

FREQUENCY OF PERICARDIAL EFFUSION AMONG END-STAGE RENAL DISEASE (ESRD) PATIENTS

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DOI: <https://doi.org/10.5281/zenodo.17241810>

Keywords

Chronic kidney disease, Dialysis,
End-stage renal disease,
Echocardiography, Pericardial
effusion, Prevalence, Risk factors

Article History

Received: 15 January 2025

Accepted: 02 March 2025

Published: 12 March 2025

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Abstract

Background: Pericardial effusion is a significant cardiovascular complication in patients with end-stage renal disease (ESRD). Despite advances in dialysis care, its prevalence remains variable across populations, and associated risk factors are not fully clarified. **Understanding its frequency is crucial for improving early diagnosis, guiding interventions, and informing echocardiographic screening strategies.** **Objective:** To determine the frequency and severity of pericardial effusion among ESRD patients undergoing maintenance dialysis and to evaluate its association with demographic and clinical factors. **Methodology:** A cross-sectional study was conducted at the Dialysis Centre, National Hospital Lahore, from July 2024 to December 2024. A total of 107 ESRD patients, aged 30–65 years, on maintenance dialysis for more than three months, were recruited through consecutive sampling. Demographic and clinical details were recorded. Each participant underwent bedside transthoracic echocardiography by a consultant cardiologist to detect and classify pericardial effusion. Data were analyzed using SPSS version 26.0. Associations were assessed using chi-square tests, with $p < 0.05$ considered statistically significant. **Results:** Pericardial effusion was present in 36.4% of patients, including mild (18.7%), moderate (12.1%), and severe (5.6%) cases. Significant associations were observed with diabetes (48.3% vs. 22.4%, $p = 0.01$), ESRD duration >5 years (50.0% vs. 29.0%, $p = 0.03$), and dialysis duration >12 months (47.3% vs. 25.0%, $p = 0.04$). No significant associations were found with age, gender, hypertension, dialysis modality, or dialysis schedule. **Conclusion:** Pericardial effusion was common in ESRD patients, particularly among those with diabetes, longer disease duration, and prolonged dialysis. Routine echocardiographic evaluation may be warranted in high-risk patients to improve timely detection and management.

INTRODUCTION

End-Stage Renal Disease (ESRD) remains a major global health problem and is associated with a high burden of cardiovascular complications. Pericardial

disease, ranging from acute pericarditis to pericardial effusion (PE) and, in severe cases, cardiac tamponade, is an important but sometimes under-recognized

cardiac manifestation in patients with advanced chronic kidney disease (CKD) and ESRD. Uremic pericarditis (occurring before or shortly after the start of renal replacement therapy) and dialysis-associated pericarditis are the principal mechanisms by which kidney failure predisposes to pericardial inflammation and effusion. Pericardial involvement can produce nonspecific symptoms (dyspnea, fatigue) or life-threatening hemodynamic compromise, and its clinical presentation in renal patients is often atypical, which can delay recognition and treatment.[1, 2]

Historically, uremic pericarditis and related pericardial effusion were reported at very high rates (some early series reported frequencies up to 40% in advanced kidney failure), but the incidence has fallen in the era of modern dialysis and improved medical care. Contemporary studies, however, still report a wide prevalence range for pericardial effusion among CKD/ESRD populations, from low single digits in broad screening cohorts to substantially higher rates (up to ~20–35%) in selected dialysis or referral populations, depending on the study population, diagnostic method (POCUS, transthoracic echocardiography), and whether small, asymptomatic effusions are counted. These differences highlight heterogeneity in reported frequency and the potential for under-detection where routine echocardiography is not performed.[3, 4]

Pericardial effusion in ESRD is multifactorial. Uremia-related serosal inflammation, volume overload, hypoalbuminemia, inflammation (e.g., higher neutrophil-to-lymphocyte ratio), infection (including viral pathogens such as SARS-CoV-2), and coexisting conditions (malignancy, autoimmune disease) have all been implicated as contributors to effusion development and severity. The clinical importance of detecting PE in ESRD patients goes beyond immediate hemodynamic risk: recent work suggests even small, “hemodynamically irrelevant” effusions may correlate with adverse outcomes and increased mortality in dialysis cohorts, and PE may be encountered more commonly among patients with CKD than in matched non-CKD populations.[5, 6]

Understanding the frequency of pericardial effusion among ESRD patients is essential for several reasons. First, it offers valuable insight into the burden of this cardiovascular complication and its implications for patient prognosis. Second, identifying its prevalence

may facilitate earlier diagnosis and timely intervention, ultimately improving survival and quality of life. Third, it can assist clinicians in optimizing management strategies, particularly in balancing fluid status in dialysis patients. Finally, the findings of this study will provide evidence to guide whether routine echocardiographic screening should be incorporated into the standard care of ESRD patients. The current study aimed to determine the Frequency of Pericardial Effusion among End-Stage Renal Disease (ESRD) patients.

Methods and Materials

This cross-sectional study was conducted at the Dialysis Centre of National Hospital, Lahore for six months, extending from July 2024 to December 2024. A non-probability consecutive sampling technique was employed. The sample size was calculated using the WHO sample size calculator software with the following parameters: a confidence level of 95%, an absolute precision of 8%, and an anticipated population proportion of 17%.[7] Based on these values, the calculated sample size was 107 participants. The study population comprised patients with end-stage renal disease (ESRD) who fulfilled the inclusion criteria. Individuals aged between 30 and 65 years, of either gender, were eligible if they were diagnosed with ESRD according to the operational definition and exhibited relevant clinical features such as resting dyspnea, a drop in blood pressure to 90/60 mmHg or below during dialysis, muffled heart sounds confirmed by a consultant physician, low voltage on electrocardiography, or elevated jugular venous pressure greater than 9 cm. Patients were excluded if they had a history of cancer, recent chest trauma, recent flu-like symptoms with leukocytosis greater than $11 \times 10^9/L$, or if they were mentally incapacitated and unable to provide informed consent.

After obtaining ethical approval from the institutional review board and the College of Physicians and Surgeons Pakistan (CPSP), written informed consent was obtained from all participants. Demographic and clinical details, including age, gender, body mass index (BMI), history of diabetes and hypertension, duration of ESRD, frequency of dialysis sessions (twice or thrice weekly), and dialysis modality (hemodialysis or peritoneal dialysis) were recorded.

Each participant underwent bedside transthoracic echocardiography, performed by a consultant cardiologist, to assess the presence and severity of pericardial effusion. The extent of effusion was documented, and patients with moderate to severe effusion were referred for appropriate interventions as advised by the cardiologist. All collected data were entered into a pre-designed proforma.

All patients underwent bedside transthoracic echocardiography, performed by a consultant cardiologist, to assess the presence and severity of pericardial effusion. Pericardial effusion was defined as the presence of fluid in the pericardial space greater than 60 mL. It was further classified: **mild** (61–100 mL), **moderate** (101–300 mL), and **severe** (>300 mL). The extent of effusion was documented, and patients with moderate to severe effusion were referred for appropriate interventions as advised by the cardiologist. All collected data were entered into a pre-designed proforma.

The data were analyzed using SPSS version 26.0. Quantitative variables such as age, duration of ESRD, and duration of dialysis sessions were expressed as mean $\pm$ standard deviation, while categorical variables such as gender, diabetes status, hypertension status, type of dialysis, dialysis schedule, and presence of pericardial effusion were presented as frequencies and percentages. Data were stratified according to age, gender, duration of ESRD, type of dialysis, dialysis schedule, diabetes status, hypertension status, and duration of dialysis sessions. Post-stratification, the chi-square test was applied to determine associations between study variables and the frequency of pericardial effusion. A p-value of less than 0.05 was considered statistically significant.

Results

The mean age of the study participants was 52.4 ± 8.6 years, with a male predominance (60.7%). The mean BMI was 24.6 ± 3.5 kg/m². More than half of the patients were diabetic (54.2%), and two-thirds were hypertensive (66.4%) (Table 1).

Table 1: Demographic characteristics of study participants (n = 107)

Variable	Mean $\pm$ SD / n (%)
Age (years)	52.4 ± 8.6
Gender	
Male	65 (60.7%)
Female	42 (39.3%)
BMI (kg/m ²)	24.6 ± 3.5
Diabetes	58 (54.2%)
Hypertension	71 (66.4%)

The mean duration of ESRD was 4.8 ± 2.1 years, while the mean duration of dialysis was 18.5 ± 7.2 months. Most patients were on hemodialysis (83.2%), and a

greater proportion underwent dialysis thrice weekly (57.9%) compared to twice weekly (42.1%) (Table 2).

Table 2: Clinical characteristics of study participants (n = 107)

Variable	Mean $\pm$ SD / n (%)
Duration of ESRD (years)	4.8 ± 2.1
Duration of dialysis (months)	18.5 ± 7.2
Dialysis frequency	

Twice weekly	45 (42.1%)
Thrice weekly	62 (57.9%)
Dialysis modality	
Hemodialysis	89 (83.2%)
Peritoneal	18 (16.8%)

Pericardial effusion was observed in 36.4% of patients. Among these, mild effusion accounted for

18.7%, moderate for 12.1%, and severe for 5.6% of cases (Table 3).

Table 3: Frequency and severity of pericardial effusion among ESRD patients (n = 107)

Pericardial Effusion	n (%)
Absent	68 (63.6%)
Mild (61–100 mL)	20 (18.7%)
Moderate (101–300 mL)	13 (12.1%)
Severe (>300 mL)	6 (5.6%)

On stratification analysis, patients with ESRD duration greater than five years (50.0% vs. 29.0%, $p = 0.03$), diabetes (48.3% vs. 22.4%, $p = 0.01$), and dialysis duration greater than 12 months (47.3% vs. 25.0%, $p = 0.04$) had a significantly higher frequency

of pericardial effusion. No statistically significant associations were noted with age, gender, hypertension status, dialysis schedule, or dialysis modality (Table 4).

Table 4: Stratification of Study Variables with Frequency of Pericardial Effusion (n = 107)

Variable	Categories	Effusion Present n (%)	Effusion Absent n (%)	p-value
Age (years)	≤50	13 (29.5%)	31 (70.5%)	0.21
	>50	26 (41.3%)	37 (58.7%)	
Gender	Male	24 (36.9%)	41 (63.1%)	0.72
	Female	15 (35.7%)	27 (64.3%)	
Duration of ESRD	≤5 years	20 (29.0%)	49 (71.0%)	0.03*
	>5 years	19 (50.0%)	19 (50.0%)	
Dialysis Modality	Hemodialysis	32 (36.0%)	57 (64.0%)	0.81
	Peritoneal	7 (38.9%)	11 (61.1%)	
Dialysis Schedule	Twice weekly	19 (42.2%)	26 (57.8%)	0.25
	Thrice weekly	20 (32.3%)	42 (67.7%)	
Diabetes Status	Diabetic	28 (48.3%)	30 (51.7%)	0.01*
	Non-Diabetic	11 (22.4%)	38 (77.6%)	
Hypertension Status	Hypertensive	29 (40.8%)	42 (59.2%)	0.18
	Non-Hypertensive	10 (27.8%)	26 (72.2%)	
Duration of Dialysis	≤12 months	13 (25.0%)	39 (75.0%)	0.04*
	>12 months	26 (47.3%)	29 (52.7%)	

*Statistically significant ($p < 0.05$)

Discussion

In this cross-sectional sample of 107 ESRD patients, pericardial effusion (PE) was detected in 36.4% of participants. This frequency lies toward the higher

end of prevalences reported in contemporary literature and is broadly consistent with recent reports that have described prevalences ranging from low single digits to about one-third of patients depending

on population and imaging strategy. Several recent large series and reviews have documented wide heterogeneity in reported PE frequency, attributing much of the variation to differences in patient selection (inpatient vs outpatient, pre-dialysis vs established dialysis), the imaging modality used, and whether small asymptomatic effusions were counted.[5, 8]

Our observed overall frequency (36.4%) was comparable to prevalence estimates reported in a number of contemporary cohorts that used routine echocardiography or focused on referred/dysfunctional populations. For example, a recent CKD-focused study reported that a substantial proportion of patients with CKD had echocardiographic PE and that moderate-severe effusions were common among those identified with PE, findings that are compatible with the relatively high point prevalence we observed when routine bedside echo was performed.[4, 5] By contrast, other population-based or broader screening studies have reported lower prevalence (often <15%), which highlights that our estimate may reflect referral/center effects (dialysis-center population) and inclusion of small asymptomatic effusions that are detectable only with systematic echocardiography.[7, 9]

We found a higher frequency of PE among patients with diabetes (48.3% vs 22.4% in non-diabetics, $p = 0.01$). This association is in line with several reports that identified diabetes and other markers of systemic illness as common comorbidities in CKD patients with PE; diabetes may act as a marker of greater comorbidity burden, vascular inflammation, and fluid management challenges, all of which plausibly increase the risk of pericardial fluid accumulation. That said, not all studies have reported diabetes as an independent predictor after multivariable adjustment: some recent analyses emphasized laboratory markers (e.g., hypoalbuminemia, neutrophil-to-lymphocyte ratio) and acute clinical features (dyspnea, chest pain) as stronger correlates of PE severity than diabetes per se, suggesting diabetes may be a surrogate for sicker patients rather than a direct causal factor in every setting.[5, 10]

Duration of kidney disease and dialysis exposure were also associated with PE in our dataset: patients with ESRD longer than five years and those dialyzing >12 months had higher PE frequency. Several prior

studies have described a similar pattern, reporting that both prolonged uremia (pre-dialysis) and longer dialysis vintage can influence pericardial involvement, through mechanisms ranging from chronic volume overload and hypoalbuminemia to ongoing low-grade inflammation or dialysis-associated pericarditis. Some investigators have, however, observed that prompt initiation and optimization of dialysis can reduce uremic pericarditis and large effusions, which may explain why cohorts with well-established, high-quality dialysis programs sometimes report lower rates of clinically significant PE.[7, 8, 11, 12]

In our study dialysis modality and schedule (hemodialysis vs peritoneal dialysis; twice vs thrice weekly) were not significantly associated with PE. This neutral finding mirrors several reports that found no consistent association between dialysis modality and the mere presence of small PE when examined cross-sectionally, although modality and intensity of dialysis have been linked to outcomes in acute uremic pericarditis or to need for therapeutic intensification in some series. A number of recent papers therefore emphasize that it is the adequacy and timeliness of dialysis (and related factors such as interdialytic weight gain and volume management) rather than modality alone that may determine pericardial risk.[5, 8]

Several studies have focused on predictors of PE severity rather than presence alone; these works frequently identified hypoalbuminemia, neutrophilia or elevated neutrophil-to-lymphocyte ratio, and signs of systemic inflammation as markers of moderate or large effusions and of need for drainage. Our results, showing significant associations with longer ESRD/dialysis duration and with diabetes, complement the literature by highlighting patient groups who may be more likely to harbour clinically relevant effusions and therefore benefit from targeted echocardiographic surveillance.[13, 14]

Clinical implications from our findings and the recent literature are twofold. First, a high index of suspicion and a low threshold to perform transthoracic echocardiography in symptomatic ESRD patients (dyspnea, hypotension during dialysis, muffled heart sounds, low ECG voltage) is justified because PE may be occult yet clinically important; several recent reviews have made the same recommendation. Second, our results add to evidence that selected high-

risk subgroups, patients with longstanding ESRD, prolonged dialysis vintage, or significant comorbidity burden such as diabetes and hypoalbuminemia, might be prioritized for periodic echocardiographic screening or closer fluid-management strategies.

Limitations:

This study had limitations that temper direct comparisons with other series. The cross-sectional design precluded causal inferences and may overestimate point prevalence in a referral dialysis-center sample compared with community cohorts. In addition, echocardiographic volume estimates have inherent measurement variability, and our threshold definitions (e.g., >60 mL for PE) differ slightly from some other reports, which complicates direct numeric comparisons. Nonetheless, by aligning with a substantial body of recent evidence showing persistent, clinically meaningful PE in contemporary CKD/ESRD populations, our findings reinforce calls for vigilance and for further prospective work examining whether routine echocardiography improves outcomes.

Conclusion:

The observed frequency of PE in our ESRD cohort was substantial and comparable to the higher prevalence reported in several recent studies. Diabetes, longer ESRD duration, and longer dialysis vintage were associated with greater PE frequency in our sample, a pattern that is broadly consistent with current literature implicating chronic comorbidity and markers of systemic illness in pericardial involvement. Future prospective multicentre studies should clarify whether screening strategies targeted to high-risk ESRD patients reduce clinically important events (tamponade, need for drainage) or improve survival and quality of life.

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