

Incremental Peritoneal Dialysis in End-Stage Kidney Disease: Impact on Dialysis Adequacy, Quality of Life, And Infectious Complications From A Tertiary Care Centre in Rural India

Dr.Chakradhar Arepalli¹, Dr.Indhumathi.E², Dr.Manodhar³, Dr.Manoj Kumar⁴, Dr.Vishnu Shankar⁵, Dr.Sairam⁶

¹Department of Nephrology, Saveetha Medical College and Hospital, Chennai, Tamilnadu, India.

²Department of Nephrology, Saveetha Medical College and Hospital, Chennai, Tamilnadu, India.

³Department of Nephrology, Saveetha Medical College and Hospital, Chennai, Tamilnadu, India.

⁴Department of Nephrology, Saveetha Medical College and Hospital, Chennai, Tamilnadu, India.

⁵Department of Nephrology, Saveetha Medical College and Hospital, Chennai, Tamilnadu, India.

⁶Department of Nephrology, Saveetha Medical College and Hospital, Chennai, Tamilnadu, India.

Abstract

Background: Incremental continuous ambulatory peritoneal dialysis (CAPD) is initiated in patients with end-stage renal disease (ESRD) who have good residual kidney function, with the aim of maintaining adequate dialysis, preserving quality of life, and reducing the risk of peritonitis. **Objective:** The aim of this study was to assess the adequacy of dialysis, quality of life, peritonitis rate, and clinical outcome among patients treated with an incremental CAPD regimen (two exchanges/day). **Methods:** We conducted a prospective observational study at a tertiary care centre between November 2023 and October 2025, enrolling twenty-five incident CAPD patients. Catheters were placed percutaneously under fluoroscopic guidance. Peritonitis episodes, dialysis adequacy (total weekly Kt/V), peritoneal equilibration test (PET) findings, and all-cause mortality were tracked, and the Medical Outcomes Study Short Form-36 (SF-36) questionnaire was administered at 12 months. **Results:** Of the 25 patients, 20 (80%) were men, with a mean age of 55 years; diabetes and hypertension were each present in 40%. Seven patients (28%) developed bacterial peritonitis, a rate of 0.4 episodes per patient-year. No fungal peritonitis, catheter loss, or CAPD-related death occurred. Mean total weekly Kt/V was 1.7, and 76% of patients showed high or high-average peritoneal transport on PET. SF-36 scores showed better preservation of emotional well-being (68.5) and social functioning (66.3) than physical functioning (55.4) and vitality (44.2). Overall mortality was 8%, with deaths attributable to non-dialysis causes. **Conclusion:** Incremental CAPD achieved satisfactory dialysis adequacy, an acceptable peritonitis rate, and reasonably preserved quality of life, with no CAPD-related deaths or technique failure of note.

Keywords: incremental peritoneal dialysis; CAPD; peritonitis; dialysis adequacy; quality of life; residual renal function; low socioeconomic status; end-stage renal disease.

INTRODUCTION

End-stage renal disease is a major and growing driver of global health expenditure, affecting more than 850 million people worldwide and imposing a disproportionate economic burden on low- and middle-income countries (LMICs) [1]. About 800 cases of chronic kidney disease (CKD) per million are reported in the Indian population, registered with around 150 to 200 new end-stage renal disease (ESRD) cases per million every year in India [2]. While renal replacement therapy (RRT) like hemodialysis (HD) and PD treatment helps manage ESRD disease processes, most patients constantly rely on dialysis as an option due to the difficulties of getting transplanted kidney in India [3]. Compared to HD, continuous ambulatory peritoneal dialysis (CAPD) offers advantages of not having to keep vascular access open all the times, does not require anticoagulant drugs and provides much higher hemodynamic stability which is critical for patients who also have other cardiovascular illnesses along with having more functioning renal function while on treatment [4,5]. Since using CAPD can be done from home, it saves caregiver responsibility and travel time for patients for treatment three times in a week for HD which is also critical for low SES population [6]. A standard CAPD schedule with 2 litres fluid exchange for 4 times daily results in about weekly Kt/V values between 1.7 and 2.1. However, if patients are having enough residual renal function at the beginning of dialysis treatment, this level of severity may not always be necessary, and result in unnecessary expenses for treatment. Therefore, incremental peritoneal dialysis allows adjusting the treatment level initially to two exchanges of daily fluid and only increasing it once their renal function goes down [7]. The rationale behind this system is based on the fact that as long as the total systemic Kt/V level represents a particular amount, there are no needs to continue exchanging fluid [8,9].

The application of this concept is very beneficial for low-SES peoples. Doing fewer exchanges means to spend less for treatment in such a way that is a great advantage for many patients who can't afford to cover all expenses related to RRT costs [10]. Moreover, it provides saving money along with preserving much time spent on peritoneal dialysis process, preventing loss of productivity, and reducing the exposure of peritoneal membrane to potentially hostile dialysis fluid [11,12].

Despite this rationale, incremental CAPD has seen little formal evaluation in Indian populations, and data specific to low-SES cohorts remain sparse. Open questions include whether solute clearance is adequate on a reduced regimen, whether limited access to clean water and hygienic living conditions raises peritonitis risk, and what the approach means for health-related quality of life (HRQoL) [13]. High-income-country studies report incremental PD peritonitis rates of 0.3–0.6 episodes per patient-year, but comparable Indian subcontinent data are scarce [14,15].

HRQoL in this setting is commonly assessed with the SF-36, a validated instrument covering eight domains that has previously been used in ESRD and PD populations to capture how physical and mental health burdens diverge [16,17]. Physical functioning and vitality are typically the most affected domains in dialysis patients, whereas emotional well-being and social functioning tend to be comparatively better preserved; this specific profile has not, to our knowledge, previously been characterised in an Indian, low-SES, incremental-CAPD cohort.

We therefore undertook this study to prospectively evaluate incremental CAPD's clinical performance in such a population — its peritonitis rate and causative organisms, dialysis adequacy by Kt/V and creatinine clearance, peritoneal membrane transport characteristics, quality of life at one year, and patient and technique survival across two years of follow-up.

OBJECTIVES

The primary objective of this study was to evaluate peritonitis rates and causative organisms among patients with ESRD of low socioeconomic status undergoing incremental CAPD. Secondary objectives were to: (i) assess dialysis adequacy through total weekly Kt/V and creatinine clearance; (ii) characterise peritoneal membrane transport status using the peritoneal equilibration test (PET); (iii) measure health-related quality of life via the SF-36 questionnaire at 12 months from dialysis initiation; and (iv) document all-cause mortality, CAPD-related mortality, technique survival, and catheter-related complications over the study period.

MATERIALS AND METHODS

Study Design and Setting

This prospective observational study was carried out in the Department of Nephrology of a tertiary care teaching hospital in South India. Enrolment and follow-up together spanned 24 months, from November 2023 to October 2025. The study followed the principles of the Declaration of Helsinki and was approved by the Institutional Ethics Committee; written informed consent was obtained from every participant before enrolment.

Patient Population

Eligible patients were adults (≥ 18 years) with a confirmed diagnosis of ESRD requiring RRT initiation, a residual urine output exceeding 400 mL per 24 hours at the time of PD start, a choice of CAPD as their dialysis modality after appropriate counselling, and documented low socioeconomic status per the Modified Kuppuswamy Scale [18]. Patients were excluded if they had active abdominal or pelvic pathology precluding peritoneal access, a history of multiple abdominal surgeries raising concern for adhesions, active systemic infection, declined consent, or were unable to perform or supervise their own exchanges.

CAPD Catheter Insertion

Consultant nephrologists inserted all catheters percutaneously using the Seldinger technique, under combined fluoroscopic and/or real-time ultrasonographic guidance. Standard double-cuffed, swan-neck-configuration Tenckhoff catheters were used, placed under local anaesthesia with intravenous sedation added as required. The perioperative protocol included bowel preparation, a prophylactic intravenous cephalosporin dose, and a two-week healing interval before the first exchange.

Incremental CAPD Protocol

All patients began on two daily 2-litre exchanges of standard glucose-based CAPD solution (1.5% dextrose Dianeal and 2.5% dextrose with each 6 hours dwell time). Total Kt/V was calculated as the sum of the peritoneal and renal components, the latter derived from 24-hour urine collections, with a total weekly Kt/V of ≥ 1.7 taken as the

adequacy threshold in line with ISPD guidance [8]. Patients were reviewed monthly for one year and the exchange volume or frequency increased whenever RRF declined significantly or adequacy targets were not met and such patients were removed from our study cohort.

Clinical Data Collection

Demographic data, including age, sex, primary renal diagnosis, and comorbidities, were recorded at enrolment. Clinical parameters — blood pressure, body weight, fluid balance, and biochemical indices (serum urea, creatinine, albumin, haemoglobin, serum electrolytes, and calcium-phosphate product) — were collected at each scheduled visit. Comorbidity burden was assessed using the Charlson Comorbidity Index [19].

Assessment of Peritonitis

Peritonitis was diagnosed per ISPD criteria, requiring at least two of the following: symptoms or signs of peritoneal inflammation (abdominal pain or cloudy effluent); a dialysate white cell count above 100 cells/ μ L with more than 50% polymorphonuclear leucocytes; or a positive dialysate culture [20]. Dialysate samples were inoculated into both aerobic and anaerobic blood culture bottles and incubated on a BACTEC automated system, with sensitivity testing performed by the Kirby-Bauer disc diffusion method. Empirical intraperitoneal antibiotics (vancomycin with ceftazidime, or gentamicin where ceftazidime was unavailable) were started at the treating nephrologist's discretion and adjusted once culture and sensitivity results were available. The peritonitis rate is expressed as episodes per patient-year, and catheter removal criteria and technique failure followed ISPD recommendations [20].

Dialysis Adequacy and PET

Total weekly Kt/V was measured at three, six, and twelve months after PD initiation. The peritoneal component was derived from dialysate and serum urea concentrations obtained during a standardised 24-hour dialysate collection, and the renal component from a timed 24-hour urine collection. Total weekly creatinine clearance (L/week/1.73 m²), similarly the sum of peritoneal and renal contributions, was normalised to body surface area using the Mosteller formula. The peritoneal equilibration test (PET) followed the standard Twardowski protocol with 2.27% dextrose dialysate, measuring dialysate-to-plasma creatinine (D/P Cr) and dialysate-to-initial glucose (D/D0 glucose) ratios at the four-hour dwell [21]. Patients were categorised as high, high-average, low-average, or low transporters against established reference ranges.

Assessment of Health-Related Quality of Life

HRQoL was assessed 12 months after dialysis initiation using the SF-36 questionnaire, version 2, administered in the patient's preferred language (Tamil or English) by a trained research assistant. The 36 items of the instrument are grouped into eight categories; namely, physical functioning (PF), role limitations because of physical health (RP), bodily pain (BP), general health perceptions (GH), vitality/energy (VT), social function (SF), role limitations because of emotional problems (RE) and mental health/emotional wellbeing (MH). In addition, an item pertaining to health transition (HT) is available revealing patient's self-reported health evolution over the prior year. All scores in the eight domains vary from 0 to 100; higher scores translated into better health outcomes. Norm-based scoring enables detection of physical component summary score (PCS) and mental component summary score (MCS) values [22].

Outcome Definitions

The major outcomes were both the number of instances of peritonitis (per patient per year) and weekly average Kt/V measured at the end of 12 months. Other important outcomes for the project included: all-cause mortality; CAPD mortality; quality of life; technique survival rate; total number of CAT, exit site infections, and tunnel infections.

Statistical Analysis

In the case of continuous variables, these have been portrayed in terms of mean $\pm$ standard deviations (SD) or median (interquartile range, IQR) depending on the distribution analyzed using the Shapiro-Wilk test. Categorical variables have been shown in terms of frequency and percentage. The comparison of SF36 scores was done across the comorbidity subgroup using the Mann-Whitney U test while the association between Kt/V and SF36 was ascertained using Pearson or Spearman correlation co-efficients as appropriate. P-values less than 0.05 were considered to be statistically significant. All analyses were performed in SPSS version 26.0 (IBM Corp., Armonk, NY).

Results

Twenty-five patients with ESRD of low socioeconomic status were enrolled and started on incremental CAPD between November 2023 and January 2025. Twenty (80%) were male and five (20%) female, with a mean cohort age of 55 $\pm$ 12.3 years (range 28–74). Diabetes mellitus and hypertension were each present in 10 patients (40%), either as the primary cause of CKD or as a significant comorbidity, and coronary artery disease was documented in

a subset of patients. Mean serum creatinine at PD initiation was 8.2 ± 2.1 mg/dL, corresponding to a mean eGFR of 6.8 ± 2.4 mL/min/1.73 m² by the MDRD formula. All patients had a residual urine output above 400 mL per 24 hours at initiation, meeting the eligibility criterion for incremental therapy. Baseline demographic and clinical characteristics are summarised in Table 1.

Table 1: Baseline Demographic and Clinical Characteristics of the Study Cohort (n = 25)

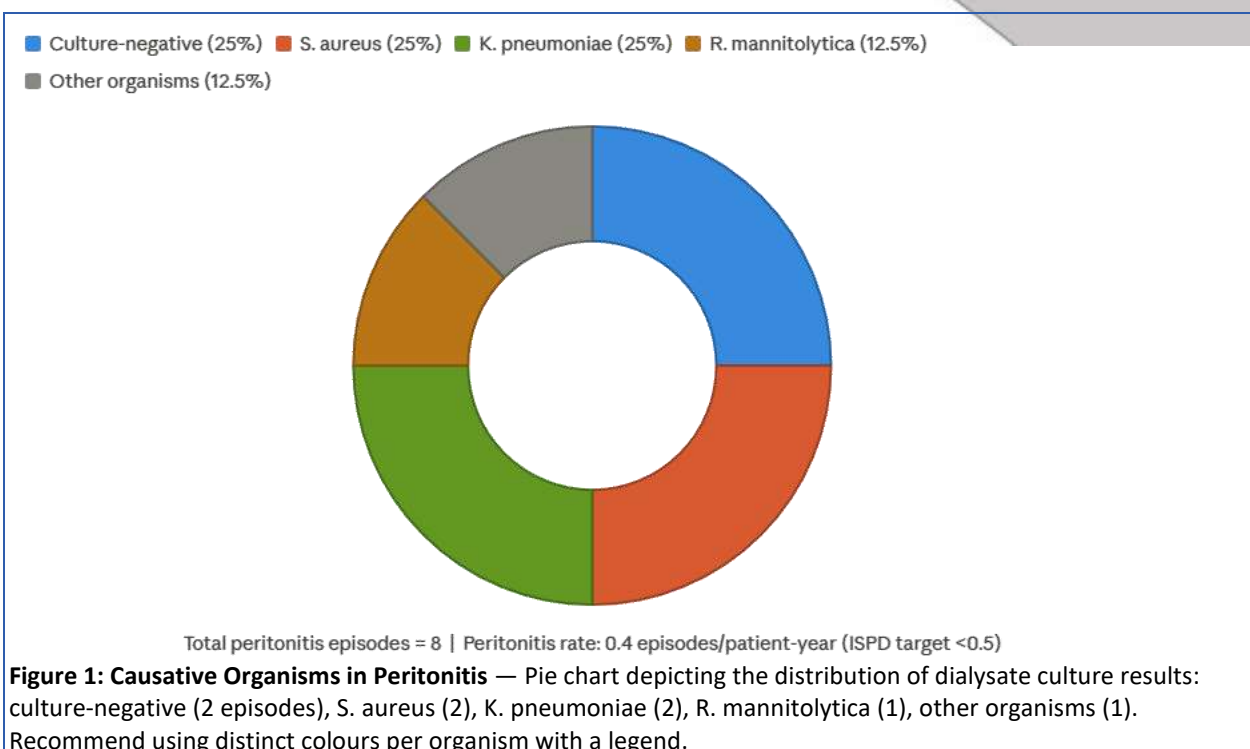
Parameter	Value / n (%)
Total patients	25
Males	20 (80%)
Mean age $\pm$ SD (years)	55 ± 12.3
Diabetes mellitus	10 (40%)
Hypertension	10 (40%)
Coronary artery disease	Present
Residual urine output (mL/24h)	>400 mL (all patients)
Mean serum creatinine at initiation (mg/dL)	8.2 ± 2.1
Mean eGFR at initiation (mL/min/1.73m ²)	6.8 ± 2.4
Duration of follow-up (months)	24 (July 2023–June 2025)

Over the 24-month study period, seven patients (28%) experienced eight episodes of bacterial peritonitis between them, for a peritonitis rate of 0.4 episodes per patient-year — below the ISPD benchmark of <0.5 episodes per patient-year [20]. Two episodes (8% of the cohort) were culture-negative. Among culture-positive episodes, the organisms identified were *Staphylococcus aureus*, *Klebsiella pneumoniae*, and *Ralstonia mannitolytica*; no episode of fungal peritonitis occurred during the study. Every episode was managed successfully with intraperitoneal antibiotic therapy, none necessitated catheter removal, and there was no peritonitis-related mortality. One patient's recurrent peritonitis led to transfer to haemodialysis, the sole instance of technique failure in the cohort. Table 2 details these peritonitis-related outcomes.

Table 2: Peritonitis Episodes — Rates, Causative Organisms, and Outcomes

Parameter	Value / n (%)
Total peritonitis episodes	7 (28%)
Peritonitis rate	0.4 episodes/patient-year
Culture-negative peritonitis	2 (8%)
<i>Staphylococcus aureus</i>	2 (28.6% of culture+)
<i>Klebsiella pneumoniae</i>	2 (28.6% of culture+)
<i>Ralstonia mannitolytica</i>	1 (14.3% of culture+)
Fungal peritonitis	0 (0%)
Catheter loss due to peritonitis	0 (0%)
Peritonitis-related mortality	0 (0%)

Technique failure (PD→HD transfer)	1 (4%)
------------------------------------	--------



Throughout the follow-up duration, all patients met the dialysis adequacy indicators. The mean weekly Kt/V total score at 12 months was 1.7 ± 0.3 , in which the residual kidney contribution to the Kt/V unit was about 0.4–0.6 for each patient, showing that the importance of the preserved residual renal function (RRF) played a significant role in ensuring adequacy of the incremental treatment at that time. The mean total creatinine elimination rate reached 48.5 ± 8.2 L/week/ 1.73 m^2 , surpassing the minimum value of 45 L/week. The 12-month mean urinary excretion was 680 ± 220 mL in the course of 24 hours, indicating the preservation of the significant level of RRF at this stage of the study. The number of patients who were classified as high transporters via peritoneal equilibrium test (PET) was nine patients (36% of the studied group), while ten patients (40%) fall into the category of high average transporters thus, making 76% altogether. One patient was classified as having a low average transport and one patient as a policy transporter. There were four patients with incomplete PET results.

Table 3: Dialysis Adequacy and Peritoneal Membrane Transport Status

Parameter	Mean $\pm$ SD / Value
Total weekly Kt/V (peritoneal + residual)	1.7 ± 0.3
Residual renal Kt/V contribution	$\sim 0.4\text{--}0.6$
Mean urine output at 12 months (mL/day)	680 ± 220
Total creatinine clearance (L/week/ 1.73 m^2)	48.5 ± 8.2
PET result – High transporter	9 (36%)

PET result – High average transporter	10 (40%)
PET result – Low average transporter	1 (4%)
PET result – Low transporter	1 (4%)
PET not performed / indeterminate	4 (16%)

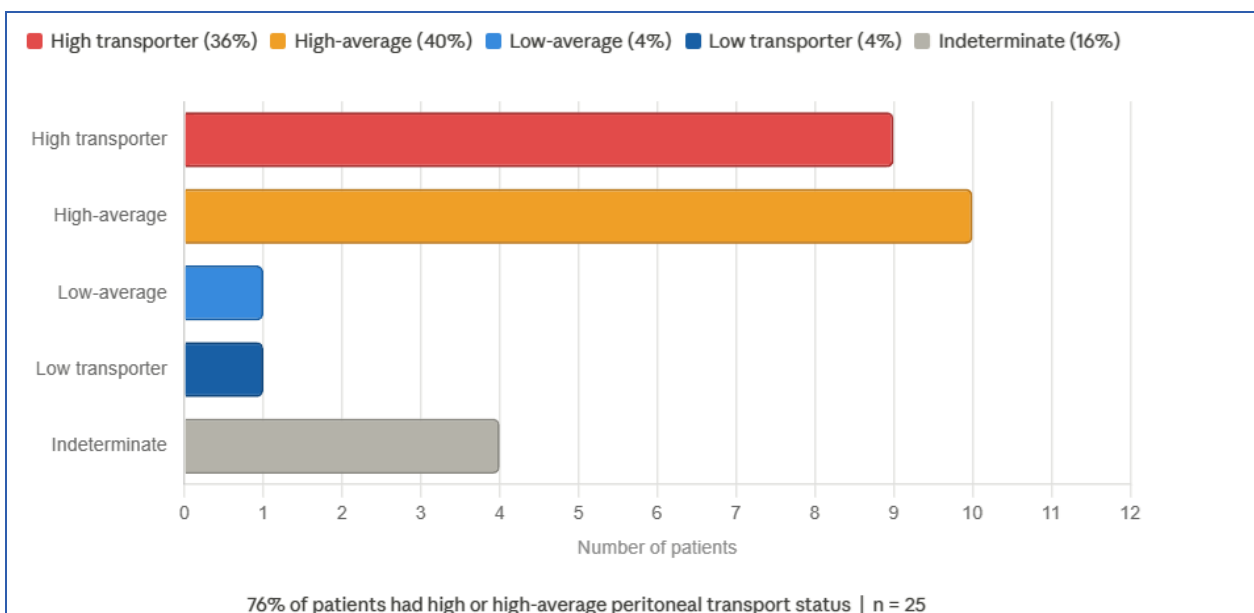


Figure 2: Peritoneal Equilibration Test (PET) Transport Categories — Stacked bar or pie chart showing distribution: High (36%), High-average (40%), Low-average (4%), Low (4%), Indeterminate (16%). Use ISPD-standard colour scheme where high transporter is red and low is blue.

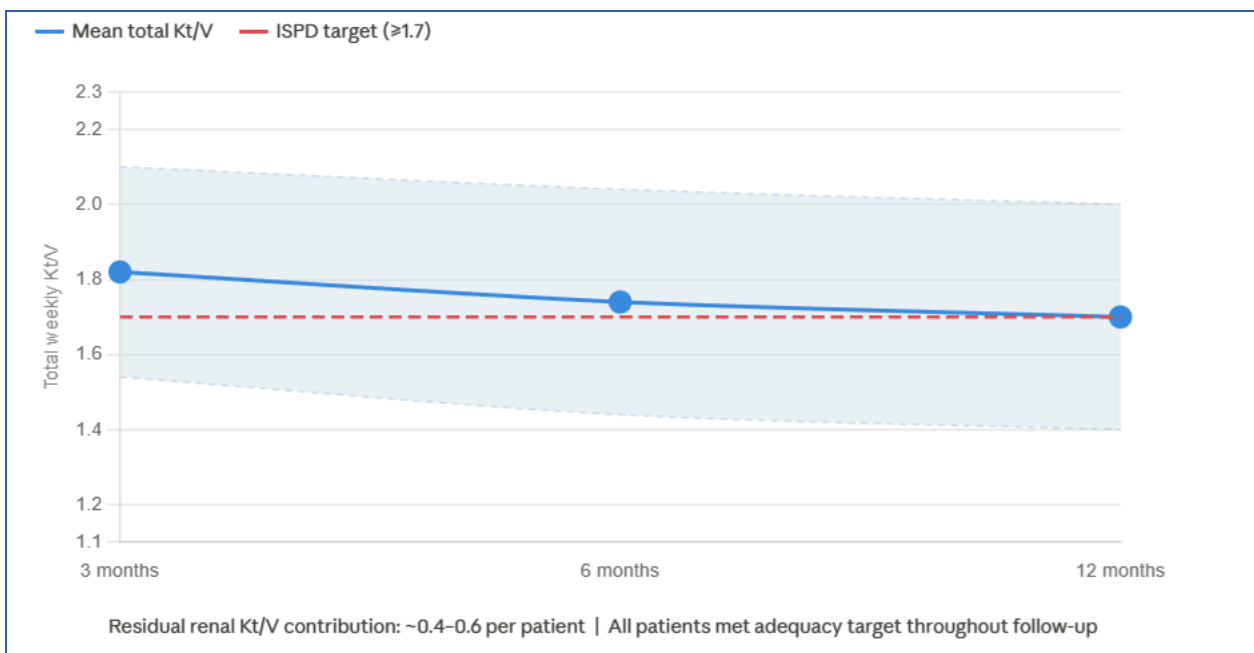


Figure 3: Total Weekly Kt/V at 3, 6, and 12 Months — Line graph with error bars ($\pm$ SD) showing mean total Kt/V at three time points. Overlay a dotted horizontal reference line at Kt/V = 1.7 (ISPD target). Include individual patient trajectories as faint lines.

At 12 months, SF-36 results traced a pattern typical of chronic dialysis therapy, with physical domains more severely affected than mental health domains. Physical functioning scored 55.4, reflecting moderate functional limitation, while vitality/energy was the lowest-scoring subscale at 44.2, consistent with the profound fatigue often accompanying ESRD and dialysis. Mental health and emotional well-being, by contrast, scored highest at 68.5, followed by social functioning at 66.3 and emotional role limitations at 63.8. These findings indicate that while home-based PD helps preserve social engagement and emotional equilibrium, the physical demands of the disease continue to take a substantial toll. Table 4 summarises the full set of SF-36 domain scores.

Table 4: SF-36 Health-Related Quality of Life Scores at 12 Months (n = 23)

SF-36 Domain	Mean Score (0–100)	Interpretation
Physical Functioning (PF)	55.4	Moderately limited
Role Limitations – Physical (RP)	48.2	Notably reduced
Bodily Pain (BP)	52.6	Moderate impact
General Health (GH)	50.1	Moderate
Energy / Vitality / Fatigue (VT)	44.2	Most impaired domain
Social Functioning (SF)	66.3	Relatively preserved
Role Limitations – Emotional (RE)	63.8	Relatively preserved
Mental Health / Emotional Well-being (MH)	68.5	Best preserved domain
Health Transition / Change (HT)	55.0	Moderate improvement

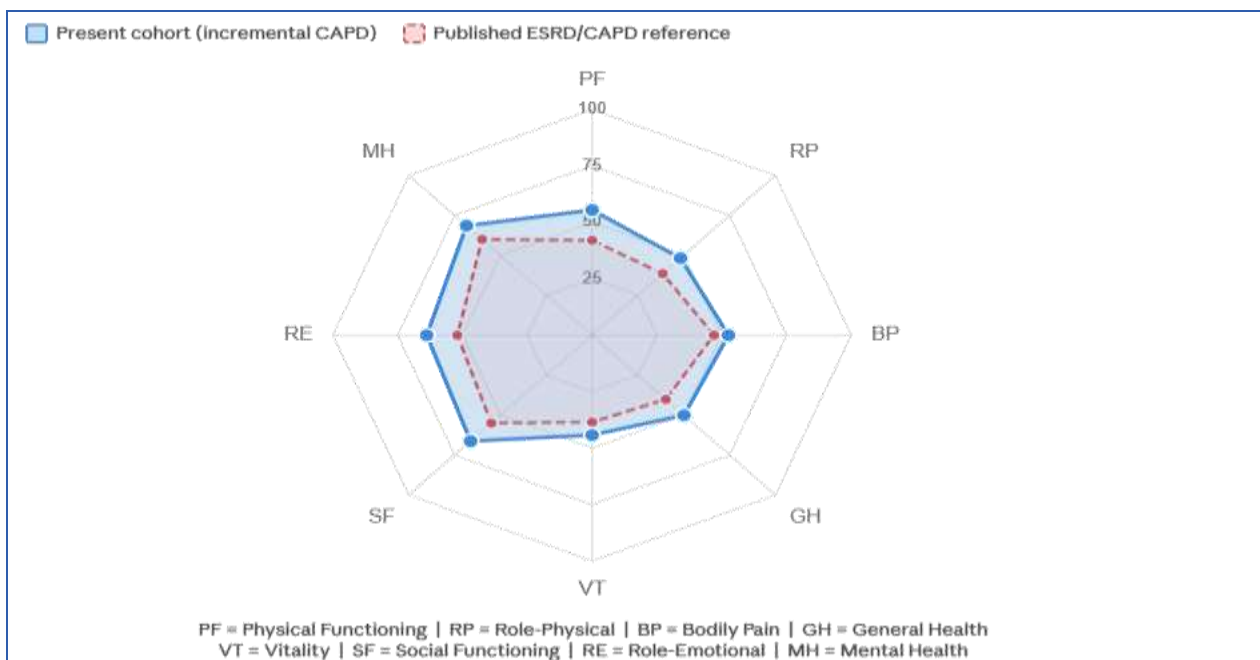


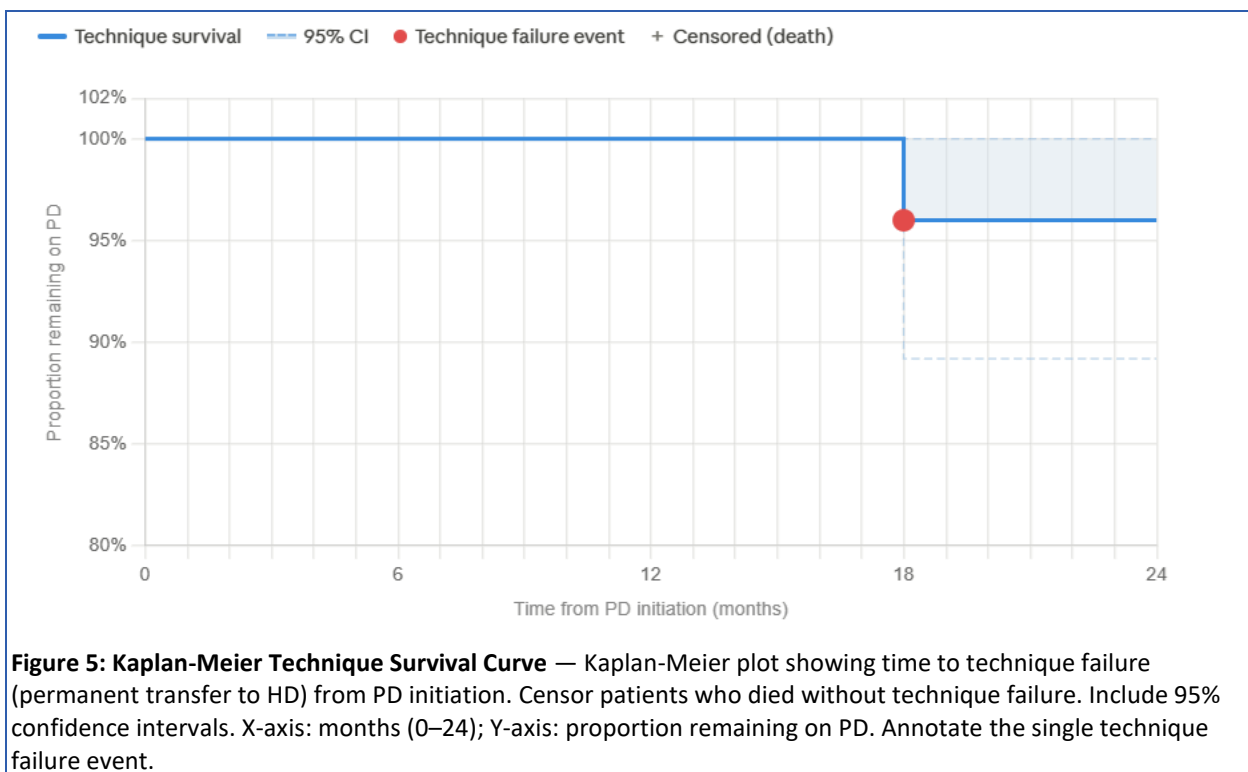
Figure 4: SF-36 Domain Scores — Radar/Spider Chart — Radar (spider) chart with all 8 SF-36 domains plotted on separate axes. Overlay two tracings: (1) mean scores from the present cohort (filled polygon, blue), and (2)

published mean scores from a matched Indian HD cohort or ESRD population (outline polygon, red) for visual comparison. Label each domain on the axis.

Two deaths occurred over the 24-month study period, an all-cause mortality of 8%, neither attributable to CAPD or peritonitis. One patient died following a major vascular surgical procedure for peripheral vascular disease, and the other from refractory heart failure due to underlying cardiomyopathy; both had well-functioning CAPD at the time of death, with no preceding peritonitis or catheter-related complications, so CAPD-related mortality was 0%. One patient (4%) experienced technique failure — permanent transfer to HD — precipitated by recurrent peritonitis. Exit-site infections occurred in two patients (8%), both resolving with topical and systemic antibiotics without progressing to tunnel infection or catheter loss. Table 5 provides a comprehensive summary of outcome data.

Table 5: Clinical Outcomes Over the 24-Month Study Period

Outcome Parameter	n (%)	Cause / Notes
Total mortality	2 (8%)	—
Cardiovascular mortality	1 (4%)	Severe heart failure
Vascular surgery complication	1 (4%)	Post-PVD surgery
CAPD-related mortality	0 (0%)	None
Technique failure (transfer to HD)	1 (4%)	Recurrent peritonitis
Catheter-related loss	0 (0%)	—
Exit-site / tunnel infections	2 (8%)	Managed conservatively
Hospitalisation for any cause	9 (36%)	Peritonitis, CV events



DISCUSSION

This prospective observational study examined how incremental CAPD performs in a cohort of 25 patients with ESRD at a tertiary care centre in South India over 24 months. The principal findings were a mean total weekly Kt/V of 1.7 with preservation of residual renal function that proved central to meeting adequacy targets, and peritonitis rate of 0.4 episodes per patient-year. Quality of life at the end of one year was better preserved in the mental health domains compared with physical health domains. No mortality or technique failure was observed during study period.

Incremental PD allows gradual fluid and solute removal, thereby minimizing rapid shifts and potentially providing greater hemodynamic stability and preservation of RRF compared with standard-dose PD. Adequacy of incremental regimen is based on the amount of native kidney function retained by the patient with renal solute clearance in addition to peritoneal fluid clearance. Yeonhee Lee et al (39) in their observational study of 347 incident incremental PD patients showed that the risk of development of anuria was very low in incremental PD group but there was no difference in patient and technique survival as well as peritonitis rate. Our study also showed the mean weekly Kt/V value of 1.7 with about 0.4-0.6 Kt/V per patient attributable to retained RRF which is consistent with the concept of incremental PD proposed first by Nolph [29] and stated afterwards by Lo et al [7]. According to study conducted by Tam et al. [30], patients with urine output above 400 ml/day exhibited achieved adequacy targets throughout the follow-up period during 12-24 months with results similar to our findings. Furthermore, it is important to notice that PD has been shown to be more effective than HD with respect to RRF preservation [31]. A meta-analysis of RCTs and non-RCTs evaluating incremental PD showed that the decline in residual renal function (RRF) was smaller compared with standard-dose PD, with no significant differences in mortality or technique failure rates (40). Maintenance of RRF has its impact on cardiovascular system including fluid status, hypertension left ventricular hypertrophy and hence on patient survival.

The predominance of high and high-average peritoneal transporters in our cohort (76%) carries implications for the long-term suitability of PD in this population. High transporters absorb glucose from the dialysate rapidly, which over time with conventional dextrose-based solutions and long dwells can accelerate ultrafiltration failure. In the near term, however, this same characteristic confers greater small-solute clearance per dwell, which may actually work in favour of achieving adequacy with only two exchanges under an incremental regimen [32]. The clinical relevance of a high transporter profile becomes more pressing once patients progress to a full four-exchange schedule, at which point automated peritoneal dialysis (APD) with its shorter dwell times may be the better fit. The high proportion of high transporters among our largely diabetic patients is consistent with the recognised link between diabetes and faster peritoneal membrane transport, as described by Davies et al. [33].

Peritonitis remains a major obstacle to the long-term continuation of CAPD. Our observed peritonitis rate of 0.4 episodes per patient-year in patients on incremental PD compares favourably with the published data from similar cohorts. Sandrini et al. reported a lower incidence of peritonitis among patients receiving incremental PD compared with those receiving standard PD; however, the difference was not statistically significant⁽¹⁴⁾. With fewer exchanges and longer dry periods in CAPD, the frequency of catheter handling is reduced, which may consequently lower the risk of peritonitis. Mehrotra et al. [23] reported 0.52 episodes per patient-year in an Indian CAPD cohort — above the ISPD target — illustrating how difficult infection control can be in resource-limited environments. In a systematic review of PD outcomes across developing countries, Karopadi et al. [24] identified peritonitis as the leading cause of technique failure, reporting rates of 0.6–1.8 episodes per patient-year. In comparison, our study observed a lower peritonitis rate of 0.4 episodes per patient-year, with no cases of technique failure, representing a favourable outcome. PDOPPS (Peritoneal Dialysis Outcomes and Practice Patterns Study) data likewise show considerable country-to-country variation in peritonitis rates, with some Asia-Pacific centres reporting figures similar to ours [25]. The organisms recovered in our cohort — chiefly *Staphylococcus aureus* and *Klebsiella pneumoniae* — mirror patterns reported elsewhere in India. Agarwal et al. [26] found Gram-positive organisms, mainly coagulase-negative staphylococci and *S. aureus*, to predominate in North Indian CAPD peritonitis, though Gram-negative organisms featured more prominently among patients with poorer domestic hygiene. The isolation of *Ralstonia mannitolytica* from an environmental setting, a Gram-negative organism that does not ferment and belongs to Burkholderiaceae family, is important to highlight since this organism is not common but can be isolated in patients with CAPD, which may be linked to contaminated water especially in patients with low socio-economic status as mentioned by authors in source number [27]. Also, the absence of peritonitis due to fungi is a reassuring observation since the patients received broad-spectrum antibiotics recently and most patients are not in immunosuppressed state.

On the other hand, the culture negative peritonitis incidence that we found was 8% which is well within the acceptable limit according to published literature. The ISPD guidelines define the acceptable limits of 20% for culture negative peritonitis to trigger laboratory quality assessment [20]; hence, our values are satisfactory and lower than the limit since we used BACTEC blood culture bottle inoculation which is known to increase the microbiological efficiency of the culture techniques compared to classical culture [28]. In addition, Li et al. [28] suggested that inoculating dialysate in blood culture bottles (in prospective trials) enhances the culture positivity level from 40% to above 80%, an encouraging finding even if resources are limited.

Quality of life using SF-36 questionnaire showed Physical functioning (55.4) and vitality (44.2) were impaired to a greater degree than emotional well-being (68.5) and social functioning (66.3), a pattern consistent with established PD cohorts elsewhere. Merkus et al. [34] described a comparable split between physical and mental health domains in a European multicentre PD cohort, attributing better-preserved mental health to the autonomy that home-based dialysis affords. In an Indian context, CAPD's home-based nature may offer an additional advantage, letting patients remain engaged in family and household roles central to their sense of identity and social participation — which could help explain the relatively preserved social and emotional scores despite considerable disease burden. Aggarwal et al. [35] similarly found higher social functioning and emotional role scores among Indian CAPD patients compared with those on IHD, in keeping with our own results.

The vitality score of 44.2 merits particular comment. Fatigue is close to a universal complaint among dialysis patients, arising from a mix of anaemia, uraemia, disturbed sleep, and the metabolic effects of chronic inflammation [36]. Among low-SES patients specifically, nutritional shortfalls and untreated depression may add further to this physical exhaustion. The lower vitality scores in our cohort relative to PD data from higher-income settings likely reflect this combined burden, and interventions targeting anaemia, nutrition, and mental health screening may offer meaningful gains in this domain — an avenue worth prospective study.

Our cohort's all-cause mortality of 8% (n=2) at 24 months, alongside zero CAPD-related mortality, compares favourably with published figures. Mujais and Story [37] reported roughly 80–85% two-year survival in a mixed PD cohort, broadly consistent with our own findings. Critically, neither of our two deaths stemmed from dialysis-related causes — one followed a peri-operative complication after vascular surgery, and the other resulted from end-stage heart failure unconnected to dialysis technique. This matters particularly in a low-SES population, where cardiovascular comorbidity is common and often poorly managed before ESRD is even diagnosed. Our low technique failure rate (4%, one patient transferred for recurrent peritonitis) further supports incremental CAPD's sustainability in this setting; Jain et al. [38] reported comparable two-year technique survival of 80–85% among Indian CAPD patients.

This study has certain limitations that should be addressed. Sample size is quite small and thus affects our ability to detect rare events or make subgroup comparisons; however, there is almost no prospective data on incremental CAPD in Indian populations. We obtained the SF-36 score at 12 months after initiation of Incremental PD, we did not have any baseline (pre-dialysis) quality of life data, which would enable us to evaluate the change over time. Future efforts should include a pre-dialysis baseline QOL and long-term follow-up and a multicentric study to strengthen the evidence for incremental CAPD in this group.

Conclusion

This prospective observational study on incremental CAPD proved to be an effective and acceptable kidney replacement therapy for ESRD patients with good residual renal function. The dialysis adequacy was maintained throughout, due largely to the preservation of residual renal function and associated with low peritonitis rate. Quality of life showed better preservation of mental health and social aspect compared to physical aspect. Larger, multicentric prospective studies with longer follow-up and comparator arms are needed to confirm these findings and identify predictors of optimal outcomes in this population.

References

1. Jager KJ, Kovesdy C, Langham R, Rosenberg M, Jha V, Zoccali C. A single number for advocacy and communication — worldwide more than 850 million individuals have kidney diseases. *Nephrol Dial Transplant*. 2019;34(11):1803-5. doi:10.1093/ndt/gfz174

2. Rajapurkar MM, John GT, Kirpalani AL, Abraham G, Agarwal SK, Almeida AF, et al. What do we know about chronic kidney disease in India: first report of the Indian CKD Registry. *BMC Nephrol.* 2012;13:10. doi:10.1186/1471-2369-13-10
3. Jha V, Garcia-Garcia G, Iseki K, Li Z, Naicker S, Plattner B, et al. Chronic kidney disease: global dimension and perspectives. *Lancet.* 2013;382(9888):260-72. doi:10.1016/S0140-6736(13)60687-X
4. Bargman JM, Thorpe KE, Churchill DN; CANUSA Peritoneal Dialysis Study Group. Relative contribution of residual renal function and peritoneal clearance to adequacy of dialysis: a reanalysis of the CANUSA study. *J Am Soc Nephrol.* 2001;12(10):2158-62. doi:10.1681/ASN.V12102158
5. Rumpsfeld M, McDonald SP, Johnson DW. Higher peritoneal transport status is associated with higher mortality and technique failure in the Australian and New Zealand peritoneal dialysis patient populations. *J Am Soc Nephrol.* 2006;17(1):271-8. doi:10.1681/ASN.2005050566
6. Li PK, Chow KM, Van de Luijngaarden MW, Johnson DW, Jager KJ, Mehrotra R, et al. Changes in the worldwide epidemiology of peritoneal dialysis. *Nat Rev Nephrol.* 2017;13(2):90-103. doi:10.1038/nrneph.2016.181
7. Lo WK, Bargman JM, Burkart J, Krediet RT, Pollock C, Kawanishi H, et al.; ISPD Adequacy of Peritoneal Dialysis Working Group. Guideline on targets for solute and fluid removal in adult patients on chronic peritoneal dialysis. *Perit Dial Int.* 2006;26(5):520-2. doi:10.1177/089686080602600504
8. Brown EA, Blake PG, Boudville N, Davies S, De Arteaga J, Dong J, et al. International Society for Peritoneal Dialysis practice recommendations: prescribing high-quality goal-directed peritoneal dialysis. *Perit Dial Int.* 2020;40(3):244-53. doi:10.1177/0896860819895364
9. Htay H, Cho Y, Pascoe EM, Darssan D, Hawley C, Clayton PA, et al. Outcomes of incremental peritoneal dialysis in incident end-stage kidney disease patients: a registry study. *Perit Dial Int.* 2019;39(6):514-22. doi:10.3747/pdi.2019.00043
10. Abraham G, Varughese S, Thandalam BN, Mathew M. Perspectives on the growing burden of CKD and ESRD in India and its management. *Clin Kidney J.* 2016;9(1):5-7. doi:10.1093/ckj/sfv140
11. Mehrotra R, Devuyt O, Davies SJ, Johnson DW. The current state of peritoneal dialysis. *J Am Soc Nephrol.* 2016;27(11):3238-52. doi:10.1681/ASN.2016010112
12. Bieber SD, Burkart J, Golper TA, Teitelbaum I, Mehrotra R. Comparative outcomes between continuous ambulatory and automated peritoneal dialysis: a narrative review. *Am J Kidney Dis.* 2014;63(6):1027-37. doi:10.1053/j.ajkd.2013.12.021
13. Cho Y, Johnson DW, Craig JC, Strippoli GF, Badve SV, Wiggins KJ. Biocompatible dialysis fluids versus standard fluids for peritoneal dialysis. *Cochrane Database Syst Rev.* 2014;(3):CD007554. doi:10.1002/14651858.CD007554.pub3
14. Sandrini M, Vizzardi V, Valerio F, Vizzardi N, Sandrini S, Cancarini G. Incremental peritoneal dialysis: a 10-year single-centre experience. *J Nephrol.* 2016;29(6):871-9. doi:10.1007/s40620-016-0293-6
15. Fernandez-Reyes MJ, Bajo MA, Del Peso G, Ossorio M, Romero S, Carretero B, et al. Incremental PD: patient characteristics, outcomes, and comparison with full-dose PD. *Int Urol Nephrol.* 2019;51(10):1811-9. doi:10.1007/s11255-019-02212-x
16. Ware JE Jr, Sherbourne CD. The MOS 36-item short-form health survey (SF-36). I. Conceptual framework and item selection. *Med Care.* 1992;30(6):473-83. PMID:1593914
17. Liem YS, Bosch JL, Myriam Hunink MG. Preference-based quality of life of patients on renal replacement therapy: a systematic review and meta-analysis. *Value Health.* 2008;11(4):733-41. doi:10.1111/j.1524-4733.2007.00308.x
18. Wani RT. Socioeconomic status scales-modified Kuppuswamy and Udai Pareekh's scale updated for 2019. *J Family Med Prim Care.* 2019;8(6):1846-9. doi:10.4103/jfmpc.jfmpc_288_19
19. Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. *J Chronic Dis.* 1987;40(5):373-83. doi:10.1016/0021-9681(87)90171-8
20. Li PK, Szeto CC, Piraino B, de Arteaga J, Fan S, Figueiredo AE, et al. ISPD peritonitis recommendations: 2016 update on prevention and treatment. *Perit Dial Int.* 2016;36(5):481-508. doi:10.3747/pdi.2016.00078
21. Twardowski ZJ, Nolph KD, Khanna R, Prowant BF, Ryan LP, Moore HL, et al. Peritoneal equilibration test. *Perit Dial Bull.* 1987;7(3):138-47.
22. Ware JE Jr, Kosinski M, Gandek B. SF-36 Health Survey: Manual and Interpretation Guide. Lincoln, RI: QualityMetric Incorporated; 2000.

23. Mehrotra R, Khawar O, Duong U, Fried L, Norris K, Nissenson A, et al. Ownership patterns of dialysis units and peritonitis rates in patients on peritoneal dialysis: an analysis of data from DaVita. *Am J Kidney Dis*. 2009;54(2):289-98. doi:10.1053/j.ajkd.2009.02.010
24. Karopadi AN, Mason G, Rettore E, Ronco C. Cost of peritoneal dialysis and haemodialysis across the world. *Nephrol Dial Transplant*. 2013;28(10):2553-69. doi:10.1093/ndt/gft214
25. Perl J, Fuller DS, Bieber BA, Boudville N, Kanjanabuch T, Ito Y, et al. Peritoneal dialysis-related infection rates and outcomes: results from the Peritoneal Dialysis Outcomes and Practice Patterns Study (PDOPPS). *Am J Kidney Dis*. 2020;76(1):42-53. doi:10.1053/j.ajkd.2019.09.016
26. Agarwal SK, Dash SC, Gupta S, Bhowmik D. Peritoneal dialysis in India: current status and challenges. *J Nephrol*. 2008;21 Suppl 13:S121-6. PMID:18446750
27. Dotis J, Printza N, Orfanou A, Papachristou F. Peritonitis due to *Ralstonia mannitolilytica* in a pediatric peritoneal dialysis patient. *New Microbiol*. 2012;35(4):503-6. PMID:23109019
28. Li PK, Szeto CC, Piraino B, Bernardini J, Figueiredo AE, Gupta A, et al. Peritoneal dialysis-related infections recommendations: 2010 update. *Perit Dial Int*. 2010;30(4):393-423. doi:10.3747/pdi.2010.00049
29. Nolph KD. What's new in peritoneal dialysis — an overview. *Kidney Int Suppl*. 1992;38:S148-52. PMID:1405367
30. Tam P, Lok CE, Bhola C, Dong J. Incremental peritoneal dialysis: can we start more patients on peritoneal dialysis? *Adv Perit Dial*. 2010;26:84-7. PMID:21348423
31. Residual Renal Function and Wellbeing in Patients on Peritoneal Dialysis. Vilar E, Farrington K. *Semin Dial*. 2007;20(6):525-30. doi:10.1111/j.1525-139X.2007.00333.x
32. Davies SJ, Mushahar L, Yu Z, Lambie M. Determinants of peritoneal membrane function over time. *Semin Nephrol*. 2011;31(2):172-82. doi:10.1016/j.semnephrol.2011.01.008
33. Davies SJ, Phillips L, Griffiths AM, Russell LH, Naish PF, Russell GI. What really happens to people on long-term peritoneal dialysis? *Kidney Int*. 1998;54(6):2207-17. doi:10.1046/j.1523-1755.1998.00181.x
34. Merkus MP, Jager KJ, Dekker FW, De Haan RJ, Boeschoten EW, Krediet RT. Physical symptoms and quality of life in patients on chronic dialysis: results of The Netherlands Cooperative Study on the Adequacy of Dialysis (NECOSAD). *Nephrol Dial Transplant*. 1999;14(5):1163-70. doi:10.1093/ndt/14.5.1163
35. Aggarwal HK, Jain D, Mor P, Yadav RK. Health-related quality of life in patients on different modalities of renal replacement therapy: a prospective observational study from a developing country. *Int J Nephrol Renovasc Dis*. 2016;9:191-202. doi:10.2147/IJNRD.S109690
36. Kosmadakis G, Carceles O, Gueutin V, Teillet L, Bucur C, Bataille S, et al. The role of exercise in patients on dialysis. *Saudi J Kidney Dis Transpl*. 2011;22(4):862-3. doi:10.4103/1319-2442.82601
37. Mujais S, Story K. Peritoneal dialysis in the US: evaluation of outcomes in contemporary cohorts. *Kidney Int Suppl*. 2006;(103):S21-6. doi:10.1038/sj.ki.5001930
38. Jain AK, Blake P, Cordy P, Garg AX. Global trends in rates of peritoneal dialysis. *J Am Soc Nephrol*. 2012;23(3):533-44. doi:10.1681/ASN.2011060607
39. Lee Y, Chung SW, Park S, Ryu H, Lee H, Kim DK, Joo KW, Ahn C, Lee J, Oh KH. Incremental Peritoneal Dialysis May be Beneficial for Preserving Residual Renal Function Compared to Full-dose Peritoneal Dialysis. *Sci Rep*. 2019 Jul 12;9(1):10105. doi: 10.1038/s41598-019-46654-2. PMID: 31300708; PMCID: PMC6626037.
- 40 Xu S, Wu W, Cheng J. Comparison of outcomes of incremental vs. standard peritoneal dialysis: a systematic review and meta-analysis. *BMC Nephrol*. 2024 Sep 16;25(1):308. doi: 10.1186/s12882-024-03669-w. PMID: 39285336; PMCID: PMC11406953.