

Utility of Point-of-Care Ultrasound in the Early Detection of Sepsis: A Prospective Observational Study

Huma Hussain¹, Tazaeen Hina Kazmi², Hina Hussain³, Rifat Yasmin⁴, Sana Shafique⁵, Muhammad Shamikh Shahid⁶
POF Hospital, Wah Medical College, NUMS, Wah Cantt

ABSTRACT

Objectives: To assess the effectiveness of point-of-care ultrasound in identifying sepsis at an early stage among patients presenting with suspected infection.

Methodology: A prospective observational single-center clinical study was undertaken at the POF Hospital, Wah Cantt, Pakistan, from July to December 2024. A total of 150 adult patients presenting with suspected sepsis were enrolled. Point-of-Care Ultrasound (POCUS) examination took place during the first hour of presentation, which assessed volume status by evaluating collapsibility of the inferior vena cava (IVC) and included assessment for potential sources of infection (pneumonia, biliary tract infection, urinary tract obstruction, intra-abdominal fluid collection etc). The results were contrasted with traditional diagnostic techniques and the ultimate clinical diagnoses.

Results Within the first hour of presentation, 117 patients (78%) out of 150 had a probable infectious source found by POCUS. The most commonly identified sources of infection were intra-abdominal fluid collections (12 cases, 8%), abnormal biliary function (21 cases, 14%), urinary tract obstruction (18 cases, 12%), and lung consolidation due to pneumonia (42 cases, 28%). The volume evaluations of IVC resulted in identifying that 64 of the patients studied (43%) were hypovolemic, 55 of them (37%) were euvolemic, and 31 of them (21%) hypervolemic. The sensitivity of POCUS for identifying sepsis-related conditions was calculated to be 89%, and the specificity was calculated to be 82%, coinciding with the final clinical determination for 131 of the patients studied (87%).

Conclusion: POCUS has shown to be an effective tool to rapidly identify infection sources and assess fluid status to aid in the early assessment and diagnosis of this condition. Incorporating the use of POCUS in initial sepsis diagnostic protocols for critical care and emergency physicians may lead to greater improvement in patient outcomes and care.

Keywords: Critical Care, Early Diagnosis, Point-of-Care Systems, Sepsis, Ultrasonography.

Authors' Contribution:

^{1,2}Conception; ¹Literature research; ¹manuscript design and drafting; ^{3,4}Critical analysis and manuscript review; ^{5,6}Data analysis; Manuscript Editing.

Correspondence:

Tazaeen Hina Kazmi
Email: tazeenhina@hotmail.com

Article info:

Received: November 03, 2025
Accepted: February 13, 2026

Cite this article. Hussain H, Kazmi TH, Hussain H, Yasmin R, Shafique S, Shahid MS. Utility of Point-of-Care Ultrasound in the Early Detection of Sepsis: A Prospective Observational Study. J Islamabad Med Dental Coll. 2026; 15(1): 57-63.
DOI: <https://doi.org/10.35787/jimdc.v15i1.1489>

Funding Source: Nil

Conflict of interest: Nil

Introduction

Sepsis is still a global health crisis because sepsis has a high rate of morbidity and mortality; therefore, sepsis is a very important issue specifically for low- and middle-income countries (LMICs) including Pakistan. According to recent reviews, systemic Gram-negative pathogens predominate in

respiratory and urinary tract infections, which are the most common local foci of sepsis.¹ In Pakistan's resource-constrained settings, adherence to internationally recommended sepsis protocols remain suboptimal despite improvements in awareness.^{1,2} Guidelines like the Surviving Sepsis Campaign emphasize the significance of prompt

identification and treatment within the first hour (the "hour 1 bundle") in order to minimize unfavorable outcomes.³ However, traditional diagnostic techniques like imaging and laboratory testing frequently cause delays, particularly when expert interpretation or transportation to radiology is needed.⁴ According to clinician surveys conducted in Karachi, many physicians have little practical experience managing sepsis, and delays in diagnosis continue to be a major obstacle to prompt intervention.⁵

In emergency and critical care settings, Point of Care Ultrasound (POCUS), which is defined as bedside ultrasonography carried out and interpreted by the treating clinician, has become a quick, non-invasive, and repeatable diagnostic technique.⁶ Worldwide, POCUS enables the prompt identification of common infectious sources, including intra-abdominal fluid, biliary or urinary tract pathology, pneumonia, pleural effusions, and volume status estimation using Inferior Vena Cava (IVC) dynamics.^{6,7} According to a study conducted in Pakistan, POCUS significantly outperformed standard clinical assessment, identifying the source of sepsis in 94% of cases with a sensitivity of roughly 74.5%.⁸

Although clinicians' confidence in diagnosing undifferentiated shock and respiratory distress has increased recognition to POCUS training programs like the Point of Care Ultrasonographic Life Support in Emergency (PULSE) workshop in Karachi, the precise effect of POCUS on sepsis recognition is still poorly understood locally.⁹ Furthermore, surveys of physicians' perceptions carried out in Karachi revealed an ongoing gap between prompt diagnostic implementation and knowledge of the burden of sepsis.⁵

The study aim was to assess the potential for improving sepsis care outcomes and timeliness, as well as the diagnostic accuracy and feasibility of integrating POCUS into early sepsis recognition protocols.

Methodology

This prospective observational single-centre clinical study was conducted in the Emergency and Medical Departments of POF Hospital, Wah Cantt, Pakistan, from July to December 2024. A total of 150 adult patients aged 18 years or older who presented with clinical suspicion of sepsis were enrolled consecutively using non-probability purposive sampling. Sepsis was identified using the Sepsis-3 criteria, which include suspected infection and organ failure symptoms like altered mental status, hypotension, tachycardia, tachypnea, or elevated serum lactate levels. Pregnant women, patients with documented end-stage organ failure, and patients already diagnosed with sepsis and receiving therapy were excluded from the study.

The sample was determined using the WHO calculator for estimation of a single proportion. The expected proportion of successful identification of the infectious source using POCUS in suspected sepsis was taken as 94%.⁸ Keeping confidence level at 95%, alpha error at 4%, and anticipated population proportion at 0.94, the required sample was estimated as 135 patients. After adding a 10% contingency for incomplete scans, the final calculated sample was 150 patients.

All eligible patients had a standardized diagnostic work-up utilizing POCUS at three predetermined time periods (T0, T1, and T2) following the acquisition of written informed consent. T0 stood for the first bedside ultrasonography performed during triage, right after arrival and prior to starting treatment. T1 referred to the POCUS evaluation that took place within the first hour of the patient's presentation, following initial stabilization but before the definitive diagnosis was confirmed. T2 indicated a follow-up scan that was carried out within the first six hours of admission in order to track development, reassess volume status, or assess treatment response.

All POCUS examinations were conducted by trained emergency physicians or critical care fellows using a portable ultrasound machine (SonoSite M-Turbo). Curvilinear and phased array probes were used depending on the targeted area. The chest, abdomen, urinary system, hepatobiliary system, and inferior vena cava (IVC) were all specifically examined as part of the POCUS protocol. Lung ultrasound was done to assess for pneumonia, pleural effusion, or pulmonary edema. Abdominal ultrasound included scanning for hepatobiliary pathology such as cholecystitis or biliary obstruction, intra-abdominal fluid collections, hydronephrosis, and other signs of urinary tract obstruction. When possible, cardiac images were acquired to rule out severe heart dysfunction or pericardial effusion. IVC diameter and the collapsibility index were used to determine the volume status; a collapse of more than 50% indicated hypovolemia.

A second experienced sonologist or departmental consultant cross-checked all results, which were recorded in a structured POCUS reporting form. Patients had routine laboratory and radiographic tests at the same time, such as a chest X-ray, blood cultures, serum creatinine, serum lactate, and complete blood counts. Determining the diagnostic value of POCUS in the early detection of the infectious source and volume status was the main outcomes. Based on a thorough clinical assessment, laboratory and imaging results, and the attending consultant's assessment of the patient's response to treatment, the final diagnosis of the source of sepsis was made.

Data were entered and analyzed using SPSS version 25. Frequencies and percentages were used to summarize categorical factors such as sepsis source, volume status category, and concordance of POCUS findings. Sensitivity and specificity of POCUS were calculated by comparing POCUS findings at T1 with the final confirmed source of sepsis, which served as the reference standard. A POCUS result was considered positive when it correctly identified the

infectious source later confirmed by clinical evaluation, laboratory findings, radiological imaging, and treatment response. A negative POCUS result was defined as failure to identify an infectious source that was subsequently confirmed. Based on these definitions, true positive, false positive, true negative, and false negative values were derived, and diagnostic accuracy indices including sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), positive likelihood ratio (LR⁺), and negative likelihood ratio (LR⁻) were calculated.

Ethical approval was taken from the institutional review board and ethics committee of POF Hospital, Wah Cantt (Ref. No. 4119/4/HOD_ER/Hosp) on 17-06-2024.

Results

A total of 150 patients with clinical suspicion of sepsis were included. The mean age was 52.4±16.2 years with 91 males (60.7%) and 59 females (39.3%). Most patients (63.3%) presented within 6 hours of symptom onset. Most patients presented with clinical indicators of sepsis, including tachycardia and elevated respiratory rate. Laboratory analyses showed leukocytosis in 78% and elevated lactate levels in 69% of cases. Blood cultures were positive in nearly two-thirds of patients, with *E. coli* (29%), *Klebsiella pneumoniae* (22%), and *Staphylococcus aureus* (18%) as the most common isolates. While, chest X-rays revealed pneumonic infiltrates in 30.7% and pleural effusion in 8%. Demographic, clinical, laboratory, and radiological findings of all patients are summarized in Table-I.

Point-of-care ultrasound (POCUS) was performed at three time points: T0 (at triage), T1 (within the first hour), and T2 (within 6 hours of admission). At T0, POCUS was feasible in 142 (94.7%) patients; technical limitations (e.g., poor windows due to obesity or agitation) limited complete scans in 8 patients. A potential source of infection was identified in 89 patients (59.3%) at T0. This number increased to 117 patients (78%) at T1, after initial

stabilization and repeat scanning. 124 patients underwent focused re-evaluation at T2, and 122 patients (98.3% of those scanned at T2) had confirmed or evolving infectious sources. The distribution of POCUS-identified infection sources at T1 is presented in Table-II.

According to volume status evaluation utilizing IVC collapsibility, 47.3% patients were hypovolemic at T0. Due to fluid resuscitation and changing clinical status, this percentage dropped to 42.7% at T1 and 37.1% at T2. Volume status across time points is summarized in Table-III.

Diagnostic accuracy of POCUS at T1 was assessed using a contingency table, taking the final confirmed source of sepsis as the reference standard (Table IV-A). Sensitivity was calculated as the proportion of patients in whom POCUS correctly identified the infectious source among all patients with a confirmed source (true positives / [true positives + false negatives]). Specificity was calculated as the proportion of patients in whom POCUS correctly excluded an infectious source among those without a confirmed source (true negatives / [true negatives + false positives]).

When compared with the final clinical diagnosis, POCUS at T1 exhibited a sensitivity of 88.5% and specificity of 81.8% in detecting the infectious source. In 77.3% patients, there was agreement between the final diagnosis and the POCUS results at T1 (Table IV-B).

No adverse events related to ultrasound scanning were recorded. T2 scans were completed within a median of 4 hours (IQR: 3–5.5 hours) following admission, and the average time from patient presentation to T1 POCUS completion was 21±7 minutes. POCUS at T1 showed a sensitivity of 88.5% (95% CI: 81.9–92.9) and specificity of 81.8% (95% CI: 46.0–84.6) when compared to the final clinical diagnosis. A patient with sepsis was almost 2.8 times more likely to have a positive POCUS finding than a non-septic patient, according to the positive likelihood ratio (LR⁺) of 2.8. A negative POCUS result

significantly decreased the likelihood of sepsis, effectively ruling it out in many cases, according to the negative likelihood ratio (LR⁻) of 0.17. These findings confirm POCUS's diagnostic value in identifying sepsis early.

Table I: Demographic, clinical, laboratory, and radiological characteristics of patients, n= 150	
Variables	Mean ± SD / Frequency (%)
Demographic Characteristics	
Age (years)	52.4±16.2
Male	91 (60.7%)
Female	59 (39.3%)
Clinical Characteristics	
Mean arterial pressure (mmHg)	68.5±12.1
Heart rate (beats/min)	108±18
Respiratory rate (breaths/min)	24.6±5.8
Temperature (°C)	38.2±1.0
Time from symptom onset (≤ 6 hours)	95 (63.3%)
Time from symptom onset (> 6 hours)	55 (36.7%)
Suspected infection on admission	129 (86%)
Confirmed sepsis (based on Sepsis-3 criteria)	116 (77.3%)
Laboratory Findings	
Total leukocyte count (×10 ⁹ /L)	15.4±4.3 (> 11 × 10 ⁹ /L in 117 [78%])
Hemoglobin (g/dL)	11.2±1.8 (< 12 g/dL in 65 [43%])
Serum lactate (mmol/L)	3.6±1.5 (> 2 mmol/L in 104 [69%])
Serum creatinine (mg/dL)	1.5 ± 0.6 (> 1.2 mg/dL in 62 [41%])
Positive blood culture	97 (64.7%)
Radiological Findings	
Chest X-ray: Pneumonic infiltrates	46 (30.7%)
Chest X-ray: Pleural effusion	12 (8.0%)

Infectious source	Frequency (%)
Lung consolidation (pneumonia)	42 (35.9%)
Biliary tract pathology	21 (17.9%)
Urinary tract obstruction	18 (15.4%)
Intra-abdominal fluid collection	12 (10.3%)
Soft tissue abscess / cellulitis	9 (7.7%)
Joint effusion / septic arthritis	5 (4.3%)
Multiple simultaneous foci	6 (5.1%)
Other	4 (3.4%)

Volume status	T0 (n=150)	T1 (n=150)	T2 (n=124)
Hypovolemic	71 (47.3%)	64 (42.7%)	46 (37.1%)
Euvolemic	49 (32.7%)	55 (36.7%)	56 (45.2%)
Hypervolemic	30 (20.0%)	31 (20.7%)	22 (17.7%)

	Final Diagnosis: Sepsis Source Present	Final Diagnosis: Sepsis Source Absent	Total
POCUS Positive	104 (True Positive)	13 (False Positive)	117
POCUS Negative	13 (False Negative)	20 (True Negative)	33
Total	117	33	150

Parameter	Value	95% CI	LR ⁺	LR ⁻
Sensitivity	88.5%	81.96 – 92.94	2.80	0.17
Specificity	81.8%	46.01 – 84.64	-	-
Concordant cases (TP + TN)	124 (82.7%)	-	-	-
Discordant cases (FP + FN)	26 (17.3%)	-	-	-

LR⁺: Positive likelihood ratio, LR⁻: Negative likelihood ratio, TP: True positive, TN: True negative, FP: False positive, FN: False negative.

Discussion

In this study, integration of POCUS at multiple time points (T0, T1, T2) demonstrated strong diagnostic performance in early sepsis identification. At T1, POCUS achieved sensitivity of 88.5%, specificity of 81.8%. These results support POCUS as a useful supplement to early sepsis strategies and are in line with international studies.

In a systematic review of POCUS in undifferentiated shock, inclusion of clinical assessment plus POCUS increased diagnostic accuracy from 45–60% (standard care alone) to 80–89%, comparable to our 88.5% sensitivity and 81.8% specificity.¹⁰ Those studies emphasized that while specificity remained high (80–100%) for causes like distributive shock, sensitivity varied from moderate to good (63–75%).^{11,12} In contrast, this study results showed slightly higher sensitivity, likely due to multimodal scanning (lungs, biliary, urinary, IVC) and the serial nature (T0–T2) enhancing detection rates.

This study findings also compare favorably with the study by Khalid et al, where POCUS identified the source in 94% of cases with sensitivity around 74.5%.⁸ This study, higher sensitivity may reflect stronger concordance via training and early T1/T2 scanning. Importantly, their study and this study support the utility of POCUS in resource-limited settings.

A meta-analysis of multi-organ POCUS for pulmonary embolism in critically ill patients found diagnostic accuracy of 90% sensitivity and 69% specificity, with a diagnostic odds ratio of 25.3.¹³ Though focused on PE rather than sepsis, this supports the effectiveness of combined lung, cardiac, and venous scanning in acutely ill patients, similar in concept to our multimodal approach in sepsis evaluation.

This study, LR⁺ of 2.8, while moderate, indicates that a positive POCUS finding increases the likelihood of

true sepsis, but is not definitively confirmatory. The LR^- of 0.17 is particularly useful: a negative result substantially lowers risk, supporting clinical exclusion in many cases. Tests with $LR^- < 0.2$ are powerful rule-out tools (e.g. in POCUS for acute renal damage), which is in line with more general diagnostic reasoning studies.^{14,15}

Clinically, developing identification was made possible by the serial acquisition at T0, T1, and T2: 59% at T0, increasing to 78% at T1, and 98% at T2. The results demonstrate that although immediate POCUS performed at triage may underestimate/ignore an early moderate result, performing repeat scans after initial resuscitation improves the sensitivity of POCUS for diagnosing sepsis. This supports the suggestions made by the RUSH protocol for serial POCUS in cases of suspected sepsis.¹⁶ The findings of this study suggest that there are dynamic variations in the Inferior Vena Cava (IVC) over time regarding their size in conjunction with fluid-responsiveness—a critical factor in directing early management of sepsis. These findings support previously published studies that demonstrate the value of POCUS in diagnosing sepsis and in monitoring response to therapy, hydration status, and resuscitation guidance.

The limitation of this study includes operator dependency and single-center design. When interpreting positive scans in patients with low pre-test probability, care must be used because this study's moderate LR^+ suggests the possibility of false positives.

Conclusion

The findings of this study add to and support previous studies showing that serial multi-system POCUS greatly improves the early detection of sepsis causes with high sensitivity and robust rule-out capability. The progressive change in the size of the IVC was observed between T0, T1, and T2 scans demonstrated the importance of periodic scrutiny and evaluation based on time. These results support

the inclusion of POCUS as part of an early-Sepsis protocol in resource-poor environments.

References

1. Raza HA, Hashmi AP, Khakwani MM, Ali MH, Jamil B. Review of sepsis in Pakistan: how far have we come?. *IJID Regions*. 2024;10:108-113. <https://doi.org/10.1016/j.ijregi.2023.12.002>
2. Yousuf F, Malik A, Saba A, Sheikh S. Risk factors and Compliance of surviving sepsis campaign: A retrospective cohort study at tertiary care hospital. *Pak J Med Sci*. 2022;38(1):90-94. <https://doi.org/10.12669/pjms.38.1.3992>
3. Evans L, Rhodes A, Alhazzani W, Antonelli M, Coopersmith CM, French C, et al. Executive summary: surviving sepsis campaign: international guidelines for the management of sepsis and septic shock 2021. *Crit Care Med*. 2021;49(11):1974-1982. <https://doi.org/10.1097/CCM.0000000000005357>
4. Diaz-Gomez JL, Mayo PH, Koenig SJ. Point-of-care ultrasonography. *N Engl J Med*. 2021;385(17):1593-1602. <https://doi.org/10.1056/NEJMra1916062>
5. Ahmed F, Abbasi L, Herekar F, Jiwani A, Patel MJ. Knowledge and perception of Sepsis among Doctors in Karachi Pakistan. *Pak J Med Sci*. 2022;38(2):380-386. <https://doi.org/10.12669/pjms.38.ICON-2022.5775>
6. Chelikam N, Vyas A, Desai R, Khan N, Raol K, Kavarthapu A, et al. Past and present of point-of-care ultrasound (PoCUS): a narrative review. *Cureus*. 2023;15(12):e50155. <https://doi.org/10.7759/cureus.50155>
7. Russ B, Arthur J, Lewis Z, Snead G. A review of lawsuits related to point-of-care emergency ultrasound applications. *J Emerg Med*. 2022;63(5):661-672. <https://doi.org/10.1016/j.jemermed.2022.04.020>
8. Khalid MA, Nawadat Q, Mazhar H. Utilizing point-of-care ultrasound for accurate identification of infection source in septic patients. *Biol Clin Sci Res J*. 2023;2023(1):307. <https://doi.org/10.54112/bcsrj.v2023i1.307>
9. Ali N, Chhotani AA, Iqbal SP, Soomar SM, Raheem A, Waheed S. Point of Care Ultrasonographic Life Support in Emergency (PULSE); a quasi-experimental study. *Int J Emerg Med*. 2023;16(1):49. <https://doi.org/10.1186/s12245-023-00525-w>

10. Berg I, Walpot K, Lamprecht H, Valois M, Lanctot JF, Srour N, et al. A systemic review on the diagnostic accuracy of point-of-care ultrasound in patients with undifferentiated shock in the emergency department. *Cureus*. 2022;14(3):e23188. <https://doi.org/10.7759/cureus.23188>
11. Verras C, Ventoulis I, Bezati S, Matsiras D, Parissis J, Polyzogopoulou E. Point of care ultrasonography for the septic patient in the emergency department: a literature review. *J Clin Med*. 2023;12(3):1105. <https://doi.org/10.3390/jcm12031105term>
12. Polyzogopoulou E, Velliou M, Verras C, Ventoulis I, Parissis J, Osterwalder J, et al. Point-of-care ultrasound: a multimodal tool for the management of sepsis in the emergency department. *Medicina*. 2023;59(6):1180. <https://doi.org/10.3390/medicina59061180>
13. Melo RH, Gioli-Pereira L, Lourenço ID, Da Hora Passos R, Bernardo AT, Volpicelli G. Diagnostic accuracy of multi-organ point-of-care ultrasound for pulmonary embolism in critically ill patients: a systematic review and meta-analysis. *Crit Care*. 2025;29(1):162. <https://doi.org/10.1186/s13054-025-05359-x>
14. Gaudreau-Simard M, Saiyin T, McInnes MD, Ruller S, Clark EG, Wooller K, et al. Test characteristics of point-of-care ultrasonography in patients with acute kidney injury. *Ultrasound J*. 2024;16(1):15. <https://doi.org/10.1186/s13089-023-00352-3>
15. Kuttub HI, Damewood SC, Schmidt J, Lin A, Emmerich K, Schnittke N. Cardiopulmonary Ultrasound to Predict Care Escalation in Early Sepsis: A Pilot Study. *J Emerg Med*. 2025;68:54-65. <https://doi.org/10.1016/j.jemermed.2024.07.009>
16. Stickles SP, Carpenter CR, Gekle R, Kraus CK, Scoville C, Theodoro D, et al. The diagnostic accuracy of a point-of-care ultrasound protocol for shock etiology: a systematic review and meta-analysis. *Can J Emerg Med*. 2019;21(3):406-417. <https://doi.org/10.1017/cem.2018.498>