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Research Article

Evaluation of outcome predictors in dengue shock syndrome: A comparative study of survivors and non-survivors during the epidemic 2024 in Rawalpindi

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Abstract

Dengue Shock Syndrome (DSS) is a severe complication of dengue fever, leading to plasma leakage and circulatory collapse. This study investigates clinical outcomes and identifies key predictors of survival in DSS patients during the 2024 Rawalpindi epidemic. A prospective cohort study of 126 DSS patients was conducted at three hospitals in Rawalpindi, Pakistan, during the 2024 epidemic peak. Data on 27 DSS variables, including demographics, clinical and laboratory findings, and hospital stay, were analyzed. Survival outcomes were assessed using t-tests and logistic regression to identify significant predictors. The mortality rate was 26.98% in patients with DSS, reflecting the critical nature of DSS. According to current study setting, higher WBC count in CBC tests, higher levels of urea and bilirubin in renal function and liver function tests, co-morbidity, admission to MICU, pleural effusion were determined to be the key predictors of DSS outcome and were associated with higher mortality rate whereas factors like ascites showed significant association with improved survival outcome (p <0.05). For rest of the variables no significant correlation was found (p >0.05). Serological markers, including NS1, IgM, and IgG, also could not significantly predict the outcomes. The identification of seven key predictors of DSS survival underscores the need for targeted management to improve outcomes. Given the limited prognostic value of serological markers, future research should focus on early triage systems and larger multicenter studies to refine treatment protocols in resource-limited settings.

Keywords: Clinical Outcomes, Dengue Shock Syndrome, Early Triage, Epidemic Management, Mortality Risk, Survival Predictors.

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Introduction

Dengue shock syndrome is the worst presentation of dengue fever, characterized by cold extremities, hypotension, plasma leakage and increased hematocrit level [1]. Dengue shock syndrome is becoming a serious public health concern in cities of Pakistan like Karachi, Rawalpindi and Lahore particularly during the months of outbreak. If left untreated or mismanaged, plasma leakage is considered to be among the major clinical features that follows the increased vascular permeability and fluid loss and leads to the severe outcomes of circulatory failure and high mortality [2].

Dengue virus pathophysiology includes the following cascade towards the progression of Dengue Shock Syndrome (DSS). When dengue virus enters the body, it starts the series of coordinated immune responses that drive dengue infections toward dengue shock syndrome. Immune cells start releasing various cytokines and chemokines that trigger inflammation process and immune system activation. This immune system activation is occasionally so intense that leads to endothelial dysfunction which in turn is responsible for the increase in vascular permeability. Increased permeability enhances the diffusion of fluid from blood vessels to the neighboring tissue leading to the decreased blood volume/hypovolemic shock. This condition is the basis of DSS and plasma leakage in severe cases [3].

DSS signs and symptoms include severe muscle and joint aches, high grade fever, hemorrhagic diathesis like thrombocytopenia [4 - 5]. Management of DSS is vital particularly in critical phase of the disease due to lack of antiviral and severity of disease thus requires early diagnosis and fluid resuscitation [6 - 7]. Diagnosis requires specific clinical manifestation like plasma leakage evidenced by hemo-concentration [8].

About 25% of Dengue infections are symptomatic termed as Dengue Fever (F) (8). As per World Health Organization (WHO) fact sheet 2023 focusing Dengue and severe dengue, ~500 000 cases of severe dengue (including DHF/DSS) occur each year. This corresponds to 0.5-1% of total worldwide Dengue infections (9). Country specific data show that 3-5% of DF cases are complicated by DHF/DSS.

Several factors have been identified as predictors of poor outcomes in DSS, which include delayed hospital presentation, comorbidities (such as diabetes and cardiovascular diseases), and inadequate fluid resuscitation. Clinical indicators such as prolonged shock, organ dysfunction, and elevated hematocrit levels are also strongly associated with higher mortality rates [10]. In Rawalpindi's 2024 dengue outbreak, the rapid surge in DSS cases placed immense pressure on healthcare systems, where a high percentage of youth were noted among the fatalities [11].

Moreover, some viral factors, including certain dengue serotypes like DENV-2, have been linked to more virulent disease manifestations [12]. Additionally, serological markers such as the NS1 antigen, IgM, and IgG have been studied in relation to disease severity, with patterns of positivity correlating with worse clinical outcomes. However, in regions like Pakistan, understanding the interaction of these demographic, clinical, and serological predictors remains complex and under-researched [10].

Despite the existence of management protocols guided by the Dengue Expert Advisory Group (DEAG), diagnostic challenges and delays in recognizing shock and organ dysfunction continue to contribute to the high mortality rates of DSS cases. It is critical to better understand how factors such as demographics, clinical presentation, and serological markers relate to outcomes in DSS patients in Pakistan to

improve future treatment approaches and to reduce mortality [10 - 11]. Current study aims to identify and evaluate the significant predictors which influence greatly in the dengue shock syndrome outcomes or consequences.

Methodology

Study design

Comparative, prospective observational study has been designed to evaluate the clinical and demographic predictors of outcomes in patients diagnosed with Dengue Shock Syndrome (DSS) during the 2024 dengue epidemic in Rawalpindi, Pakistan.

Ethical considerations

Ethical approval was obtained from the Institutional Review Board (IRB) of Rawalpindi Medical University. As this was a retrospective study utilizing anonymized hospital record data, the requirement for informed consent was waived.

Study population

The study included 126 patients diagnosed with Dengue Shock Syndrome (DSS) during the peak of the 2024 dengue epidemic according to Dengue Expert Advisory Group (DEAG) criteria managed at major healthcare facilities in Rawalpindi, including Benazir Bhutto Hospital, Holy Family Hospital, and Rawalpindi Teaching Hospital. Inclusion criteria required that patients must have complete clinical and laboratory records documenting their diagnosis of DSS, hospital stay and outcome. Exclusion criteria included patients with incomplete data or non-dengue-related shock.

Data collection

Data from 126 patients was collected to test 27 different variables from patient demographics, key clinical features and laboratory findings to predict DSS outcome. Variables included gender, age, respiratory rate, pulse pressure, urine output, Hb, Hct, platelets, WBCs count, NS1, IgM, IgG, duration of fever at presentation, ALT level, bilirubin level, LDH level, urea level, creatinine level, sodium level, potassium level, duration of illness before hospital admission, pleural effusion, peritoneal ascites, gall bladder wall thickness, splenomegaly, co-morbidity and MICU admission

Demographics: Gender and age.

Clinical presentation: The clinical presentation includes the duration of fever, respiratory rate, pulse pressure of less than 20 mmHg, duration of illness before hospital admission, and the presence of co-morbidities.

Dengue serology: Tests were performed for NS1 antigen, IgM, and IgG antibodies.

Laboratory findings: At admission complete blood count (CBC) including admission hemoglobin (Hb), hematocrit (HCT), white blood cell count (WBCs) and platelets count were performed. Where available liver function tests (ALT and Bilirubin); renal function tests (urea, creatinine), LDH, sodium potassium levels were also performed.

Dengue serological markers: included NS1, IgM, IgG.

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Imaging findings: The Ultrasound findings were included peritoneal free fluid (ascites), pleural effusion, gallbladder wall thickness, and splenomegaly.

Treatment data: included ICU admission details.

Outcome variables: Survived (yes/no), not-survived (yes/no).

All the above-mentioned variables were tested against both of the survived and not-survived DSS patients' groups. To predict significant predictors of DSS outcome all above mentioned variables (parameters) were tested using t-tests statistics considering unequal variances and also using multivariate logistic regression analysis. Results accuracy were determined by using both the tests separately.

Groups

The study population was divided into two groups.

Group 1: Patients who survived DSS (in logistic regression analysis coded as 1)

Group 2: Patients who succumbed to DSS (in logistic regression analysis coded as 0)

Statistical analysis

Descriptive statistics were used to summarize the demographics, clinical features, and laboratory findings for both survivors and non-survivors.

T-Test analysis Using Microsoft Excel analysis was conducted to compare the means of some numerical variables to predict the significant role of any variable towards the DSS outcome.

Multivariate logistic regression Using an online tool with the name of "Stats Blue" was employed to identify independent predictors of mortality. Factors such as gender, age, duration of fever, shock signs, blood tests, renal tests, liver function tests, serological tests and parameters of hospital stay were included in the regression model.

Results

Study population: one hundred and twenty-six (126) patients diagnosed with Dengue Shock Syndrome (DSS) were included in the study. The study cohort included 63 females and 63 males. Out of these, 92 patients survived (survival rate 73%) with 46 females and 46 males, while 34 succumbed to the disease (mortality rate 26.98%) with 17 female and 17 males.

Demographic variables and outcome: Mean age of the survivors was insignificantly lower than those who could not survive (29.18 years vs. 32.35 years; $p = 0.21$) using t test (Table 1). Gender variable showed insignificant difference between survivors and died male and female individuals ($p = 0.73$) using logistic regression (Table 7).

Clinical variables and outcomes: Variables such as respiratory rate, pulse pressure, duration of fever at presentation and duration of illness before hospital admission were non-significant predictors of outcome ($p > 0.05$) represented in Table 1-2, 4. Figure 1 summarizes categorical variables versus the binary outcome (survived/died).

ICU admissions and outcome: A significant difference was observed in ICU admissions, with a lower rate of survival among those admitted to the MICU. Among 34 patients who died 22 patients were admitted to MICU whereas among 92 survivors only 16 patients were admitted to MICU. Using logistic regression, MICU admission was significant predictor ($p = 0.00$) of worse outcome (higher death rate). This increased death outcome might not be due to the admission in MICU but rather due to the severe condition of DSS patients who needed to be shifted in MICU from HDU.

Serological and ultrasonographic variables and outcome: No significant correlations were found between DSS outcome and the presence of dengue serological markers such as NS1, IgM, and

IgG (p >0.05). Ultrasonographic findings including peritoneal fluid (p = 0.01) and pleural effusion (p = 0.02) (Table 2; see also distribution in Table 3) showed significant difference between survivors and non-survivors whereas gall bladder wall thickening and splenomegaly did not significantly differ between survivor and non-survivor groups (p >0.05).

Laboratory findings at admission Hematological parameters at admission such as hemoglobin levels, hematocrit and platelets count showed no significant differences between survivors and non-survivors (p >0.05) whereas WBC count showed significant difference between survivors and non-survivors (p = 0.02). Increased WBC count predicts increased mortality chances. Among renal function tests (such as creatinine level and urea level), liver function tests (Bilirubin level and ALT) and LDH test, urea level and bilirubin level were appeared to be significant predictors of DSS outcome as their P values were determined as 0.04 and 0.03 respectively (Table 1) and in regression models (Table 5: urea p=0.04; Table 6: bilirubin p=0.03). Figure 2 highlights significant numerical variables versus outcome, and Figure 3 presents the distribution and univariable associations for the nine numerical variables assessed (note WBC p<0.05). Figure 4 shows regression coefficients with 95% CIs—variables whose CIs do not cross zero correspond to p<0.05. An increased urea level suggests somehow kidney dysfunction which may lead to worse outcome. In addition, increased bilirubin levels also suggest inappropriate liver functioning leading to the worse outcome.

Comorbidities: There showed significance association between the death and comorbidities. 77 survivors had no comorbidity while only 15 survivors had comorbidity. The p-value of 0.02 (<0.05) shows significant association between comorbidity and death (Table 2 - 3).

Multivariable modeling: When categorical and numerical variables were combined (Table 7), pleural effusion (p=0.04) and ascites (p=0.003) remained significant; WBC showed an attenuated borderline association (p=0.07). Overall model fit statistics are reported with each table (Tables 2, 4–7). Serological markers remained non-significant in their dedicated model (Table 8; model p=0.66).

Significant outcome predictors: Across analyses, MICU admission, comorbidity, pleural effusion, ascites, WBC count, urea, and bilirubin emerged as the main variables associated with DSS outcome (Tables 1 - 8; Figures 1 - 4).

Table 1: T-test analysis to evaluate certain variables as predictors of outcome (mean values and p values).

S/No	Variable	Not Survived (n=34)	Survived (n=92)	P-value
1	Age	32.35294	29.18478	0.21
2	Hemoglobin(g/dL)	14.37059	13.71957	0.3
3	Hematocrit (%)	40.70588	41.825	0.25
4	WBC (x10^9/L)	7.847059	5.750761	0.03*
5	Platelets (x10^9/L)	54.26471	55.09783	0.45
6	Respiratory Rate	20.20588	19.5	0.22
7	Total duration of illness before hospital admission	4.588235	4.391304	0.27
8	Duration of fever at presentation	6.029412	5.967391	0.43
		Not survived (n=24)	**Survived (n= 75)**	
9	Urea level	57.24792	29.6224	0.0003*
		Not survived (n=6)	**Survived (n=35)**	
10	Bilirubin level	4.016667	0.603143	0.041*

Table 2: Logistic regression analysis using five categorical and one numerical variable to predict DSS outcome in 126 patients.

Variable	Coefficient	Standard Error	P-value	Odds Ratio	95% Confidence Interval
Total duration of illness before admission	-0.0664	0.14	0.63	0.9358	(0.7112,1.2313)
Co-morbidity	-1.1143	0.4816	0.02*	0.3281	(0.1277,0.8433)
Ascites	1.336	0.5238	0.01*	3.8039	(1.3626,10.6189)
Pleural effusion	-1.1947	0.5396	0.02*	0.3028	(0.1052,0.8719)
GB thickness	-0.0811	0.5279	0.87	0.9221	(0.3277,2.5948)
Splenomegaly	-0.243	1.3356	0.85	0.7843	(0.0572,10.7482)
Constant	1.6238	0.8068	0.04		

*Significant predictors of DSS outcome
Model fit: Chi-square=17.2901, df = 6, *p*-value = 0.008

Table3: Number of patients presenting different categorical variable symptoms (Present/Absent) and their respective outcomes (Survived/Died).

Parameters	Survived (Present)	Survived (Absent)	Died (Present)	Died (Absent)
Ascites	61	31	15	19
GB Thickness	70	22	26	8
Pleural Effusion	48	44	22	12
Splenomegaly	2	90	1	33
Co-morbidity	15	77	14	20

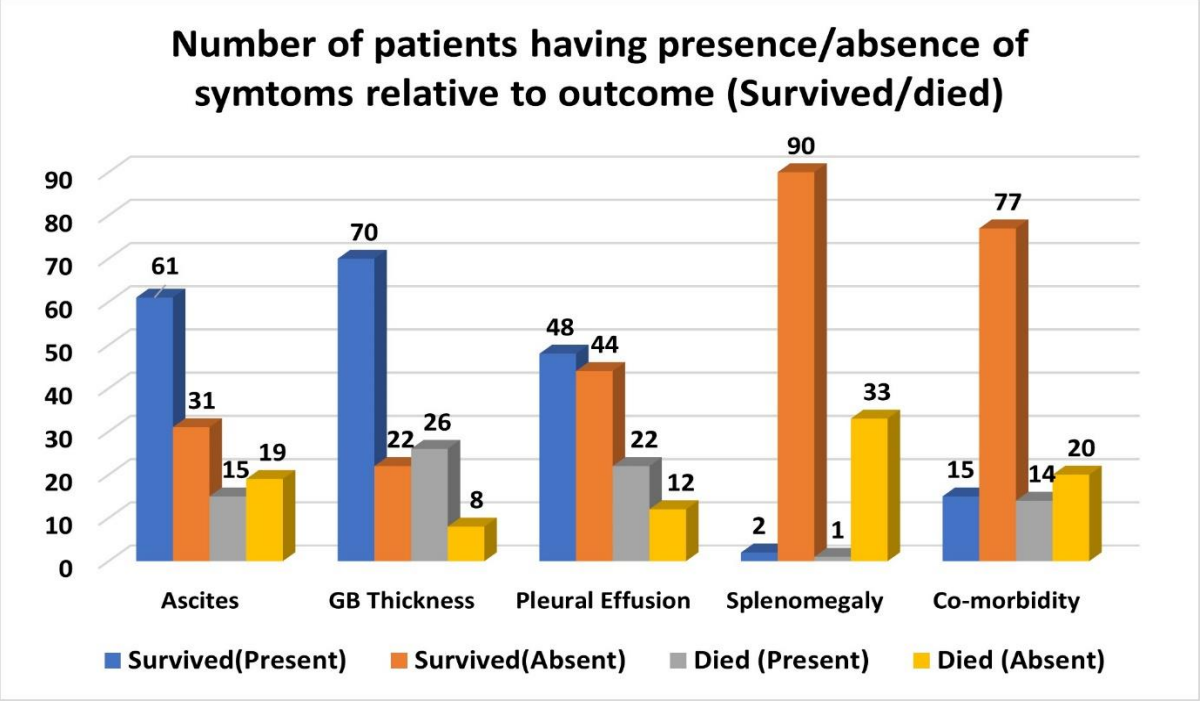

Figure 1: Categorical variables with respective binary outcomes (survived/died).

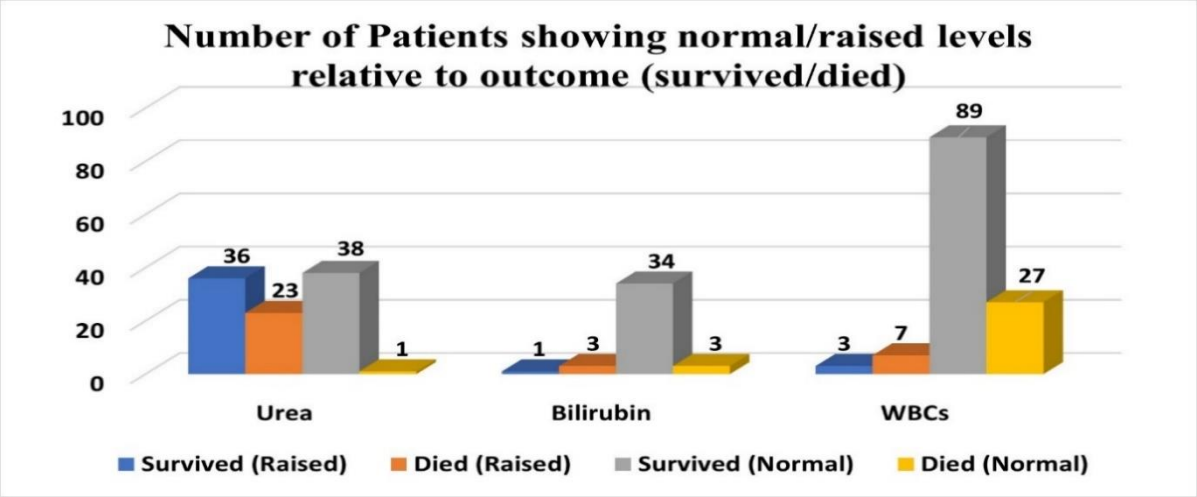

Figure 2: Significant numerical variables with respective binary outcomes (survived/died).

Table 4: Logistic regression analysis using nine numerical variables to predict DSS outcome in 122 patients (Calculations were made from 89 survived and 33 died patients).

Variable	Coefficient	Standard Error	p-value	Odds Ratio	95% Confidence Interval
Pulse Pressure	-0.0214	0.0162	0.18	0.9789	(0.9483,1.0104)
Duration of Fever at presentation	0.0854	0.1365	0.53	1.0891	(0.8334,1.4233)
Hb	-0.071	0.0598	0.23	0.9314	(0.8284,1.0473)
Hct	0.0423	0.0317	0.18	1.0432	(0.9804,1.1099)
Platelets	0.0049	0.0063	0.43	1.0049	(0.9926,1.0174)
WBCs	-0.1049	0.0483	0.02*	0.9004	(0.8191,0.9897)
Age	-0.0054	0.0128	0.67	0.9946	(0.9699,1.0199)
Respiratory rate at arrival	-0.0605	0.0533	0.25	0.9413	(0.8479,1.0449)
Duration of illness before admission	-0.1616	0.1785	0.36	0.8508	(0.5996,1.2072)
Constant	2.91	1.8942	0.12		

*WBCs count appeared as potential predictors of DSS outcome
Model Fit: Chi-square=11.5293, df=9 *p*-value=0.24.

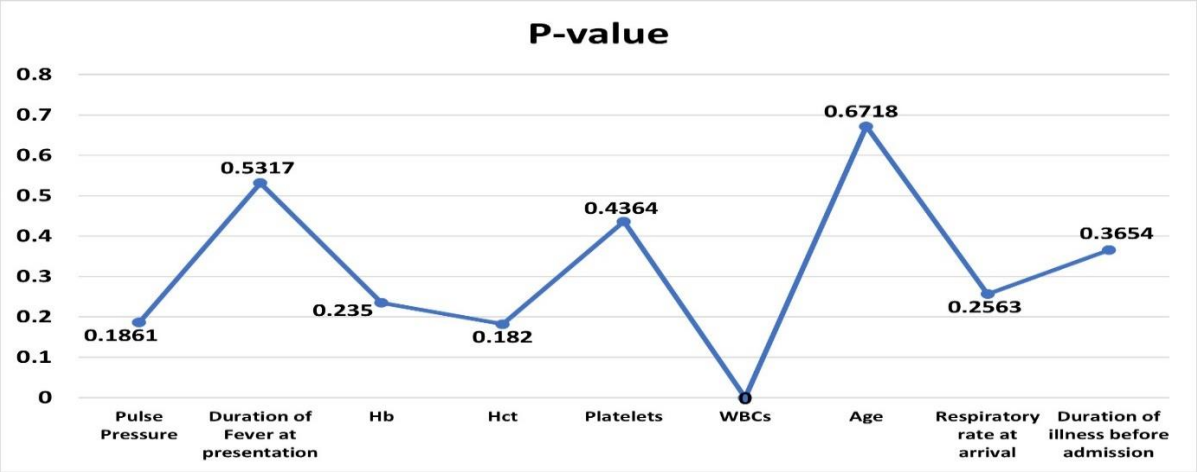

Figure 3: Graphical presentation of 9 numerical variables. WBCs count shows p-value less than 0.05 suggesting significant predictor.

Table 5: Logistic regression analysis using four numerical variables to predict DSS outcome in 99 patients (Calculations were made from 75 survived and 24 died patients).

Variable	Coefficient	Standard Error	p-value	Odds Ratio	95% Confidence Interval
Potassium	-0.7989	0.4488	0.07	0.4498	(0.1867,1.0840)
Sodium	0.0349	0.0547	0.52	1.0355	(0.9303,1.1528)
Creatinine	0.0077	0.4488	0.98	1.0077	(0.4182,2.4284)
Urea	-0.0338	0.0167	0.04*	0.9668	(0.9356,0.9991)
Constant	1.2529	8.11	0.87		

*Urea appeared as potential predictor of DSS outcome
Model fit: Chi square=23.9277, df=4, *p*-value=0.0001.

Table 6: Logistic regression analysis using three numerical variables to predict DSS outcome in 43 patients (Calculations were made from 37 survived and 6 died patients).

Variable	Coefficient	Standard Error	p-value	Odds Ratio	95% Confidence Interval
ALT	0.0008	0.002	0.68	1.0008	(0.9970,1.0046)
Bilirubin	-1.0647	0.4917	0.03*	0.3448	(0.1316,0.9039)
LDH	-0.0005	0.0003	0.08	0.9995	(0.9989,1.0001)
Constant	4.0598	1.0975	0.0002		

*Bilirubin appeared as potential predictor of DSS outcome.
Model fit: Chi-square= 17.0459, df = 3, *p*-value= 0.0007.

When categorical data and numerical data are combined in Logistic regression analysis then variable values may change according to parameters being tested in a set simultaneously. Table 7 below presents this changed p-value having no effect on the status of significant predictors. Different sets of variables were tested in logistic regression analysis to verify the results significance.

Table 7: Logistic regression analysis using numerical and categorical variables to predict DSS outcome in 126 patients (Calculations were made from 92 survived and 34 died patients).

Variable	Coefficient	Standard Error	p-value	Odds Ratio	95% Confidence Interval
Gender	-0.165	0.49	0.73	0.8479	(0.3245,2.2154)
Age	-0.0009	0.0158	0.95	0.9991	(0.9688,1.0304)
Urine output	0.2549	0.5259	0.62	1.2903	(0.4603,3.6170)
Pleural effusion	-1.1712	0.5939	0.04*	0.31	(0.0968,0.9928)
Ascites	1.635	0.5657	0.003*	5.1295	(1.6926,15.5451)
GB wall Thickness	0.0267	0.5857	0.96	1.027	(0.3259,3.2369)
Splenomegaly	-0.7483	1.3782	0.58	0.4731	(0.0318,7.0492)
Duration of fever at presentation	0.1053	0.1511	0.48	1.1111	(0.8263,1.4940)
Hb	-0.0807	0.0606	0.18	0.9224	(0.8191,1.0388)

Variable	Coefficient	Standard Error	p-value	Odds Ratio	95% Confidence Interval
Hct	0.0385	0.0342	0.26	1.0392	(0.9719,1.1113)
Platelets	0.008	0.0075	0.28	1.008	(0.9934,1.0230)
WBCs	-0.0949	0.0539	0.07*	0.9095	(0.8183,1.0108)
Total duration of illness before admission	-0.1865	0.1946	0.33	0.8299	(0.5667,1.2153)
Respiratory rate	-0.0762	0.0572	0.18	0.9267	(0.8284,1.0366)

*Variables appeared as potential predictors of DSS outcome when higher numbers of variables were tested simultaneously in multivariate logistic regression analysis.
Model Fit: Chi-square = 26.3564, df = 15, *p*-value = 0.03.

Table 8: Logistic regression analysis of serological markers (categorical variables) to predict DSS outcome in 122 patients (Calculations were made from 90 survived and 32 died patients).

Variable	Coefficient	Standard Error	p-value	Odds Ratio	95% Confidence Interval
IgG	0.4528	0.4709	0.33	1.5727	(0.6249,3.9581)
IgM	-0.3562	0.4704	0.44	0.7003	(0.2785,1.7608)
NS1	-0.4225	0.6044	0.48	0.6554	(0.2005,2.1427)
Constant	1.3425	0.5976	0.02		

Model Fit: Chi-square = 1.5760, df = 3, *p*-value = 0.66

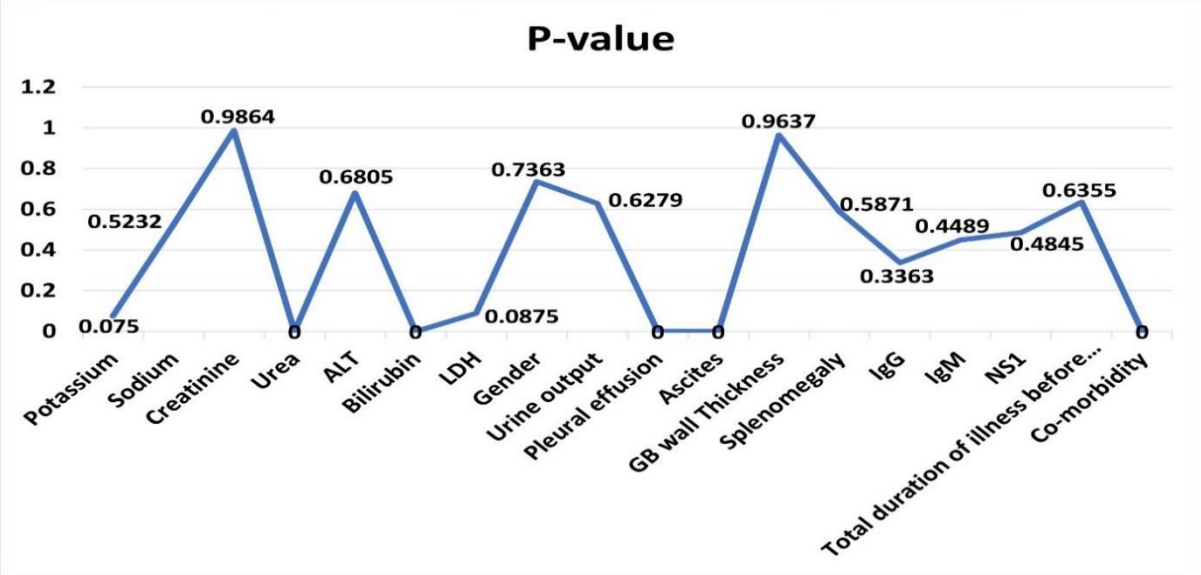

Figure 4: Variables touching zero lines are the significant predictors of DSS outcome based on less than 0.05 p-values.

Discussion

This study provides critical insights about the predictors of outcome and improving the management of Dengue Shock Syndrome (DSS) during the 2024 epidemic in Rawalpindi. A total of 126 DSS patients were included in the study who presented during the peak of epidemic. The mortality rate of 26.98% demonstrates the severity of DSS and the challenges faced by healthcare system during such outbreaks. Important

findings of the current study are the identification of independent variables for the prediction of DSS outcome. Significant predictors included the MICU admission, co-morbidity, pleural effusion, peritoneal ascites, urea levels, bilirubin levels and WBCs count.

According to logistic regression analysis applied on current research data the increased MICU admissions predicted the worse outcome (increased mortality rate) and is supported by study conducted on PICU [12]. Increased co-morbidity caused increased death outcome, whereas increased ascites predicted the better outcome (increased survival rate). Ascites predicts the outcome in better survival rate. This finding may be considered in a way that ascites development in patients triggers the early management strategies that may lead to better outcome (survival) [13] but further investigations and monitoring other confounding parameters may better interpret such kind of results with relevance to clinical presentations. Increased pleural effusions are directly proportional to the severe disease outcomes (mortality). Increased levels of urea, bilirubin and WBCs count also significantly suggest these variables to be prominent predictors of worse outcome.

The compliance of current results to prior studies on DSS management is clear, but with some important differences. Worldwide the significance of early intervention in dengue management is well-documented and current study, although insignificantly, endorses that early presentation to hospital showed better outcome (Table 1). Prior studies from Southeast Asia have emphasized factors like prolonged shock and organ failure as strong predictors of mortality [14], current study findings comply with this, suggesting organ dysfunction/failure variables like increased urea and bilirubin levels and presence of pleural effusions and ascites suggestive of shock are prominent predictors of DSS outcome (Table 2, 5, 7). Furthermore, despite prolonged fever typically being a concern, in current cohort, fever duration did not significantly correlate with outcomes (Table 1, 4). This points to possible regional differences in disease dynamics or can be due to the variability of healthcare access during current epidemic.

In previous literature age, factors have been reported as significant predictors of DSS outcome stating that children of 6-10 years of age are more prone to DSS complication predicting poor survival in children [15]. Current study showed no age difference in predicting DSS outcome. Gender differences in DSS have been debated in literature [11] with some studies noting poorer outcomes in females [15 - 16] potentially due to hormonal or immune-related factors. However, present study has found no statistically significant difference between male and female survival rates (p = 0.73). This could be due to the study cohort selection criteria, but it also raises questions about how gender-specific responses to dengue may vary depending on local epidemiology and healthcare conditions.

Role of comorbidities in progression of DSS and then prediction of severe outcome is reportedly significant. Among comorbidities diabetes mellitus plays important role for disease progression and difficult management [17]. Likewise hypertension also pose great threat to the DSS patients in terms of increased probability of worsening outcome [18]. Current study results comply with the previous research presenting the co-morbidity factor as significant predictor in DSS severe outcome (Table 2). Current study shows increased levels of WBC counts, urea levels and bilirubin levels as significant predictors of worse DSS outcome. These results comply with previous knowledge as it is documented that high levels of WBCs are significantly

associated with major bleeding issues which further lead to prolonged hospital stay [19] and poor outcome. Raised levels of blood urea indicate renal dysfunction in DSS patients leading to worse outcome [20]. Likewise: raised levels of bilirubin also suggestive of liver dysfunction suggestive of poor survival outcomes in DSS patients [19].

Among other significant categorical predictors are pleural effusion and peritoneal ascites. In literature both of these variables are considered in children to be the prominent predictors of DSS outcome [13]. In current study, increased pleural effusion cases predict the poor outcome of survival [13], whereas peritoneal ascites predicts the better survival outcome. The compliance of current results in case of ascites is supported by previous scientific evidence and is due to the early noticing of peritoneal ascites leading to early management and better survival [13, 21]. Furthermore, results related to pleural effusion also showed significant compliance with previous research. In present study pleural effusion was present in 48 out of 92 survivors and in 22 out of 34 non-survivors whereas peritoneal ascites was present in 61 out of 92 survivors and 15 out of 34 non-survivors (Table 2, 3).

Interestingly, despite the central role that serological marker (NS1, IgM, IgG) play in dengue diagnostics, our study found no significant correlation between these markers and patient outcomes. This lack of correlation, while surprising, suggests that the timing of serological positivity relative to disease progression may limit its utility in predicting clinical outcomes, particularly in a critical care context where other factors, such as hemodynamic stability, take precedence. This surely warrants a larger sample size to conclude but none the less worth mentioning that hemodynamic status [14] takes precedence compared to serological markers in patient outcome.

The comorbid conditions play a major role in deciding the outcome of many medical illnesses and they should be taken into consideration while managing patients with dengue shock syndrome. This study shows a significant association between comorbidities and death. 77 survivors had no comorbidity while 15 survivors reported with comorbidity. Out of 34 non-survivors, 14 had DSS with co-morbidities and 20 patients had no co-morbidity (Figure 1). Presence of comorbidity is associated with higher death rates in Dengue patients [22].

While this study adds valuable data, especially in a Pakistan's context where research on DSS is relatively scarce, it is not without limitations. Our cohort size was not much large, limiting the power to detect some differences, particularly around age and gender or more debatable clinical variables. Moreover, the observational nature of the study means that results were dependent on the quality and completeness of existing medical records, which may introduce biases or inconsistencies.

Another limitation is the lack of advanced imaging or cardiac assessments [23] in many of the patients, which could have provided deeper insights into the pathophysiology of DSS, especially regarding shock and organ dysfunction. Future studies that incorporate more comprehensive diagnostic workups may offer a more complete picture of how DSS progresses in different patient populations.

This study provides the groundwork for further research into the predictors of DSS outcomes, but it also opens up several avenues for future investigation. Larger, multi-center studies across Pakistan are needed to confirm the findings, particularly around the role of ICU admission, comorbidity and development of ascites during the course of DSS progression. Additionally, there is a need to explore the viral dynamics of dengue in Pakistan, including serotype-specific differences, to

better understand why some patients progress to shock and others do not. Biomarker studies could predict the transition from uncomplicated dengue to DSS before clinical deterioration would be invaluable, particularly in resource-constrained settings.

Conclusion

This study highlights the seven significant factors, such as WBC count, Urea levels, bilirubin levels, ICU admission, co-morbidity, pleural effusion and peritoneal ascites to be the key predictors of survival in DSS. Some traditional markers of severity, such as fever duration and serological status, platelet counts, and hematocrit levels did not show strong correlations with survival outcome in present cohort study. Even then the importance of rapid, aggressive intervention cannot be overstated. These findings offer practical insights for clinicians managing DSS in Pakistan and provide a foundation for refining current treatment protocols to better address the challenges of dengue outbreaks.

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Conflict of interest

The authors have no conflict of interest.

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Data availability statement

All the data used in this study is already provided in paper.

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