RESEARCH PAPER

Utility of Point of Care Ultrasound (Pocus) For Volume Status Assessment and Clinical Decision Making in Acute Kidney Injury: A Cross-Sectional Study

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Received: 24th April, 2026; Revised: 20th May 2026; Accepted: 30th June, 2026; Available Online: 10th July, 2026

ABSTRACT

Background: Accurate assessment of volume status is crucial for managing acute kidney injury (AKI), yet traditional clinical tools are often unreliable. Point-of-care ultrasound (POCUS) offers real-time, bedside evaluation of hemodynamic parameters.

Objectives: To assess the utility of POCUS for extracellular volume status evaluation and its impact on clinical decision-making in AKI patients.

Methods: This was a cross-sectional study showed in a tertiary care hospital over three months. Seventy adult patients with AKI (KDIGO stage 3–5, not on maintenance dialysis) were enrolled. POCUS was used to assess inferior vena cava (IVC) diameter as well as collapsibility, and lung ultrasound for B-lines. Clinical management decisions before and after POCUS were documented. Renal function, blood pressure trends, and hospitalization rates were followed up at two weeks and one month.

Results: POCUS findings were discordant with clinical assessment in 28.5% of cases and led to management changes in 42.8% of patients, including diuretic initiation and fluid restriction. Patients managed with POCUS guidance showed better eGFR improvement (47.1 ± 9.4 ml/min at one month vs. baseline 35.2 ± 8.6 ml/min) and improved blood pressure control. Fewer hospitalization events for fluid imbalance occurred in the POCUS-concordant group.

Conclusion: POCUS is a valuable adjunct for volume status assessment in AKI, improving diagnostic precision, management decisions, and patient outcomes.

Keywords: POCUS, Acute Kidney Injury, Volume Status, IVC Collapsibility, Lung Ultrasound

How to cite this article: Venkat MA, Raveesh A, Kumar PN, Utility of Point of Care Ultrasound (Pocus) For Volume Status Assessment and Clinical Decision Making in Acute Kidney Injury: A Cross-Sectional Study Int J Drug Deliv Technol. 2026;16(71s): 1072-1080. DOI: 10.25258/ijddt.16.71s.126

Source of support: Nil.

Conflict of interest: None

INTRODUCTION

Acute kidney injury (AKI) is a predominant and serious condition, especially in hospitalized and critically ill patients, with consequences ranging from improved morbidity and mortality to continued hospital stays besides higher healthcare costs. The cornerstone of AKI management often hinges on accurate assessment of volume status, a challenging task using traditional clinical tools like physical examination, central venous pressure, or laboratory markers. These conventional methods lack sufficient accuracy, especially in unstable patients or those with complex fluid dynamics. In this context, point-of-care ultrasound (POCUS) has appeared as a transformative bedside technology that allows rapid, non-invasive, and repeatable assessment of hemodynamic parameters and organ function in real-time [1].

POCUS refers to clinician-performed ultrasonography used at the bedside to answer focused clinical questions. In nephrology and acute care, it enables assessment of the kidneys, inferior vena cava (IVC), lungs, as well as cardiac chambers key anatomical targets for estimating volume status and guiding treatment decisions [2]. The immediacy of data acquisition and interpretation helps

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overcome delays inherent in formal imaging modalities and allows integration with ongoing clinical assessments.

The role of POCUS in AKI management goes beyond detecting hydronephrosis. It supports classification of AKI into prerenal, intrinsic, and postrenal types, enabling tailored interventions. For instance, kidney ultrasound may identify obstructive uropathy, while lung ultrasound detecting B-lines suggests volume overload, guiding fluid restriction or diuretic therapy [3]. POCUS also aids in distinguishing volume depletion from fluid overload crucial in avoiding iatrogenic harm caused by empirical fluid therapy. In a retrospective study, collapsibility of the IVC assessed via POCUS showed a strong inverse relationship with urine sodium as well as fractional excretion of sodium (FENa), reinforcing its value in estimating intravascular volume [4].

Importantly, POCUS has extended beyond single-organ evaluation. Multi-organ POCUS incorporating lung, heart, IVC, and venous Doppler assessments offers a more complete view of the hemodynamic status in patients with AKI, especially those with complex syndromes such as cardiorenal or hepatorenal syndromes. This integrated approach allows for refined fluid management and better clinical outcomes [5].

Studies show that nephrologist-performed POCUS impacts real-time clinical decisions. In one prospective evaluation, nephrologists modified fluid therapy in over 30% of patients based on POCUS findings, including administration of diuretics, fluids, and vasopressors. Notably, the POCUS findings correlated with formal radiology results in 100% of cases where both were performed [6]. Such evidence supports the growing integration of POCUS into nephrology practice.

The pediatric population has also benefited significantly from POCUS. In pediatric intensive care units (PICUs), clinicians use POCUS to guide dialysis settings, adjust fluid therapy, and differentiate between shock types all critical aspects of managing AKI in children [7]. The flexibility of POCUS allows frequent reassessments, ensuring dynamic monitoring of fluid shifts and early detection of complications.

Despite these advantages, adoption of POCUS in nephrology is still limited, particularly in low-resource settings like India. Barriers include insufficient access to equipment, lack of trained faculty, and minimal incorporation into nephrology training programs. However, technological innovations such as smartphone-connected ultrasound probes and AI-assisted image interpretation are making POCUS more accessible and easier to use in diverse clinical settings [8].

In cirrhotic patients with AKI, volume status is particularly difficult to assess due to overlapping causes like hepatorenal syndrome, spontaneous bacterial peritonitis, and volume depletion. A simplified 5-point POCUS protocol examining the kidneys, urinary bladder, lungs, IVC, and focused cardiac function has proven effective in enhancing diagnostic accuracy and avoiding fluid overload in such cases [9]. This targeted approach allows timely therapeutic decisions and minimizes harm from misdiagnosis.

Point-of-care ultrasound (POCUS) has demonstrated efficacy as a quick and dependable diagnostic instrument for identifying renal tract obstruction in individuals presenting with acute kidney damage. Its bedside application allows clinicians to quickly assess for hydronephrosis and other obstructive causes without the delays associated with formal imaging. This immediate diagnostic capability facilitates timely urological intervention and can prevent progression of kidney injury [10].

POCUS is revolutionizing the way volume status is assessed and AKI is managed. Its portability, diagnostic precision, and ability to guide dynamic treatment decisions position it as a key component in personalized nephrology care. As access to training and affordable devices improves, particularly in countries like India, POCUS has the potential to become a standard of care for AKI evaluation and management.

METHODOLOGY

1. Study Design

This study was a cross-sectional, hospital-based observational investigation with the goal of evaluating the efficacy of point-of-care ultrasound (POCUS) in monitoring extracellular volume status and its impact on clinical decision-making in patients with acute kidney injury (AKI).

2. Study Setting

The study was carried out in the Departments of Nephrology and Internal Medicine at a tertiary care hospital. Bedside assessments were performed in wards, ICUs, and emergency units using portable ultrasound machines.

3. Study Duration

The study was performed over a 3-month period, during which eligible patients were enrolled, evaluated using POCUS, and followed up for short-term clinical outcomes.

4. Participants – Inclusion/Exclusion Criteria

Patients aged 18 years or older with AKI Stage 3–5 (KDIGO) and not on maintenance dialysis were included. Exclusion criteria were maintenance dialysis, pregnancy, and poor acoustic windows due to obesity or chest deformities.

5. Study Sampling

Convenience sampling was used. All eligible and consenting patients presenting during the study period were consecutively enrolled until the target sample size was achieved.

6. Study Sample Size

Based on previous data showing 79% sensitivity of POCUS, and with 10% precision at 95% confidence, a sample size of 64 was calculated. Accounting for a 10% non-response rate, the final target was 70 patients.

7. Study Groups
No interventional groups were created. Patients were later grouped based on whether POCUS findings led to a change in clinical management, allowing outcome comparisons.

8. Study Parameters
Key parameters included demographics, comorbidities, lab values (creatinine, eGFR), clinical signs of fluid status, and POCUS findings (IVC size, collapsibility, lung B-lines). Management changes were also recorded.

9. Study Procedure
After initial clinical evaluation, POCUS was performed by trained physicians using a standard protocol. Any resulting changes in fluid or diuretic management were noted. Patients were followed at 2 weeks and 1 month.

10. Study Data Collection
Data were gathered with a standardized form at the bedside and subsequently inputted into an Excel database. POCUS findings, clinical decisions, and follow-up outcomes were systematically documented.

11. Data Analysis
Data were examined using SPSS software. Categorical variables remained presented as frequencies and percentages; numerical data as mean and SD. Chi-square, t-test, and ANOVA were used, with $p<0.05$ considered significant.

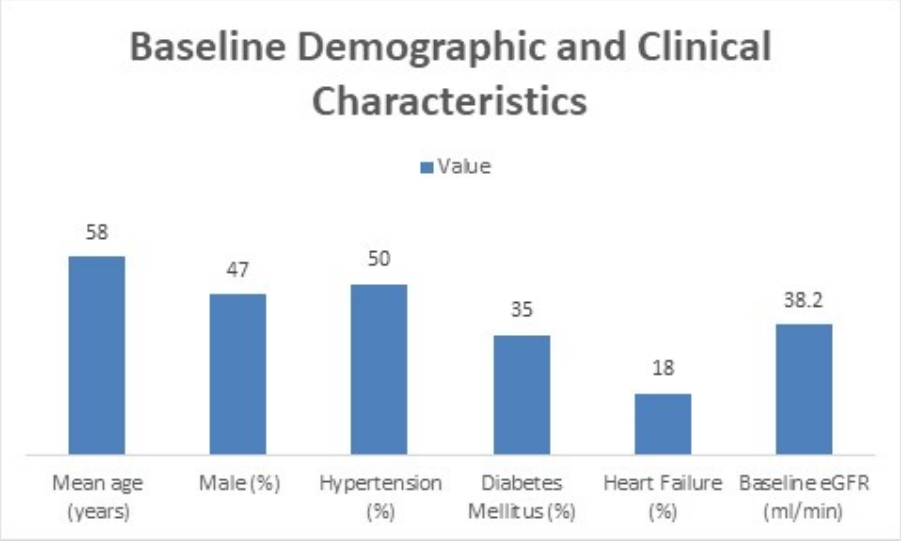
12. Ethical Considerations
The study obtained authorization from the Institutional Ethics Committee. Informed consent was acquired from all participants, and data were anonymized to ensure confidentiality.

RESULTS

1. Baseline Demographic and Clinical Characteristics
Most patients were male as well as hypertensive, with a mean age of 58 years. Comorbidities such as diabetes and heart failure were common (Table 1).

Table 1: Table 1: Baseline Demographic and Clinical Characteristics (n=70)

Parameter	Value
Mean age (years)	58 ± 13.4
Male (%)	47 (67.1%)
Hypertension (%)	50 (71.4%)
Diabetes Mellitus (%)	35 (50%)
Heart Failure (%)	18 (25.7%)
Baseline eGFR (ml/min)	38.2 ± 12.6



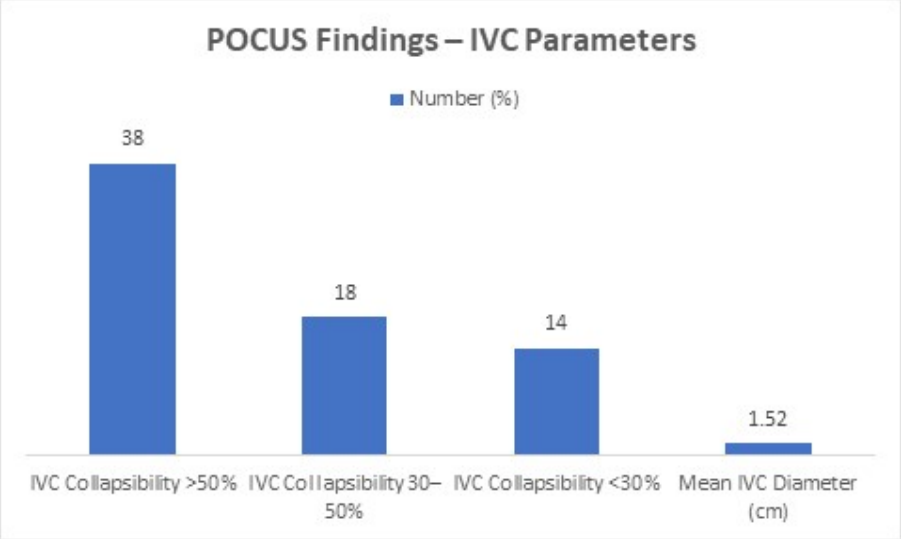
Graph 1: Baseline Demographic and Clinical Characteristics

2. POCUS Findings – IVC Parameters
Over half the patients had IVC collapsibility >50%, suggesting intravascular depletion. Hypovolemia was more frequent in patients with sepsis (Table 2).

Table 2: IVC Diameter and Collapsibility Index by POCUS

IVC Parameter	Number (%)
IVC Collapsibility >50%	38 (54.3%)
IVC Collapsibility 30–50%	18 (25.7%)

IVC Collapsibility <30%	14 (20%)
Mean IVC Diameter (cm)	1.52 ± 0.3



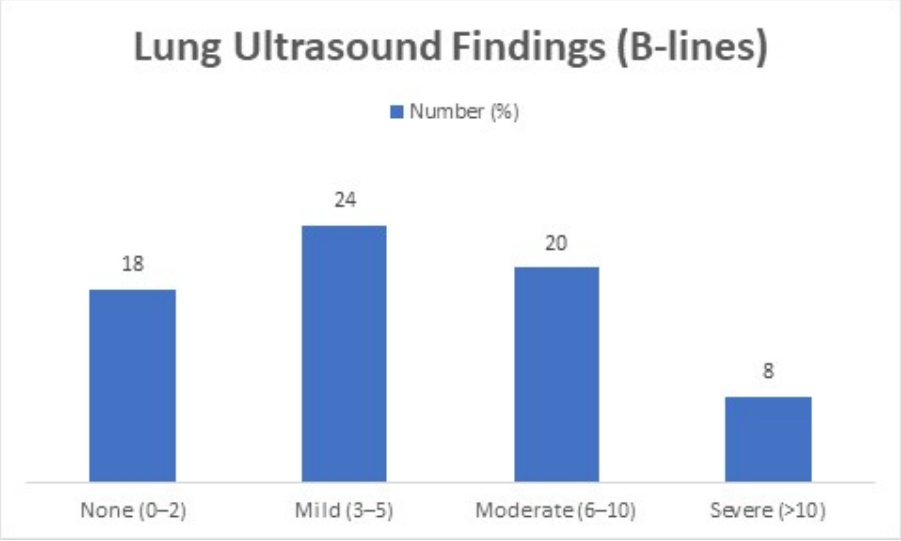
Graph 2: IVC Diameter and Collapsibility Index by POCUS

3. Lung Ultrasound Findings (B-lines)

Nearly 40% of patients showed moderate-to-severe B-lines, suggesting pulmonary congestion. These patients were more likely to require fluid restriction (Table 3).

Table 3: Lung Ultrasound Findings – Number of B-lines

B-line Severity	Number (%)
None (0–2)	18 (25.7%)
Mild (3–5)	24 (34.3%)
Moderate (6–10)	20 (28.6%)
Severe (>10)	8 (11.4%)



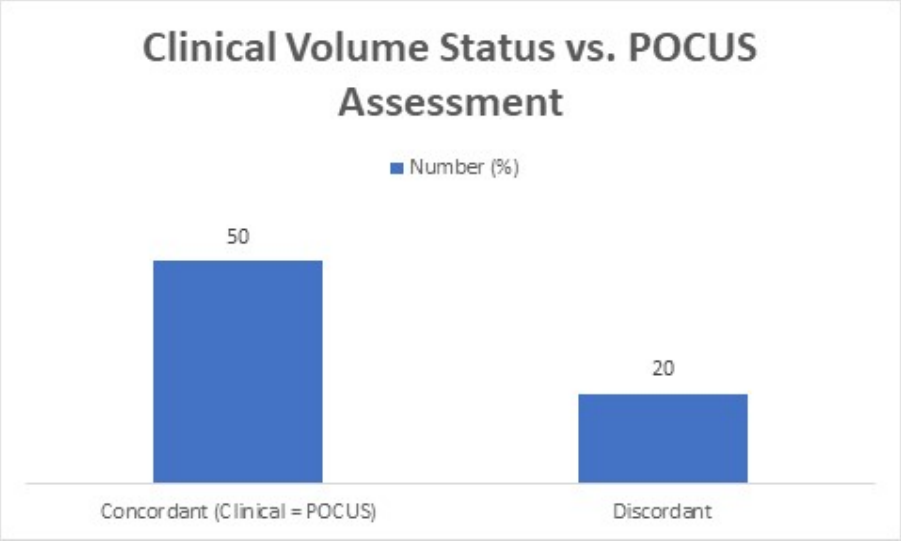
Graph 3: Lung Ultrasound Findings – Number of B-lines

4. Clinical Volume Status vs. POCUS Assessment

POCUS detected volume status mismatch in 28.5% of cases compared to clinical examination alone. This suggests POCUS provides more objective guidance (Table 4).

Table 4: Concordance Between Clinical and POCUS Volume Assessment

Assessment Match Type	Number (%)
Concordant (Clinical = POCUS)	50 (71.5%)
Discordant	20 (28.5%)



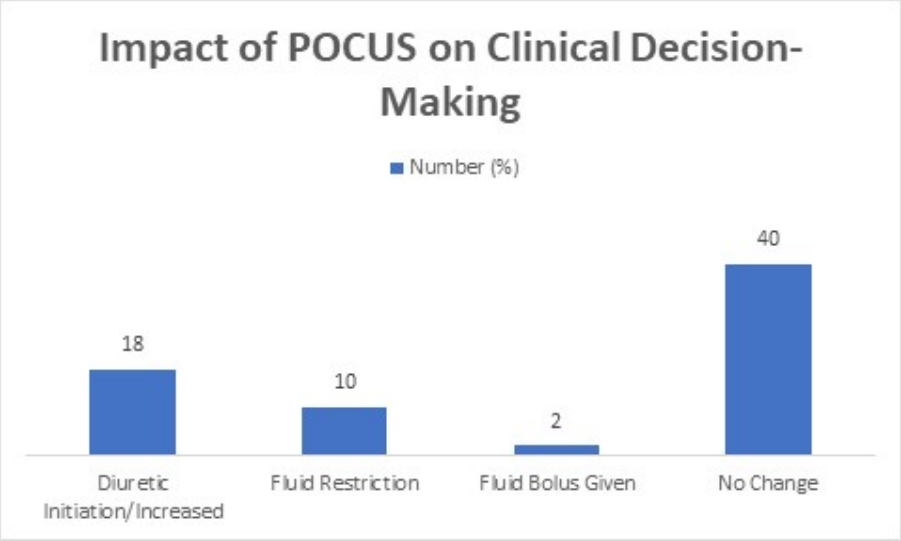
Graph 4: Concordance Between Clinical and POCUS Volume Assessment

5. Impact of POCUS on Clinical Decision-Making

POCUS led to a change in fluid management in 42.8% of patients, most commonly resulting in fluid restriction or diuretic initiation (Table 5).

Table 5: POCUS-Driven Management Changes

Type of Change	Number (%)
Diuretic Initiation/Increased	18 (25.7%)
Fluid Restriction	10 (14.3%)
Fluid Bolus Given	2 (2.9%)
No Change	40 (57.1%)



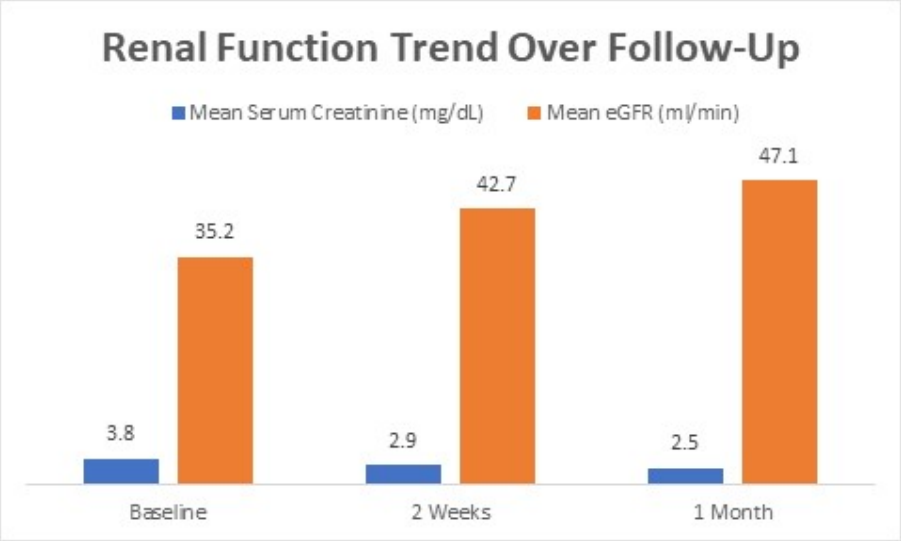
Graph 5: POCUS-Driven Management Changes

6. Renal Function Trend Over Follow-Up

Patients with POCUS-guided management showed a greater improvement in eGFR at 2 weeks and 1 month follow-up (Table 6).

Table 6: Renal Function Over Time

Timepoint	Mean Serum Creatinine (mg/dL)	Mean eGFR (ml/min)
Baseline	3.8 ± 1.1	35.2 ± 8.6
2 Weeks	2.9 ± 0.9	42.7 ± 10.3
1 Month	2.5 ± 0.7	47.1 ± 9.4



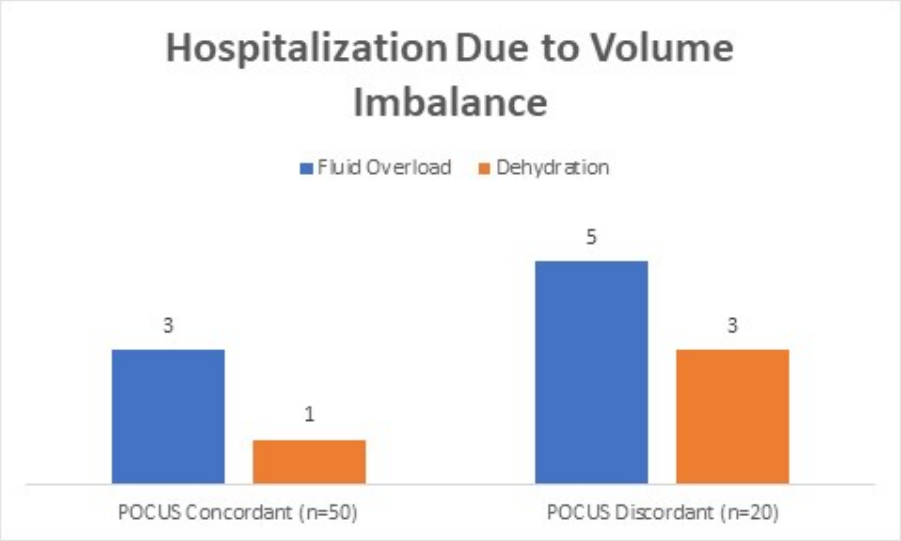
Graph 6: Renal Function Over Time

7. Hospitalization Due to Volume Imbalance

Patients with discordant clinical vs. POCUS assessment had a higher rate of hospitalization for fluid overload or dehydration (Table 7).

Table 7: Hospitalization Events During Follow-Up

Reason for Admission	POCUS Concordant (n=50)	POCUS Discordant (n=20)
Fluid Overload	3 (6%)	5 (25%)
Dehydration	1 (2%)	3 (15%)



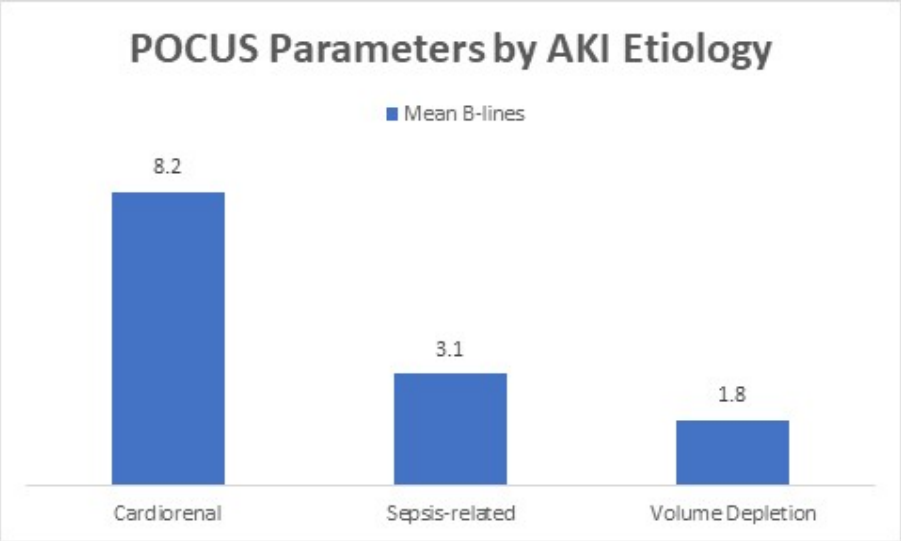
Graph 7: Hospitalization Events During Follow-Up

8. POCUS Parameters by AKI Etiology

Patients with cardiorenal AKI showed higher B-line scores, while sepsis-related AKI had higher IVC collapsibility, indicating hypovolemia (Table 8).

Table 8: POCUS Findings by AKI Etiology

AKI Etiology	Mean B-lines	IVC Collapsibility (%)
Cardiorenal	8.2	28%
Sepsis-related	3.1	58%
Volume Depletion	1.8	65%



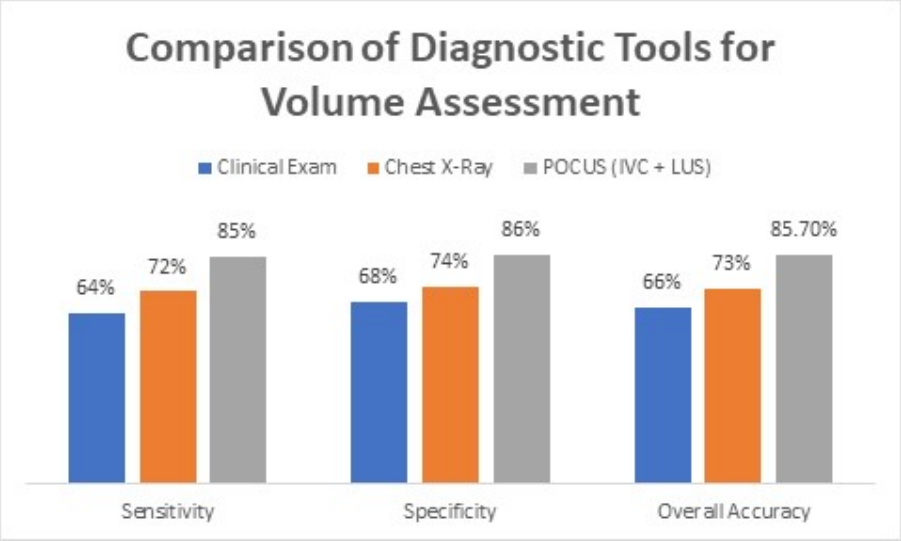
Graph 8: POCUS Findings by AKI Etiology

9. Comparison of Diagnostic Tools for Volume Assessment

POCUS had higher agreement with final clinical diagnosis compared to chest X-ray and clinical exam alone, supporting its diagnostic value (Table 9).

Table 9: Agreement with Final Volume Diagnosis

Method	Sensitivity	Specificity	Overall Accuracy
Clinical Exam	64%	68%	66%
Chest X-Ray	72%	74%	73%
POCUS (IVC + LUS)	85%	86%	85.7%



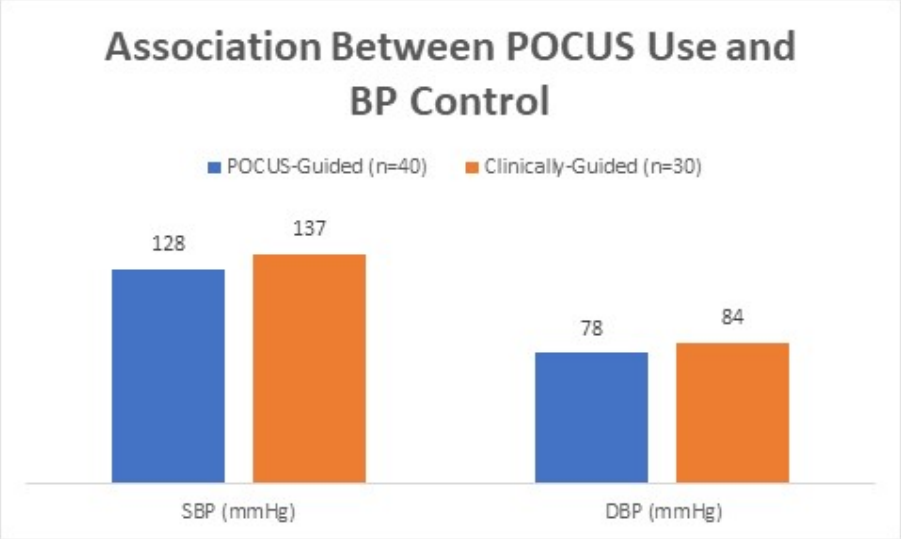
Graph 9: Agreement with Final Volume Diagnosis

10. Association Between POCUS Use and BP Control

POCUS-guided volume management was associated with better blood pressure control at 1 month follow-up compared to standard assessment (Table 10).

Table 10: Blood Pressure Changes at 1-Month Follow-Up

Group	SBP (mmHg)	DBP (mmHg)
POCUS-Guided (n=40)	128 ± 9	78 ± 6
Clinically-Guided (n=30)	137 ± 11	84 ± 8



Graph 10: Blood Pressure Changes at 1-Month Follow-Up

DISCUSSION

This cross-sectional study evaluated the effectiveness of point-of-care ultrasound (POCUS) in assessing volume status and influencing clinical decision-making in patients with severe kidney injury (AKI). Our findings support the growing body of evidence that POCUS is a valuable bedside tool, particularly in the accurate assessment of volume status and guiding individualized management in AKI.

Our results showed that POCUS altered clinical decision-making in 42.8% of patients, a finding consistent with prior studies. Karakala et al. (2021) reported that POCUS modified management in over 30% of nephrology inpatients, most commonly through fluid restriction or initiation of diuretics [1]. Similarly, Abdellah and Koratala (2022) highlighted that nephrologist-performed POCUS led to timely changes in treatment strategies based on IVC and lung findings [2]. This supports our observation that discordance between clinical examination and POCUS occurred in nearly 29% of patients, reinforcing the limitations of traditional bedside assessments alone.

Our study also demonstrated that over 54% of patients had IVC collapsibility >50%, indicative of hypovolemia, especially in septic AKI cases. This is in line with results by Babar et al. (2017), who identified a strong correlation between IVC parameters and biochemical markers of volume depletion [4]. Moreover, patients with cardiorenal AKI in our cohort showed significantly more B-lines on lung ultrasound, suggesting fluid overload, aligning with patterns reported in Gómez-Johnson et al. (2025), who emphasized multi-organ POCUS as a key to differentiating between volume states [5].

Notably, our data showed that patients managed based on POCUS findings experienced better renal function recovery (eGFR improvement at 2 weeks and 1 month) and more controlled blood pressure. These outcomes support findings by Tan and Ross (2024), who demonstrated that integrating POCUS into inpatient nephrology care improves clinical efficiency and patient outcomes [6].

Our findings correlate with Nepal et al. (2020), who showed that POCUS reliably detects urinary obstruction and avoids delays in AKI workup [10]. This validates its role in both diagnostic and therapeutic pathways. Overall, our study confirms that POCUS is an essential adjunct in AKI evaluation, offering greater diagnostic precision, timely intervention, and improved patient-centered outcomes compared to traditional methods.

CONCLUSION

This study highlights the significant clinical value of point-of-care ultrasound (POCUS) in evaluating volume status and guiding management in acute kidney injury. POCUS improved diagnostic accuracy, revealed discordance with clinical assessment in nearly one-third of cases, and led to management changes in 42.8% of patients. Its use was associated with better renal recovery, improved blood pressure control, and fewer hospitalizations related to fluid imbalance. These findings support integrating POCUS into routine nephrology preparation to enhance patient-centered care and results.

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