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ASSESSING THE RELIABILITY OF THE DIPSTICK METHOD FOR SPONTANEOUS BACTERIAL PERITONITIS: A COMPARATIVE STUDY WITH ASCITIC FLUID ANALYSIS

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Abstract

Background:

Cirrhosis frequently progresses to ascites, and spontaneous bacterial peritonitis (SBP) remains a life-threatening complication associated with significant mortality, particularly when diagnosis is delayed. Although ascitic fluid polymorphonuclear (PMN) count ≥250 cells/mm³ is the diagnostic gold standard, laboratory dependence may hinder timely management in resource-limited settings. This study evaluates the diagnostic accuracy of leukocyte esterase dipstick testing as a rapid bedside tool for early detection of SBP in cirrhotic patients with ascites.

Materials and Methods:

This cross-sectional diagnostic accuracy study was conducted at Federal Government Polyclinic Hospital, Islamabad, enrolling 250 consecutive adult cirrhotic patients with ascites undergoing diagnostic paracentesis. Leukocyte esterase dipstick testing was performed bedside and compared with the reference standard of ascitic fluid PMN count ≥250 cells/mm³. Diagnostic performance parameters including sensitivity, specificity, predictive values, and overall accuracy were calculated using SPSS, with $p < 0.05$ considered statistically significant.

Results:

A total of 250 cirrhotic patients with ascites were analyzed, of whom 75 (30.0%) were diagnosed with spontaneous bacterial peritonitis based on ascitic PMN count ≥250 cells/mm³. Patients with SBP more frequently presented with fever, abdominal pain, hepatic encephalopathy, higher serum bilirubin levels, and low ascitic protein (all $p < 0.05$), while age and gender distribution were comparable between groups. Using a dipstick threshold of ≥1+, leukocyte esterase testing demonstrated a sensitivity of 84.0%, specificity of 89.7%, positive predictive value of 77.8%, negative predictive value of 92.9%, and overall diagnostic accuracy of 88.0% for SBP detection.

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Conclusion:

Leukocyte esterase dipstick testing shows high diagnostic accuracy as a rapid, bedside screening tool for spontaneous bacterial peritonitis in cirrhotic patients with ascites. Its low cost and immediate availability make it a practical adjunct in resource-limited settings to support early clinical decisions and prompt antibiotic initiation.

INTRODUCTION:

Cirrhosis represents the final common pathway of chronic liver disease and remains a major global health burden, accounting for substantial morbidity and mortality worldwide.[1] Progressive hepatic dysfunction leads to portal hypertension and the development of ascites, one of the most common and clinically significant complications of decompensated cirrhosis.[2] Among patients with ascites, spontaneous bacterial peritonitis (SBP) is a frequent and life-threatening infection characterized by bacterial translocation into ascitic fluid in the absence of an evident intra-abdominal surgically treatable source.[3]

SBP is associated with significant short-term mortality, with reported in-hospital mortality rates ranging from 20% to 30%, particularly when diagnosis and treatment are delayed.[4] The condition often presents with subtle or nonspecific clinical manifestations, including fever, abdominal discomfort, worsening ascites, hepatic encephalopathy, or renal dysfunction.[5] In some patients, SBP may be entirely asymptomatic, underscoring the importance of routine diagnostic paracentesis in all hospitalized cirrhotic patients with ascites.[6] Early detection and prompt initiation of appropriate antibiotic therapy have been shown to significantly reduce mortality and prevent progression to septic shock and multi-organ failure.[7]

The current gold standard for the diagnosis of SBP is an ascitic fluid polymorphonuclear (PMN) leukocyte count ≥250 cells/mm³, regardless of culture positivity.[3] Although ascitic fluid analysis is widely accepted and clinically validated, it requires laboratory infrastructure, trained personnel, and timely sample processing.[8] In resource-limited settings, delays in cell count reporting are common, potentially postponing therapeutic decisions. Furthermore, culture facilities may be unavailable or yield low sensitivity due to prior antibiotic exposure or suboptimal handling. These challenges are particularly relevant in low- and middle-income countries, where healthcare resources and laboratory accessibility may be constrained.[9]

In response to these limitations, rapid bedside diagnostic methods have been explored. One such approach involves the use of leukocyte esterase reagent strips, originally developed for urine analysis, to detect leukocytes in ascitic fluid.[10] Leukocyte esterase is an enzyme released by activated neutrophils, and its detection provides an indirect estimate of neutrophil concentration.[11] The reagent strip method offers several advantages: it is inexpensive, requires minimal training, produces results within minutes, and can be performed at the bedside without specialized equipment.[9,12] These attributes make it particularly attractive in emergency departments and resource-constrained hospitals where immediate laboratory support may not be available.

Multiple studies conducted across diverse geographic settings have evaluated the diagnostic performance of dipstick testing for SBP. Differences in study design, reagent strip brands, cut-off definitions, and patient populations contribute to heterogeneity in reported outcomes.[13,14] Moreover, there remains limited locally generated data from Pakistan evaluating the reliability and clinical applicability of this method in routine hospital practice.

Given the high burden of cirrhosis and SBP in South Asia, and the frequent constraints in laboratory turnaround time in public sector hospitals, there is a compelling need to assess whether dipstick testing can serve as a reliable, rapid adjunct or screening modality for SBP diagnosis.[1] Establishing its diagnostic accuracy in comparison with standard ascitic fluid analysis could have meaningful implications for early

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antibiotic initiation and patient outcomes in resource-limited environments.[15]

The present study aims to evaluate the reliability and diagnostic performance of leukocyte esterase dipstick testing in detecting spontaneous bacterial peritonitis, using ascitic fluid PMN count as the reference standard. By determining its sensitivity, specificity, predictive values, and overall diagnostic accuracy, this study seeks to clarify the potential role of dipstick testing as a practical bedside tool for early SBP detection in a resource-constrained tertiary care setting.

MATERIALS AND METHODS:

This cross-sectional diagnostic accuracy study was conducted in the Department of Medicine, at Federal Government Polyclinic Hospital, (FGPC) Islamabad after approval by the Institutional Ethics Committee. The study was carried out over four months, from March 2025 to June 2025. All data were anonymized to maintain participant confidentiality.

A total of 250 consecutive adult patients (≥18 years) with established cirrhosis and clinically detectable ascites who underwent diagnostic paracentesis were enrolled. Cirrhosis was diagnosed based on clinical features, biochemical parameters, and ultrasonographic findings. Patients were included irrespective of the presence or absence of clinical suspicion of SBP to avoid selection bias. Exclusion criteria included: prior antibiotic therapy within 7 days before paracentesis, secondary peritonitis due to intra-abdominal pathology (e.g., bowel perforation, abscess), recent abdominal surgery, peritoneal tuberculosis, and hemorrhagic ascites that could interfere with cell count interpretation.

Diagnostic paracentesis was performed under strict aseptic conditions at the bedside by trained physicians. Approximately 40–60 mL of ascitic fluid was obtained from each patient. Immediately after aspiration, the sample was divided into aliquots:

- One aliquot was used for bedside dipstick testing.
- The second aliquot was sent to the hospital laboratory for cell count analysis and routine biochemical testing.

All samples were processed within one hour of collection to minimize cellular degradation.

Leukocyte esterase reagent strips (urine dipstick strips) were used as the index diagnostic test. The reagent strip was immersed directly into freshly obtained ascitic fluid and removed immediately. After a standardized reaction time of 60–120 seconds (as per manufacturer's instructions), the color change on the leukocyte esterase pad was visually compared with the reference color chart.

A dipstick reading of ≥1+ was considered positive for SBP. Results were interpreted by trained medical personnel who were blinded to laboratory cell count results to reduce observer bias.

The reference standard for SBP diagnosis was ascitic fluid PMN count ≥250 cells/mm³, determined using manual counting with a hemocytometer. Laboratory personnel performing cell counts were blinded to dipstick results. SBP was diagnosed irrespective of culture results, in accordance with established diagnostic criteria.

Demographic data (age, gender), clinical features (fever, abdominal pain, hepatic encephalopathy), and laboratory parameters (serum bilirubin, ascitic protein concentration) were recorded on a structured proforma. Ascitic protein levels <1 g/dL were categorized as low protein ascites.

Data were entered and analyzed using IBM SPSS Statistics version 23. Continuous variables were expressed as mean ± standard deviation and compared using the independent samples t-test. Categorical variables were presented as frequencies and percentages and compared using the chi-square test or Fisher's exact test where appropriate. Diagnostic performance of the dipstick method was assessed by calculating sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall diagnostic accuracy, using PMN count ≥250 cells/mm³ as the gold standard. A p-value <0.05 was considered statistically significant.

RESULTS:

A total of 250 consecutive patients with cirrhosis and ascites undergoing diagnostic paracentesis were included in the final analysis. Based on the reference standard of ascitic polymorphonuclear

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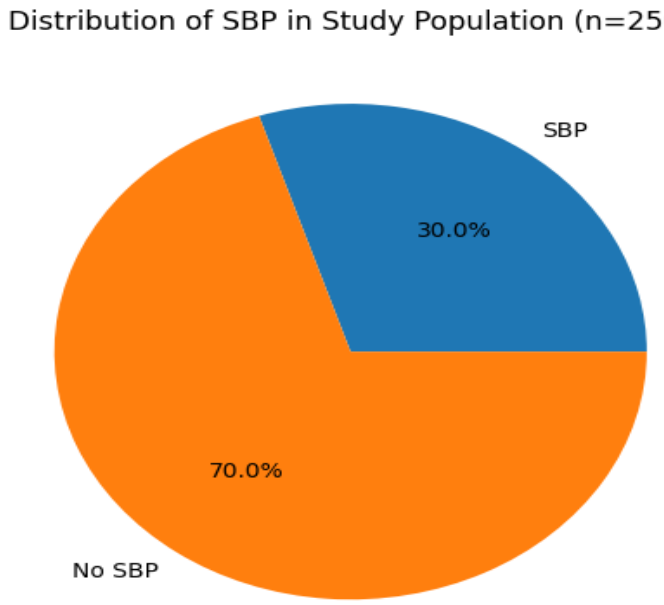
(PMN) leukocyte count ≥250 cells/mm³, 75 patients (30.0%) were diagnosed with spontaneous bacterial peritonitis (SBP), while 175 (70.0%) did not meet diagnostic criteria as shown in Figure 1.

Figure 1: Pie chart showing the distribution of SBP (30%) versus Non-SBP (70%)



Baseline demographic and clinical characteristics are summarized in Table 1. The mean age of the cohort was comparable between groups (SBP: 56.8 ± 9.4 years vs. non-SBP: 54.2 ± 10.1 years; p = 0.08). Male predominance was observed overall, with no statistically significant difference between groups (65.3% vs. 59.4%; p = 0.39). Several clinical and biochemical parameters were significantly associated with SBP.

Table 1: Baseline characteristics of the study population (n = 250)

VARIABLE	SBP (n=75)	No SBP (n=175)	p-VALUE
Age (years), mean ± SD	56.8 ± 9.4	54.2 ± 10.1	0.08
Male gender, n (%)	49 (65.3%)	104 (59.4%)	0.39
Fever (>38°C), n (%)	46 (61.3%)	28 (16.0%)	<0.001
Abdominal pain, n (%)	52 (69.3%)	41 (23.4%)	<0.001
Hepatic encephalopathy, n (%)	31 (41.3%)	34 (19.4%)	0.001
Serum bilirubin (mg/dL), mean ± SD	4.9 ± 2.1	3.6 ± 1.8	<0.001
Ascitic protein <1 g/dL, n (%)	48 (64.0%)	61 (34.8%)	<0.001

* p ≤ 0.05 was considered statistically significant.

Using the predefined positivity threshold of ≥1+ leukocyte esterase, the dipstick test yielded positive results in 81 patients (32.4%). Cross-tabulation is presented in Table 2.

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Table 2: Cross-tabulation of Leukocyte Esterase Dipstick Results with Ascitic Fluid PMN Count

	SBP PRESENT	SBP ABSENT	TOTAL
Dipstick Positive	63	18	81
Dipstick Negative	12	157	169
Total	75	175	250

Diagnostic Performance of Leukocyte Esterase Dipstick for SBP is shown in Table 3.

Table 3: Diagnostic Performance of Leukocyte Esterase Dipstick for SBP (n=250)

PARAMETER	VALUE (95% CI)
Sensitivity	84.0%
Specificity	89.7%
Positive Predictive Value	77.8%
Negative Predictive Value	92.9%
Diagnostic Accuracy	88.0%

DISCUSSION:

Spontaneous bacterial peritonitis remains one of the most severe infectious complications of cirrhosis and continues to contribute substantially to morbidity and mortality in patients with decompensated liver disease.[16] In the present study, SBP was identified in 30% of hospitalized cirrhotic patients with ascites, a prevalence consistent with contemporary epidemiological data. Recent global analyses confirm that bacterial infections, including SBP, complicate the course of decompensated cirrhosis in approximately one-third of hospitalized patients, reflecting persistent vulnerability to infection in this population.[1] The high prevalence observed in our cohort likely reflects advanced liver dysfunction and hospitalization-related risk, patterns similarly reported across tertiary centers.

Age did not demonstrate a statistically significant association with SBP in our analysis. This observation aligns with recent evidence suggesting that susceptibility to SBP is more strongly influenced by the severity of portal hypertension, immune dysfunction, and ascitic fluid characteristics rather than chronological age alone. Piano et al. highlighted that cirrhosis-associated immune dysfunction (CAID) plays a central mechanistic role in infection predisposition, independent of demographic variables.[16] Likewise, EASL guidelines emphasize disease stage and systemic inflammation as primary determinants of infection risk rather than age per se.[15]

Male gender was not independently associated with SBP in our cohort. Although cirrhosis may be more prevalent among males in certain regions due to etiological factors, recent epidemiological reviews have not identified sex as an independent predictor of SBP once liver disease severity is accounted for.[1,16] This finding reinforces that host immune impairment and portal hypertensive changes, rather than gender, govern SBP susceptibility.

Fever showed a strong association with SBP in our study, consistent with systemic inflammatory activation triggered by bacterial translocation. Fernández et al. demonstrated that bacterial infections in cirrhosis frequently present with inflammatory features, although they may occasionally be attenuated due to immune dysregulation.[17] Importantly, clinical manifestations alone lack sufficient sensitivity to exclude SBP, as emphasized in updated practice guidance documents.[15]

Abdominal pain was significantly more common among SBP patients, reflecting peritoneal irritation secondary to infection. However, clinical features remain heterogeneous. Piano et al. reported that up to one-third of infected cirrhotic patients may present atypically or with subtle findings, underscoring the limitations of symptom-based diagnosis.[16] Our findings

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therefore support routine diagnostic paracentesis regardless of symptom severity.

Hepatic encephalopathy demonstrated a significant association with SBP in our cohort. Contemporary data indicate that infections are major precipitants of acute decompensation and acute-on-chronic liver failure (ACLF), frequently manifesting as encephalopathy.[16,17] Systemic inflammation and endotoxemia contribute to blood–brain barrier dysfunction and neuroinflammation, explaining the observed clinical correlation. This relationship highlights the importance of prompt infection screening in cirrhotic patients presenting with altered mental status.

Serum bilirubin levels were significantly higher in patients with SBP, reflecting more advanced hepatic dysfunction. Elevated bilirubin has been consistently associated with worse outcomes in infected cirrhotic patients. In a large prospective analysis, Piano et al. demonstrated that markers of hepatic failure, including hyperbilirubinemia, independently predicted infection-related mortality.[16] These findings reinforce that advanced liver dysfunction predisposes to bacterial translocation and impaired immune response.

Low ascitic protein concentration was strongly associated with SBP in our study. Reduced ascitic protein reflects diminished complement and opsonic activity, impairing bacterial clearance. Contemporary reviews continue to recognize low ascitic protein as a major risk factor for SBP and an indication for primary prophylaxis in high-risk patients.[15] This biological mechanism remains well-established and clinically relevant.

With respect to diagnostic performance, the leukocyte esterase dipstick demonstrated a sensitivity of 84.0% and specificity of 89.7% in our cohort. These findings are consistent with recent systematic evaluations of reagent strip testing. Oey et al., in a meta-analysis, reported pooled sensitivities around 80–85% and specificities approaching 90%, although heterogeneity was noted due to differences in strip brands and positivity thresholds.[14] Similarly, Khairnar et al. observed high diagnostic accuracy when standardized cut-offs were applied in an observational study.[18] Variability in performance across studies likely reflects methodological differences, patient selection, and operator interpretation.

The high negative predictive value (92.9%) observed in our study is particularly noteworthy. In moderate-prevalence settings, a high NPV supports the role of dipstick testing as a rapid screening tool capable of ruling out SBP with reasonable confidence. This aligns with findings from Oey et al., who suggested that reagent strips may be most useful in excluding SBP when immediate laboratory cell counts are unavailable.[14] However, false positives and false negatives remain possible, and confirmatory PMN count remains the diagnostic gold standard, as reaffirmed by contemporary EASL guidance.[15]

The limitations of the study include; it was conducted at a single tertiary care center with a relatively modest sample size, which may limit generalizability to other settings. In addition, dipstick interpretation was visually assessed and may be subject to inter-observer variability despite standardization efforts. Larger multicenter studies are warranted to further validate its diagnostic accuracy and assess its impact on patient-centered outcomes.

CONCLUSION:

Leukocyte esterase reagent strip testing demonstrates promising diagnostic performance as a rapid bedside screening tool for spontaneous bacterial peritonitis in patients with cirrhosis and ascites. Its ease of use, low cost, and immediate availability make it particularly attractive in resource-limited settings where laboratory turnaround times may delay definitive ascitic fluid analysis. While it should not replace standard cytological and biochemical evaluation, dipstick testing may serve as a valuable adjunct to facilitate early clinical decision-making and timely initiation of antibiotic therapy.

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REFERENCES:

Asrani SK, Devarbhavi H, Eaton J, Kamath PS. Burden of liver diseases in the world. J Hepatol. 2019 Jan;70(1):151-171.

Ginès P, Krag A, Abraldes JG, Solà E, Fabrellas N, Kamath PS. Liver cirrhosis. Lancet. 2021 Oct 9;398(10308):1359-1376.

Rimola A, García-Tsao G, Navasa M, Piddock LJ, Planas R, Bernard B, Inadomi JM. Diagnosis, treatment and prophylaxis of spontaneous bacterial peritonitis: a consensus document. International Ascites Club. J Hepatol. 2000 Jan;32(1):142-53.

Ginès P, Cárdenas A, Arroyo V, Rodés J. Management of cirrhosis and ascites. N Engl J Med. 2004 Apr 15;350(16):1646-54.

Runyon BA; AASLD Practice Guidelines Committee. Management of adult patients with ascites due to cirrhosis: an update. Hepatology. 2009 Jun;49(6):2087-107.

Evans LT, Kim WR, Poterucha JJ, Kamath PS. Spontaneous bacterial peritonitis in asymptomatic outpatients with cirrhotic ascites. Hepatology. 2003 Apr;37(4):897-901.

Sort P, Navasa M, Arroyo V, Aldeguer X, Planas R, Ruiz-del-Arbol L, Castells L, Vargas V, Soriano G, Guevara M, Ginès P, Rodés J. Effect of intravenous albumin on renal impairment and mortality in patients with cirrhosis and spontaneous bacterial peritonitis. N Engl J Med. 1999 Aug 5;341(6):403-9.

Nousbaum JB, Cadranel JF, Nahon P, Khac EN, Moreau R, Thévenot T, et al. Diagnostic accuracy of the Multistix 8 SG reagent strip in diagnosis of spontaneous bacterial peritonitis. Hepatology. 2007 May;45(5):1275-81.

Koulaouzidis A, Leontiadis GI, Abdullah M, Moschos J, Gasem J, Tharakan J, Maltezos E, Saeed AA. Leucocyte esterase reagent strips for the diagnosis of spontaneous bacterial peritonitis: a systematic review. Eur J Gastroenterol Hepatol. 2008 Nov;20(11):1055-60.

Shizuma T. Spontaneous bacterial and fungal peritonitis in patients with liver cirrhosis: A literature review. World J Hepatol. 2018 Feb 27;10(2):254-266.

Simerville JA, Maxted WC, Pahira JJ. Urinalysis: a comprehensive review. Am Fam Physician. 2005 Mar 15;71(6):1153-62. Erratum in: Am Fam Physician. 2006 Oct 1;74(7):1096.

Khatwani NR, Chhutto MA, Abro HA, Habib-ur-Rahman, Shaikh MA. Diagnostic validity of leukocyte esterase dipstick test for diagnosis of spontaneous bacterial peritonitis in cirrhotic patients. J Ayub Med Coll Abbottabad. 2011 Jan-Mar;23(1):51-4.

Patel KP, Gallagher JP, Korbitz PM, Schmidt C, Ingviya T, Sempokuya T, Manatsathit W. Performance of Leukocyte Esterase Reagent Strips in the Detection of Spontaneous Bacterial Peritonitis in Cirrhotic Patients: A Systematic Review and Meta-analysis. J Clin Exp Hepatol. 2022 Mar-Apr;12(2):519-532.

Oey RC, Kuiper JJ, van Buuren HR, de Man RA. Reagent strips are efficient to rule out spontaneous bacterial peritonitis in cirrhotics. Neth J Med. 2016 Jul;74(6):257-61.

European Association for the Study of the Liver. EASL Clinical Practice Guidelines for the management of patients with decompensated cirrhosis. J Hepatol. 2018 Aug;69(2):406-460.

Piano S, Singh V, Caraceni P, Maiwall R, Alessandria C, Fernandez J, et al. Epidemiology and Effects of Bacterial Infections in Patients With Cirrhosis Worldwide. Gastroenterology. 2019 Apr;156(5):1368-1380.e10.

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

Fernández J, Acevedo J, Castro M, Garcia O, de Lope CR, Roca D, et al. Prevalence and risk factors of infections by multiresistant bacteria in cirrhosis: a prospective study. Hepatology. 2012 May;55(5):1551-61.

Khairnar H, Ingle M, Pandey V, Kolhe K, Chauhan S, Sawant P, Walke S, Chaudhary V. Accuracy of Leukocyte Esterase Reagent Strip (LERS) test for rapid bedside screening of spontaneous bacterial peritonitis: An observational study. J Family Med Prim Care. 2020 Nov 30;9(11):5542-5546.