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Clinical Profile, Microbial Spectrum, and Short-Term Outcomes in Patients with Spontaneous Bacterial Peritonitis: A Cross-Sectional Analytical Study

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ABSTRACT

Introduction: Spontaneous Bacterial Peritonitis (SBP) is a common and severe complication of ascites in cirrhotic patients, contributing significantly to morbidity and mortality. This study aimed to assess the clinical, laboratory, and microbiological profiles and identify association of adverse outcomes among SBP patients.

Method: A cross-sectional study was done over 18 months in a tertiary hospital. A total of 84 cirrhotic patients with ascites were enrolled. SBP was diagnosed based on ascitic fluid polymorphonuclear leukocyte count ≥250 cells/mm³. Statistical analyses included Pearson correlation, logistic regression, and Kaplan-Meier survival analysis.

Result: SBP was diagnosed in 29.8% of patients. Ascitic neutrophil count was significantly higher in SBP cases (292.3 ± 31.9 vs. 126.5 ± 15.0, p <0.001). E. coli was the most common isolate (60%). UGI bleeding (p = 0.001), hepatorenal syndrome (p = 0.003), and CTP Class C status (p = 0.0017) were significantly more in SBP. SBP patients had longer hospital stays and less duration of survival (24.3 vs. 27.9 days, p = 0.03). SBP was an independent predictor of mortality (OR = 5.6, p = 0.04).

Conclusion: SBP is associated with severe complications, increased ICU need, and reduced short-term survival. Early diagnosis and risk stratification are needed for improving outcomes.

Keywords: Cirrhosis, Ascites, Spontaneous Bacterial Peritonitis, Hepatorenal Syndrome, Child-Turcotte-Pugh

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INTRODUCTION

Ascites is a common and serious complication of liver cirrhosis, affecting nearly in about 50% of patient with decompensated cirrhosis in 10 years.[1] Among the complications of ascites, Spontaneous Bacterial Peritonitis (SBP**)** represents a life-threatening condition, characterized by infection of the ascitic fluid in the absence of any evident intra-abdominal surgically treatable source. SBP significantly contributes to increased morbidity, prolonged hospitalization, and mortality in cirrhotic patients.[2]

The pathogenesis of SBP primarily involves bacterial translocation from the gut into the peritoneal cavity, facilitated by impaired immunity, altered gut permeability, and decreased bactericidal activity of ascitic fluid.[3] Clinically, SBP may present with subtle or overt features including fever, abdominal pain, altered mental status, or may be entirely asymptomatic. Prompt diagnosis relies on ascitic fluid analysis, where a polymorphonuclear leukocyte (PMN) count of >250 cells/mm³ and/or a positive culture confirms the diagnosis.[4]

Despite the availability of standard treatment protocols, the outcome of SBP varies widely depending on underlying liver function [5], presence of complications such as hepatorenal syndrome (HRS) [6], and timely initiation of therapy [7,8]. Several studies have focused on clinical and microbiological aspects of SBP [9,10]; however, limited data are available on correlating these findings with short-term outcomes such as ICU admission, hospital stay, and survival.

This study aims to evaluate the clinical profile, laboratory markers, microbial spectrum, complications, and short-term outcomes in patients with SBP compared to those with non-infected ascites. Furthermore, statistical models such as correlation, logistic regression, and survival analysis were applied to identify association of ICU admission, mortality, and duration of hospital stay.

MATERIALS AND METHODS

This cross-sectional study was done between February 2024 and July 2025 in the Department of Medicine at a tertiary care teaching hospital. A total of 84 adult patients diagnosed with liver cirrhosis and ascites were included in the study. The diagnosis of cirrhosis was done based on a combination of clinical history, laboratory parameters, and radiological findings. Diagnostic paracentesis for all patients was done at the time of admission, and the ascitic fluid was analyzed for cell counts, protein levels, albumin, and culture sensitivity testing.

Patients with aged ≥18 years and clinically and radiologically confirmed cirrhosis and ascites were included in the study. If patient had received antibiotics in the three weeks preceding admission, had secondary peritonitis from an intra-abdominal surgical source, or had tuberculous, malignant, or hemorrhagic ascites and cases of ascites due to non-cirrhotic portal hypertension were also excluded.

Spontaneous bacterial peritonitis (SBP) was diagnosed when the ascitic fluid showed a polymorphonuclear leukocyte (PMN) count of ≥250 cells/mm³, with or without a positive microbial culture, in the absence of a secondary cause of peritonitis. Ascitic fluid samples were taken under strict aseptic precautions before the administration of any antibiotics.

Detailed clinical data were collected, including presenting symptoms, presence of hepatic encephalopathy, upper gastrointestinal (UGI) bleeding, hepatorenal syndrome (HRS), and requirement for intensive care unit (ICU) admission. Laboratory investigations included complete blood counts, liver and renal function tests, coagulation profiles, viral markers, and serum electrolytes. Severity of liver disease was assessed using the Child-Turcotte-Pugh (CTP) classification, and hepatic encephalopathy was graded according to the West Haven criteria.

The primary outcomes such as hospital stay duration, ICU admission, in-hospital mortality were assessed. Statistical analysis was done using SPSS version 25. Descriptive statistics were presented as mean ± standard deviation for continuous variables and as frequency with percentages for categorical variables. Between-group comparisons were conducted using independent t-tests or Mann-Whitney U tests for continuous data and Chi-square or Fisher's exact tests for categorical data. Pearson correlation analysis was used to assess the relationship between ascitic neutrophil count and duration of hospital stay. Binary logistic regression was employed to determine association of ICU admission and mortality. Additionally, Kaplan-Meier survival analysis was done to compare survival durations between SBP and non-SBP groups, with statistical significance assessed using the log-rank test. A p-value of less than 0.05 was considered statistically significant.

RESULTS

In our study there was no significant differences in age or gender between patients with spontaneous bacterial peritonitis (SBP) and those without SBP (table 1).

Patients with SBP had a significantly higher neutrophil count (292.3 ± 31.9 cells/mm³) compared to those without SBP (126.5 ± 15.0 cells/mm³) ($p < 0.001$), showing a marked inflammatory response. Other laboratory parameters, including bilirubin, albumin, PT, INR, and creatinine, did not show significant differences ($p > 0.05$).

Micro-organisms identified in SBP cultures were predominantly *E. coli* (60%), followed by *Klebsiella* and *Staphylococcus pneumoniae* (20% each).

UGI bleeding was more prevalent in the SBP group (48.0%) compared to the non-SBP group (10.2%) ($p = 0.001$). Ascites grade distribution did not show a significant difference between the two groups ($p > 0.05$).

Table 1: Association of Spontaneous Bacterial Peritonitis (SBP) With Clinical Variables

Variable	SBP Present (n=25) (%)	SBP Absent (n=59) (%)	Total n (%)	p-value
Age-group				
≤30	6 (24.0)	9 (15.3)	15 (17.9)	0.74
31-40	6 (24.0)	17 (28.8)	23 (27.4)	
41-50	6 (24.0)	18 (30.5)	24 (28.6)	
51-60	5 (20.0)	13 (22.0)	18 (21.4)	
≥61	2 (8.0)	2 (3.4)	4 (4.8)	
Mean ± SD	42.0 ± 9.9	42.1 ± 12.0	42.1 ± 10.5	
Gender				
Female	8 (32.0)	23 (39.0)	31 (36.9)	0.54
Male	17 (68.0)	36 (61.0)	53 (63.1)	
International Ascites Club Grading				
Grade 1	4 (16.0)	20 (33.9)	24 (28.6)	0.24
Grade 2	16 (64.0)	31 (52.5)	47 (56.0)	
Grade 3	5 (20.0)	8 (13.6)	13 (15.5)	
UGI Bleeding				
Absent	13 (52.0)	53 (89.8)	66 (78.6)	0.001*
Present	12 (48.0)	6 (10.2)	18 (21.4)	
Hepatorenal Syndrome (HRS)				
Absent	18 (72.0)	56 (94.9)	79 (94.0)	0.003*
Present	7 (28.0)	3 (5.1)	10 (6.0)	
Hepatopulmonary Syndrome (HPS)				
Absent	24 (96.0)	59 (100.0)	83 (98.8)	0.3
Present	1 (4.0)	0 (0.0)	1 (1.2)	
Child-Turcotte-Pugh (CTP) Score				
A	4 (16.0)	21 (35.6)	25 (29.8)	0.017*
B	9 (36.0)	27 (45.8)	36 (42.9)	
C	12 (48.0)	11 (18.6)	23 (27.4)	
Encephalopathy				
Absent	18 (72.0)	43 (72.9)	61 (72.6)	0.94
Present	7 (28.0)	16 (27.1)	23 (27.4)	
Total	25 (100.0)	59 (100.0)	84 (100.0)	

Table 2: Correlation and Regression Analysis

Analysis Type	Associated Variable 1	Variable 2/Outcome	Statistical Measure	95% CI	p-value
Correlation Analysis*	Hospital Stay (days)	Ascitic Fluid Neutrophils	r = 0.38	-	0.001
	SBP Present	ICU Admission	OR = 1.67	0.38-7.34	0.49
Binary Logistic Regression	Albumin Used	ICU Admission	OR = 1.04	0.26-4.15	0.96
	CTP Class C vs A/B	ICU Admission	OR = 3.82	1.01-14.4	0.04#

*Person correlation test; #Statistically significant; SBP - Spontaneous Bacterial Peritonitis; CTP - Child-Turcotte-Pugh

The SBP group had significantly worse outcomes. A higher proportion of SBP patients were classified as CTP Class C (48.0%) compared to the non-SBP group (18.6%) (p = 0.0017). Additionally, the West Haven criteria showed that 52.0% of SBP patients had severe hepatic encephalopathy (Grade 3), compared to 22.0% in the non-SBP group (p = 0.03).

Patients with SBP had a significantly higher incidence of hepatorenal syndrome (HRS) (28.0% vs. 5.1%, p = 0.003), although hepatic encephalopathy was similarly prevalent in both groups (28.0% vs. 27.1%, p = 0.94). Hepatopulmonary syndrome (HPS) was rare and not significantly different between the two groups (p = 0.30).

Table 2 shows the correlation between hospital stay duration and ascitic fluid neutrophil count. A statistically significant positive correlation (r = 0.38, p = 0.001) was seen using Pearson's correlation test. This shows that patients with higher neutrophil counts in ascitic fluid have a longer hospital stay, showing that increased inflammatory activity is associated with prolonged clinical management.

Table 2 also shows the results of a binary logistic regression analysis evaluating association of ICU admission among patients with ascites. Although SBP presence (OR = 1.67, p = 0.49) and albumin use (OR = 1.04, p = 0.96) were not significant associated, patients with Child-Turcotte-Pugh (CTP) Class C had a significantly increased odds of ICU admission (OR = 3.82, 95% CI: 1.01-14.4, p = 0.04). This shows that hepatic decompensation plays a significant role in determining the severity and critical care requirement in these patients.

As seen in Table 3, SBP was found to be a significant independent association of mortality (OR = 5.6, 95% CI: 1.02-30.7, p = 0.04), showing a 5.6 times increased risk of death in patients with SBP compared to those without SBP. Neither albumin use (OR = 0.85, p = 0.84) nor CTP Class C status (OR = 2.71, p = 0.16) reached statistical significance, although the latter showed a trend toward

increased mortality.

Table 4 shows Kaplan-Meier survival analysis, comparing the survival duration of patients with and without SBP. The mean survival duration was significantly lower in the SBP group (24.3 ± 3.2 days) compared to the non-SBP group (27.9 ± 2.1 days), with a log-rank p-value of 0.03. This shows that SBP is associated with reduced short-term survival in patients with cirrhotic ascites.

Table 3: Binary Logistic Regression - association of Mortality

Associated Variable	Odds Ratio (OR)	95% CI	p-value
SBP Present	5.6	1.02-30.7	0.04
Albumin Used	0.85	0.17-4.18	0.84
CTP Class C vs A/B	2.71	0.66-11.1	0.16

SBP - Spontaneous Bacterial Peritonitis; CTP - Child-Turcotte-Pugh
CI – Confidence Interval

Table 4: Kaplan-Meier Survival Analysis Between SBP and Non-SBP Groups

Group	Mean Survival (days) ± SD	Log-Rank p-value
SBP	24.3 ± 3.2	**0.03**
Non-SBP	27.9 ± 2.1	

SBP - Spontaneous Bacterial Peritonitis

DISCUSSION

In the present study among 84 cirrhotic patients with ascites, majority were in the 31-50-year age and male were more common (53:31) similar to other study. Spontaneous bacterial peritonitis (SBP) was seen in 29.8 % of cases, similar to a prevalence of 21.4 % reported by Duah A et al [3] and the 67 % culture-positive rate shown by Ajayi AO et al [11].

Upper-gastrointestinal bleeding shown as a powerful clinical correlate of SBP ($\chi^2 = 14.9$; $p = 0.001$). This finding is similar to Shih HA et al., who showed that bacteremia in bleeding cirrhotics worsens short-term survival.[12] Mortality in our SBP cohort (16 %) was 5 times higher than in non-SBP ascites (3.4 %; $\chi^2 = 4.2$; $p = 0.04$), confirming SBP as a risk factor by Deleuran T et al. study. [13]

Hepatorenal syndrome (HRS) was significantly seen among SBP patients (28 % vs 5.1 %; $\chi^2 = 8.7$; $p = 0.003$), showing that infection may cause renal dysfunction.[14] we found fewer SBP (1.2%) in patients already having HRS than expected from from study by Fasolato S et al[15] who reported 33.6% had a bacterial infection-induced renal failure. They reported the prevalence of renal failure was higher in spontaneous bacterial peritonitis (SBP) than in other types of infections. This difference may show earlier antibiotic use, differing ascitic protein levels or unmeasured confounders in our population.

Liver-disease severity strongly associated with infection risk. almost half of SBP cases were Child-Turcotte-Pugh (CTP) class C, whereas only one-fifth of non-SBP patients fell into this group ($p = 0.0017$). The gradient accords with Miozzo SAS et al [16], who showed increasing SBP incidence with worsening CTP stage, and with the observations of Elzouki et al.[17] (CTP plus acute kidney injury as mortality markers) 87 and Paul K et al [18] (highest SBP burden in class C).

We did not find a statistically significant link between West Haven encephalopathy grade and SBP, similar finding was seen in Paul K et al [17] study. However, Huang CH et al.'s [19] composite seven-stage model, which integrates both encephalopathy and SBP, still show superior mortality discrimination in cirrhosis, showing relationship between the two phenomena.

Microbiologically, *Escherichia coli* showed (52 %), similar to other study finding. (41.7 % in Duah A et al.[3]; 70 % in Ajayi AO et al.[11]). Ascitic neutrophil count mean value in SBP (292.3 ± 31.9 cells mm^{-3}) was almost doubled than non-SBP (126.5 ± 15.0 cells mm^{-3}; $p < 0.001$). This shows the diagnostic utility of the absolute neutrophil count advocated by Sheta T et al [20], who showed an ANC cut-off of 2.8×10^2 cells mm^{-3} for high sensitivity and specificity. Our results are similar to Victor GH et al. who showed neutrophil increase in infected ascites, though the differences were not significant.[21] Conversely, routine serum indices (bilirubin, INR, creatinine) did not differentiate infection in our series, at variance with the hepatitis-C-based cohort of Metwali K et al[22] where CRP and other biochemical markers were associated. Aetiological heterogeneity may account for these divergent signals.

Tay PWL et al.'s [23] meta-analysis showed the worldwide SBP prevalence at 17.1 %, highest in Africa, while Nguyen LC et al [24] showed increasing fluoroquinolone resistance and the challenge of culture-negative SBP. Our prevalence and majority of Gram-negative isolates show the need for region-specific surveillance and empirical antibiotic stewardship.

CONCLUSION

This study shows the significant clinical impact of spontaneous bacterial peritonitis (SBP) in patients with cirrhotic ascites. While there were no differences in age or gender SBP patients show significantly increase in ascitic neutrophil counts and a higher prevalence of complications such as upper gastrointestinal bleeding, hepatorenal syndrome, and severe hepatic encephalopathy. SBP was found as associated factor of mortality and associated with longer hospital stays and reduced survival durations. Patients with advanced liver disease (CTP Class C) were more likely to require ICU admission, showing the role of hepatic decompensation in disease severity. These findings show the need for early diagnosis and aggressive management of SBP to improve patient outcomes.

Individual Author's Contribution: RKT contributed to study design and manuscript preparation. **NG** participated comprehensively in all stages of the research, including study conception, design, data collection, analysis, interpretation, and manuscript writing, ensuring complete oversight of the study's development and execution.

Availability of data: The data of this study are available from the corresponding author upon reasonable request.

Declaration of Non-use of generative AI Tools: This article was prepared without the use of generative AI tools for content creation, analysis, or data generation. All findings and interpretations are based solely on the authors' independent work and expertise.

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