Original Article

Clinical, Laboratory and Plasma Leakage Profile of Dengue Fever in Children: Determinants of Disease Severity in a Tertiary Care Centre

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Abstract

Background: Early risk stratification is critical to successfully manage severe dengue disease and prevent clinical deterioration. This study aims to evaluate the clinical profile of paediatric dengue and assess the diagnostic utility of the novel Dengue Severity Prediction Index (DSPI) and Plasma Leakage Status (PLS). **Material and Methods:** A retrospective cross-sectional study was conducted on 85 children (aged 1–12 years) with laboratory-confirmed dengue at a tertiary care teaching hospital. The DSPI (scored from 0 to 6) was developed by assigning one point each for the presence of thrombocytopenia (<100,000/mm³), leukopenia (<4000/mm³), clinical shock, and ultrasonographic evidence of ascites, pleural effusion, and gallbladder wall edema. The study analysed associations between the DSPI, overall PLS, and World Health Organization (WHO) 2009 severity classifications. **Results:** The paediatric cohort had a mean age of 6.88 years with a male predominance (64.7%). According to WHO 2009 criteria, 51.8% of patients presented with warning signs and 21.2% had severe dengue. The DSPI demonstrated a highly significant correlation with the patients' plasma leakage burden ($p < 0.001$). Children with low DSPI scores (0–1) had no evidence of plasma leakage, whereas those with high scores (≥4) predominantly exhibited moderate-to-severe plasma leakage. Receiver operating characteristic (ROC) analysis revealed excellent discriminatory power for identifying severe dengue, yielding an area under the curve (AUC) of 0.992. Using an optimal cut-off of DSPI provided 100% sensitivity and 97.0% specificity. **Conclusion:** The DSPI is a highly sensitive and specific prognostic tool that successfully integrates routine clinical, laboratory, and ultrasonographic markers. Even at a minimal threshold, it offers exceptional utility for the early detection of severe dengue, facilitating timely and life-saving interventions in vulnerable paediatric patients.

Keywords: Dengue fever, plasma leakage, Dengue Severity Prediction Index (DSPI), ultrasonography, risk stratification, prognostic markers, thrombocytopenia.

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Introduction

Dengue, a mosquito borne viral infection, emerging as a global public health threat, with estimated 2.5 billion people at risk primarily in tropical and subtropical regions.[1] Four viral serotypes, DENV1-4, causing dengue fever may manifest with fever, headache, and myalgia.[2] The condition may progress rapidly to severe, potentially fatal conditions characterized by plasma leakage, hypovolemic shock, severe thrombocytopenia, and dysregulated immune responses.[3,4] Due to this criticality of progression, there is need for comprehensive studies to better predict, understand and manage disease severity.

As disease can rapidly deteriorate into life-threatening capillary leak syndrome, hemorrhage, and multi-organ dysfunction, clinical management relies heavily on early recognition. Viral characteristics and laboratory markers are frequently highlighted as crucial predictive risk factors for severe dengue.[5,6] Specifically, serotype of involved virus and patients' prior immune status strongly dictate the disease trajectory.[7,8] Infection with DENV3 and DENV2 are consistently linked to a higher incidence of severe dengue, including dengue hemorrhagic fever and shock syndrome.[9,10] Early positivity for NS1 antigen during the first week of illness acts as a valuable prognostic indicator, correlating with development of plasma leakage.[11,12] Leukopenia and hemoconcentration along with severe thrombocytopenia consistently a robust predictor of progression to severe dengue disease.[13]

In addition to they mentioned serological and hematological indicators imaging abnormalities including chest X-ray showing pleural effusion and gallbladder wall edema are also identified as predictive parameters for clinical deterioration closely correlating with systemic vascular leak elevated liver enzymes and abdominal pain.[14,15] Early detection of fluid accumulation

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(ascites and pleural effusion) are direct indicators of capillary leak and elevated risk of severe complication.[14] By integrating these diverse factors a prognostic model utilizing a combination of laboratory markers and ultrasonographic evidence can accurately stratify patients. Studies show that higher composite scores on this index consistently predict greater burden of moderate to severe plasma leakage syndrome among dengue patients.[16,17]

Therefore, this study was undertaken with objectives to study the clinical profile and severity of dengue fever among children aged up to 12 years, to assess the clinical manifestations of dengue fever, to evaluate hematological and biochemical abnormalities associated with dengue infection, to classify the severity of dengue according to WHO 2009 criteria. The other objective was to evaluate the association between the Dengue Severity Prediction Index (DSPI), Plasma Leakage Status (PLS) and dengue severity.

Materials and Methods

Study design and setting: A retrospective cross-sectional study was conducted in the Department of Paediatrics of a tertiary care teaching hospital. Medical records of children diagnosed with dengue fever and admitted during the study period were reviewed. The study was undertaken to evaluate the clinical manifestations, laboratory abnormalities, disease severity, and predictors of severe dengue among children aged up to 12 years.

Study duration: The study included cases admitted over a two-year period from March 2024 to February 2026.

Study population: Children aged ≤12 years admitted with a diagnosis of dengue fever during the study period constituted the study population.

Case definition: Dengue fever was diagnosed based on compatible clinical features along with laboratory confirmation by one or more of the following - positive NS1 antigen test, positive dengue IgM antibody test and positive dengue serology as documented in hospital records.

Sample size: All eligible children meeting the inclusion criteria during the study period and having complete clinical, laboratory, and outcome data were included in the analysis. Consecutive sampling of available medical records was employed.

Inclusion criteria: Children aged up to 12 years with laboratory-confirmed dengue infection and complete clinical and laboratory records available for review.

Exclusion criteria: Children with coexisting bacterial sepsis, hematological disorders affecting platelet counts, chronic liver disease, chronic kidney disease and incomplete medical records were excluded.

Data collection: Data were extracted retrospectively from inpatient case records, laboratory registers, radiology records, and discharge summaries using a structured data extraction form.

Demographic variables (age and sex), clinical variables like fever, vomiting, abdominal pain, rash, myalgia, bleeding manifestations, hepatomegaly, shock and duration of hospitalization were noted. Laboratory variables including hemoglobin, total leukocyte count, platelet count, haematocrit, Aspartate aminotransferase (AST) and Alanine aminotransferase (ALT). Ultrasonographic variables like ascites, pleural effusion and gall bladder wall edema. Outcome variables including recovery, requirement of intensive care, presence of shock and severe dengue were noted.

Classification of dengue severity: Patients were classified according to the World Health Organization (WHO) 2009 Dengue Classification into dengue without warning signs, dengue with warning signs and severe dengue. Warning signs included persistent vomiting, severe abdominal pain, clinical fluid accumulation, mucosal bleeding, hepatomegaly, rising haematocrit with rapid fall in platelet count. Severe dengue was defined by the presence of severe plasma leakage leading to shock or respiratory distress, Severe bleeding, and Severe organ involvement.

Dengue Severity Prediction Index (DSPI): To strengthen the assessment of disease severity, a composite variable termed the Dengue Severity Prediction Index (DSPI) was developed using clinical, laboratory, and ultrasonographic markers associated with plasma leakage and severe dengue.

One point was assigned for the presence of each of the following variables platelet count <100,000/mm³, leukopenia (<4000/mm³), ascites on ultrasonography, pleural effusion on ultrasonography, gall bladder wall edema on ultrasonography, and shock. The total DSPI score ranged from 0 to 6. Patients were subsequently categorized into three risk groups – low risk (score of 0-1), moderate risk (score of 2-3) and high risk (score of ≥4).

Plasma Leakage Status (PLS): PLS was quantified by 3 variables collected during the study. Based on ascites, pleural effusion and gall bladder edema, one point was assigned to each parameter. Overall PLS was assessed as no leakage (score 0), mild leakage (score 1), significant leakage (score ≥2).

Statistical Analysis: Data were entered into Microsoft Excel and analyzed using JASP version 0.19.3 (University of Amsterdam, Netherlands). Continuous variables were summarized as mean ± standard deviation or median with interquartile range depending on data distribution. Categorical variables were expressed as frequencies and percentages. Comparisons between severity groups were performed using Chi-square test or Fisher's exact test for categorical variables, and Independent t-test or Mann–Whitney U test for continuous variables, as appropriate.

The association between DSPI, PLS categories and dengue severity was assessed using Chi-square analysis. To evaluate the discriminatory ability of DSPI for identifying severe dengue, Receiver Operating Characteristic (ROC) curve analysis was performed. The Area Under the Curve (AUC), sensitivity, specificity, and optimal cut-off values were calculated using the Youden Index. Odds ratios with 95% confidence intervals were calculated for variables significantly associated with severe dengue. A p-value <0.05 was considered statistically significant.

Ethical Considerations: Approval was obtained from the Institutional Ethics Committee prior to commencement of the study. As the study involved retrospective review of hospital records, a waiver of informed consent was obtained from the Ethics Committee. Patient confidentiality was maintained by anonymizing all records prior to data extraction and analysis. The study was conducted in accordance with the ethical principles of the Declaration of Helsinki and the Indian Council of Medical Research guidelines for biomedical research involving human

participants.

Results

Demographic characteristics: A total of 85 children with laboratory-confirmed dengue infection were included in the study. The mean age of the study population was 6.88 ± 3.83 years (median: 7 years; range: 1–12 years). Males constituted 55 (64.7%) of the study population, while females accounted for 30 (35.3%).

Clinical profile: Fever was present in all patients by study definition. Among associated clinical manifestations, vomiting was observed in 41 children (48.2%), abdominal pain in 33 (38.8%), lethargy in 22 (25.9%), myalgia in 37 (43.5%), and rash in 38 (44.7%). Bleeding manifestations were documented in 14 children (16.5%). Hepatomegaly was present in 47 children (55.3%), while splenomegaly was noted in 16 children (18.8%). Shock was documented in 13 children (15.3%) [Figure 1].

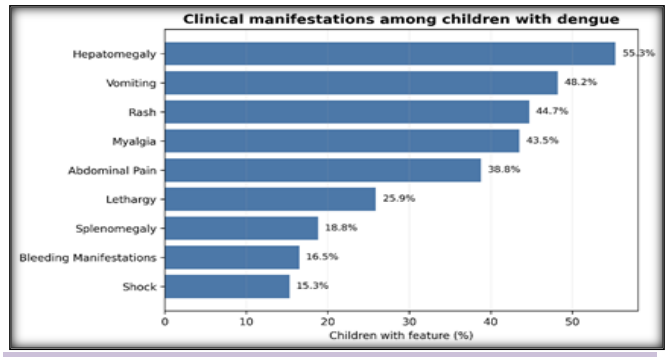

Figure 1: Distribution of clinical manifestations of dengue among cases included in the cohort (n=85)

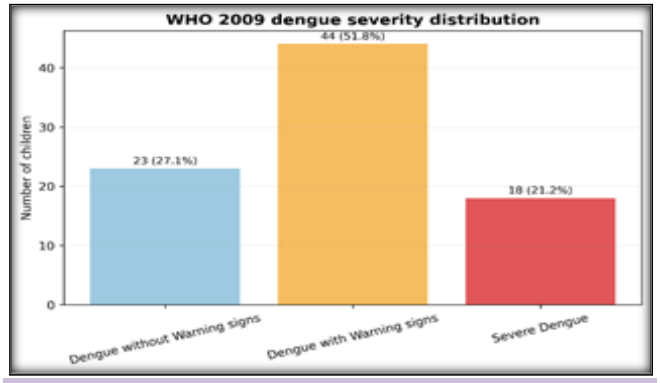

Figure 2: WHO severity distribution of cases considered in the study (n=85)

Haematological profile: The mean hemoglobin concentration was 11.42 ± 1.31 g/dL, while the mean haematocrit was 33.71 ± 3.38%. The mean total leukocyte count was 5853.65 ± 1977.16 cells/mm³. Leukopenia (<4000 cells/mm³) was observed in 14 children (16.5%). The mean platelet count was 1.38 ± 0.96 lakh/mm³. Thrombocytopenia (<1 lakh/mm³) was present in 32 children (37.6%).

Ultrasonographic findings: Ascites was present in 12 children (14.1%), pleural effusion in 5 children (5.9%), and gall bladder wall edema in 13 children (15.3%).

Classification of dengue severity: According to the WHO 2009 classification, 23 children (27.1%) were classified as dengue without warning signs, 44 (51.8%) as dengue with warning signs, and 18 (21.2%) as severe dengue [Figure 2].

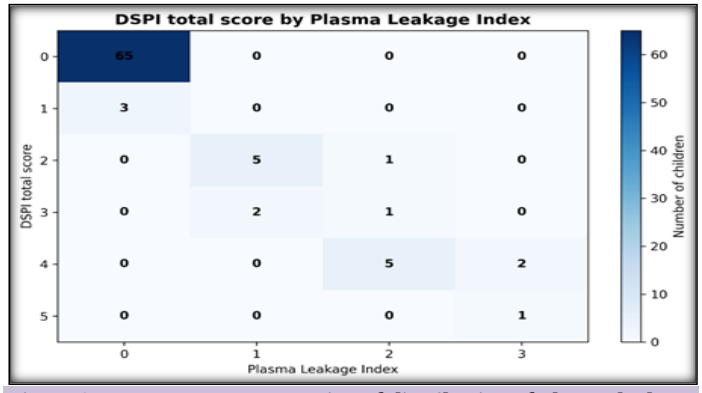

Figure 3: Heat map representation of distribution of plasma leakage scores across Dengue Severity Prediction Index (DSPI) categories with respect to Plasma Leakage Scores (PLS). Increasing DSPI scores were associated with progressively higher plasma leakage burden, with all patients having DSPI scores ≥4 demonstrating moderate-to-severe plasma leakage.

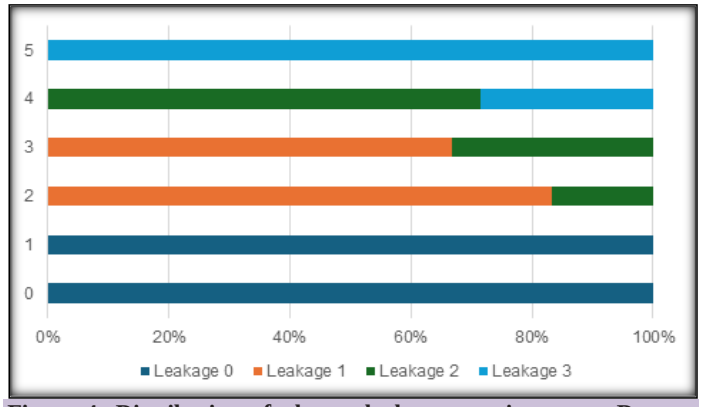

Figure 4: Distribution of plasma leakage severity across Dengue Severity Prediction Index (DSPI) scores. Increasing DSPI scores were associated with progressively greater ultrasonographic evidence of plasma leakage. Children with DSPI scores of 0–1 demonstrated no plasma leakage, whereas those with DSPI scores of 4–5 predominantly exhibited moderate-to-severe plasma leakage

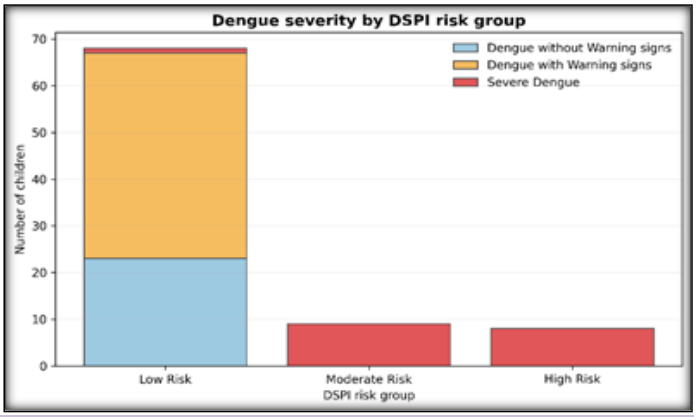

Figure 5: Stacked Bar Chart showing dengue severity as per Dengue Severity Prediction Index (DSPI) categories.

The DSPI demonstrated a clear association with plasma leakage severity [Figure 3]. All children with DSPI scores of 0–1 had no evidence of plasma leakage (Figure 4). Children with DSPI scores of 2–3 predominantly exhibited mild-to-moderate plasma leakage, whereas those with DSPI scores of 4–5 demonstrated moderate-to-severe plasma leakage (Figure 5). A progressive increase in plasma leakage burden was observed with increasing DSPI scores (Figure 3). A statistically significant association was observed between the DSPI and PLS ($\chi^2 = 160.75$, df = 15, $p < 0.001$). Children with DSPI scores of 0–1 demonstrated no evidence of plasma leakage, whereas increasing DSPI scores were associated with progressively greater plasma leakage severity. Moderate-to-severe plasma leakage was predominantly observed among children with DSPI scores ≥4 [Figure 3].

Receiver operating characteristic curve analysis was performed to evaluate the ability of the DSPI to discriminate severe dengue from non-severe dengue. The DSPI showed excellent diagnostic performance, with an area under the curve of 0.992, indicating a high level of discrimination (Figure 6). Using the Youden Index, the optimal cut-off was identified as DSPI ≥1, which provided 100% sensitivity and 97.0% specificity for detecting severe dengue. These findings suggest that even a low DSPI threshold may be useful for early identification of children at risk of severe dengue, although prospective validation in larger cohorts is required before routine clinical application.

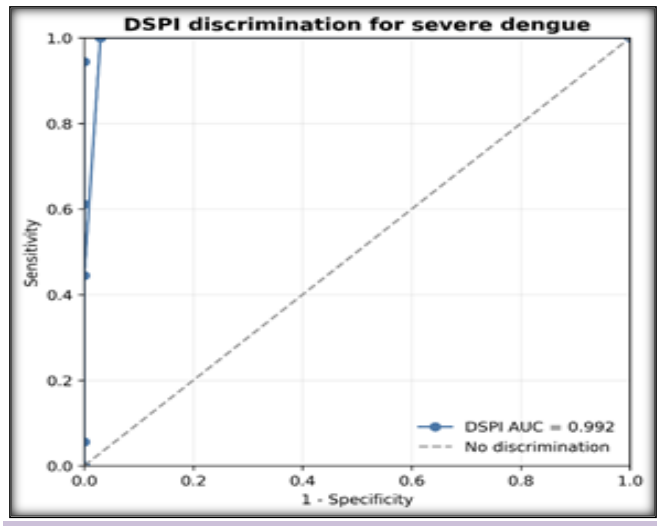

Figure 6: Receiver operating characteristic (ROC) curve showing the discriminatory performance of the Dengue Severity Prediction Index (DSPI) for identifying severe dengue among children with laboratory-confirmed dengue infection. The DSPI demonstrated excellent discrimination for severe dengue, with an area under the curve (AUC) of 0.992. The optimal cut-off was DSPI ≥1, which yielded 100% sensitivity and 97.0% specificity by the Youden Index.

Discussion

Earlier identification severe dengue fever among highly vulnerable pediatric patient is critical because disease can rapidly deteriorate into life threatening capillary leak syndrome multi organ dysfunction and hypovolemic shock. Consistent with established literature highlighting hematological markers as robust predictors of progression to severe disease this study also highlighted significant laboratory abnormalities including thrombocytopenia and leukopenia are important predictors of severe disease.[18–20] Integration of radiological findings including pleural effusion and gall bladder wall edema with the laboratory data is vital for accurate prognostic modeling. Major finding of exceptional diagnostic and prognostic utility of DSPI integrating platelet counts leukopenia clinical shock ultrasonographic evidence of fluid accumulation to stratify patient risk. DSPI demonstrated highly significant progressive association with the PLS. Specifically children with low DSPI scores demonstrated absolutely no evidence of plasma leakage whereas those with high scores predominantly exhibited moderate to severe plasma leakage. Further analysis showed that the DSPI has excellent discriminative power for identifying severe dengue yielding an area under curve of 0.992. DSPI provided 100% sensitivity and 97.0% specificity, suggesting that even a minimal DSPI threshold can serve as a highly reliable, easily integrated tool for early risk stratification and timely intervention in paediatric patients.

A comprehensive meta-analysis of 143 articles identified secondary infection preexisting diabetes renal disease as important predictors of severe disease. They identified clinical warning signs such as hepatomegaly (OR=5.92), ascites (OR=6.30), pleural effusion (OR=5.72), and abdominal pain (OR=2.00) as important warning signs of severe dengue disease.[21] Another systematic review of nine observational studies confirmed that comorbidity secondary infection warning signs and abnormal hematocrit rise low platelet count or independent risk factors.[22] Siddharth Jain et al, identified late hospital presentation (≥5 days), dyspnea at rest, altered sensorium, gastrointestinal bleeding, and hematuria as predictors of severe dengue disease.[23] In line with these findings, a composite index DSPI and PLS can be considered as superior marker of predictive scores that can be utilized for predictive analysis of dengue.

Limitations of the study: the retrospective, cross-sectional design relying on hospital records limits the ability to establish a definitive temporal causality between the onset of specific clinical markers and disease progression. the study did not evaluate the specific viral serotype (DENV1-4) or the patients' prior immune status (primary versus secondary infection); both variables are heavily emphasized in the broader literature as crucial predictive risk factors that strongly dictate the trajectory of dengue severity and phenomena like antibody-dependent enhancement. Prospective validation in larger, multi-centre studies is necessary before the DSPI and PLS indices can be widely adopted for routine clinical application.

Conclusion

Our findings demonstrate that the DSPI, integrating routine clinical, hematological, and ultrasonographic markers, has a highly significant, progressive association with the patients' underlying plasma leakage burden; children with higher scores (≥4) consistently exhibited moderate-to-severe leakage, while those with minimal scores (0–1) showed no evidence of fluid accumulation. Furthermore, the index exhibited outstanding

discriminatory power for identifying severe dengue, yielding an area under the curve of 0.992 and achieving 100% sensitivity alongside 97.0% specificity at an optimal cut-off score of ≥1. Ultimately, the DSPI serves as a highly reliable and easily implementable tool for early risk stratification.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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