17].

Abdominal pain was the most common warning sign found among 56.29% dengue patients in this study followed by 42.38% respondents who had both persistent vomiting & lethargy. In a Malaysian study, the findings were correlated that, abdominal pain/tenderness was the most common warning sign of dengue patients (50.0%) followed by persistent vomiting (44.0%) [18].

Among all the dengue patients, 39.74% stayed 3-5 days for their recovery from dengue infection. Patient with increase serum ferritin level (in group B) stayed more time in hospital than the patients who had normal serum ferritin level (in group A) & the result was found highly significant ( $P < 0.001$ ). In a Bangladeshi study by Prattay et al., noted similar study that average duration of hospital stay was 4.9 days and they also narrated a positive correlation between respondents' recovery time from dengue cases with delayed hospitalization ( $p < 0.01$ ) [13].

We observed statistically significant differences in systolic & diastolic blood pressures along with the pulse pressure on the day of admission in two groups of patients; patients with very high ferritin and low ferritin level. Thereafter during treatment, the pressure shows differences but that are not significant enough. Hematocrit (%) level found significant difference among the two groups on the day of admission & 3 days after admitted to the hospital ( $p < 0.05$ ). Platelet ( $\times 10^9$ )/L level also found significant differences ( $p < 0.05$ ) among two groups on admission day, after 3 days & 5 days and on discharge from the hospital. WBC( $\times 10^9$ )/L & Neutrophil/lymphocyte ratio (%) did not show significant difference between two groups ( $p > 0.05$ ). Among the respondents of present study, most of them (64.24%) had normal level of serum ferritin. In present study, (according to WHO 2009 dengue guideline) a significant association was found between serum ferritin level & dengue severity ( $< 0.001$ ) where severe dengue patients (72.22%) were frequently reported among the respondents who had high ferritin level & poor disease progression. Similar findings were revealed in other studies that increase serum ferritin level was associated with severity of dengue [19-26].

Currently there is no specific drug or preventive vaccine available for Dengue infection. The mainstay of management of Dengue infected patients is supportive care and close monitoring for complications. Most of these patients recover within 5 to 7 days from onset of the febrile illness while only a small percentage progress to Severe Dengue. Severe Dengue often occurs at the end of febrile or during convalescent stage and carries a very high mortality [27]. It is very crucial to predict the severe form well in advance even prior to the appearance of warning signs by a simple diagnostic marker so that early identification and appropriate management would improve the outcome in these patients. For the purpose of early illness severity prediction in dengue virus infection, serum ferritin may be a crucial biomarker.

### **Conclusion:-**

This study established that patients with severe dengue infection were most commonly found among elevated serum ferritin level. No significant association was found between age and gender of the respondents with serum ferritin level. However, a significant association was seen with BMI, most of the patients were obese followed by overweight in patients with high ferritin level. A significant association was also found between blood pressure, pulse pressure and some warning signs like mucosal bleed, clinical fluid accumulation and liver enlargement with serum ferritin level. Laboratory investigations showed hematocrit level, platelet count and serum creatinine were highly associated with ferritin level. Also, patients with high ferritin level had longer duration of hospital stay compared to patients with normal level. Therefore, we can conclude that higher serum ferritin level on the day of admission of patients with dengue infection was associated with more severe form of the disease on follow up in hospital. So, serum ferritin level can be used as a predictor of disease severity in patients with dengue infection.

**References:-**

- [1] Tuiskunen Bäck, A., &Lundkvist, Å. (2013). Dengue viruses—an overview. *Infection ecology & epidemiology*, 3(1), 19839.
- [2] Welsch, S., Miller, S., Romero-Brey, I., Merz, A., Bleck, C. K., Walther, P. & Bartenschlager, R. (2009). Composition and three-dimensional architecture of the dengue virus replication and assembly sites. *Cell host &microbe*, 5(4), 365-375.
- [3] WHO. Dengue and severe dengue. 2019. Available: <https://www.who.int/newsroom/factsheets/detail/dengue-and-severe-dengue/>
- [4] Shah MY, Naqash MM, Goel RK, Galhan D, Kumar S, Chhabra V, et al. Clinical profile of dengue fever infection in patients admitted in tertiary care centre Agroha, Hisar, Haryana, India. *Int J of Res M ScI* 2016; 4 (6): 2146-149.
- [5] Srinivasa K, Ajay J, Manjunath GA. Clinical profile and outcome of dengue among hospitalized children - a single centre prospective study. *J Pediatr Res* 2017; 4 (02): 145-50.
- [6] Rao M, Aparna A, Jyothi RC. Clinical profile and outcome of dengue infections in children. *IOSR* 2016; 15 (2): 07-13.
- [7] Sharmin, S., Glass, K., Viennet, E., & Harley, D. (2018). Geostatistical mapping of the seasonal spread of under-reported dengue cases in Bangladesh. *PLoS neglected tropical diseases*, 12(11), e0006947.
- [8] Directorate General of Health Services. The Ministry of Health and Family Welfare of Bangladesh. Daily Dengue Status Report. (last viewed on 30th September 2022).
- [9] Bäck, A. T., & Lundkvist, A. (2013). Dengue viruses—an overview. *Infect Ecol Epidemiol* 3: 19839.
- [10] SM Najmus Sakib. Study finds new dengue variant dominant in Bangladesh. 2021; Anadolu Agency.
- [11] World Health Organization, (WHO). Dengue Guidelines for diagnosis, treatment, prevention and control. 2009.
- [12] Martina, B. E., Koraka, P., & Osterhaus, A. D. (2009). Dengue virus pathogenesis: an integrated view. *Clinical microbiology reviews*, 22(4), 564- 581.
- [13] Roy Chaudhuri, S., Bhattacharya, S., Chakraborty, M., & Bhattacharjee, K. (2017). Serum ferritin: a backstage weapon in diagnosis of dengue fever. *Interdisciplinary perspectives on infectiousdiseases*, 2017.
- [14] Suresh, S. C., Hanumanthaiah, R., Ramakrishna, C., Sandeep, R., Narasimhasetty, P. S., Ramakrishna, V., & Raju, B. (2021). Serum ferritin as a prognostic indicator in adult dengue patients. *The Americanjournal of tropical medicine and hygiene*, 104(3), 1072.
- [15] Makroo, R. N., Raina, V., Kumar, P., & Kanth, R.K. (2007). Role of platelet transfusion in the management of dengue patients in a tertiary care hospital. *Asian journal of transfusion science*, 1(1), 4.
- [16] Tan, V. P. K., Ngim, C. F., Lee, E. Z., Ramadas, A.,Pong, L. Y., Ng, J. I., ... & Dhanoa A, (2018). The association between obesity and dengue virus (DENV) infection in hospitalized patients. *PloS one*, 13(7), e0200698.
- [17] Eregowda, A., & Valliappan, S. (2015). Clinical profile of dengue infection in a tertiary care hospital. *Indian Journal of Child Health*, 68-71.
- [18] Roy Chaudhuri, S., Bhattacharya, S., Chakraborty, M., & Bhattacharjee, K. (2017). Serum ferritin: a backstage weapon in diagnosis of dengue fever. *Interdisciplinary perspectives on infectious diseases*, 2017.
- [19] Samanta, J., & Sharma, V. (2015). Dengue and its effects on liver. *World Journal of Clinical Cases: WJCC*, 3(2), 125.
- [20] Rathore, A. P., Senanayake, M., Athapathu, A. S., Gunasena, S., Karunaratna, I., Leong W. Y., ... & St. John, A. L. (2020). Serum chymase levels correlate with severe dengue warning signs and clinical fluid accumulation in hospitalized pediatricpatients. *Scientific reports*, 10(1), 11856.
- [21] Chaiyaratana, W., Chuansumrit, A., Atamasirikul, K., & Tangnararatchakit, K. (2008). Serum ferritin levels in children with dengue infection. *Southeast Asian J Trop MedPublic Health*, 39(5), 832-6.

- [22] van de Weg, C. A., Huits, R. M., Pannuti, C. S., Brouns, R. M., van den Berg, R. W., van den Ham, H. J., ... & Kallas, E. G. (2014). Hyperferritinaemia in dengue virus infected patients is associated with immune activation and coagulation disturbances. *PLoS Neglected Tropical Diseases*, 8(10), e3214.
- [23] Soundravally, R., Agieshkumar, B., Daisy, M., Sherin, J., & Cleetus, C. C. (2015). Ferritin levels predict severe dengue. *Infection*, 43, 13-19.
- [24] Nadeem, M., Shafiq, M. M., Manzoor, M. S., & Ahmed, S. I. (2016). Serum ferritin: an indicator of disease severity in patients with dengue infection. *JRMC*, 20, 165-7.
- [25] Ahmed, F., Begum, N. A., Rahman, M. M., Shakur, M. S., & Sharmin, S. (2019). Diagnostic value of ferritin for the severity of dengue infection in children. *Bangabandhu Sheikh Mujib Medical University Journal*, 12(3), by-the.
- [26] Suresh, S. C., Hanumanthaiyah, R., Ramakrishna, C., Sandeep, R., Narasimhasetty, P. S., Ramakrishna, V., & Raju, B. (2021). Serum ferritin as a prognostic indicator in adult dengue patients. *The American journal of tropical medicine and hygiene*, 104(3), 1072.
- [27] Roy Chaudhuri, S., Bhattacharya, S., Chakraborty, M., & Bhattacharjee, K. (2017). Serum ferritin: a backstage weapon in diagnosis of dengue fever. *Interdisciplinary perspectives on infectious diseases*, 2017.



**Open Access** This article is licensed under a

Creative Commons Attribution 4.0 International

License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license, and indicate if changes were made. The images or other third-party material in this article are included in the article's Creative Commons license, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons license and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this license, visit <https://creativecommons.org/licenses/by/4.0/>.