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A Comparative Study on Hemodialysis Versus Peritoneal Dialysis Regarding the Efficacy and Safety in the Management of ESRD

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ABSTRACT

*End-stage renal disease (ESRD) requires renal replacement therapy when native kidney function is no longer sufficient to maintain fluid and metabolic homeostasis. Hemodialysis (HD) and peritoneal dialysis (PD) differ in the mechanism and tempo of solute and fluid removal and may therefore have different efficacy and safety profiles. This hospital-based prospective observational study was conducted in the nephrology inpatient setting of King George Hospital, Visakhapatnam, over six months from July to December 2024. Adults with ESRD receiving maintenance HD or PD who were willing to participate were eligible; patients with a transplanted kidney or those unwilling to participate were excluded. Demographic characteristics, vital signs, blood urea, blood urea nitrogen (BUN), serum creatinine and dialysis-related complications were assessed before and after treatment. Continuous variables were summarized as mean $\pm$ standard deviation and compared using *t*-tests; categorical variables were compared using chi-square or Fisher's exact tests, with $p < 0.05$ considered statistically significant. The reported mean age was 60.5 ± 10.2 years in HD and 58.1 ± 9.8 years in PD ($p = 0.045$). Pre-dialysis blood pressure and weight were slightly higher in the HD group, without statistically significant differences. Post-dialysis values remained broadly stable in both groups. HD showed lower post-treatment urea, BUN and serum creatinine than PD, with the reported between-group *p*-values for these parameters being 0.07, 0.06 and 0.02, respectively. Peritonitis occurred more frequently with PD than HD (18% versus 5%; $p = 0.002$), whereas sepsis and catheter infection did not differ significantly. Overall, the study findings suggest that HD provided more rapid biochemical clearance, while PD was associated with greater hemodynamic stability but a higher reported risk of peritonitis. Modality selection should therefore be individualized according to clinical status, infection risk, residual renal function, access to care and patient preference.*

Keywords: End-Stage Renal Disease, Hemodialysis, Peritoneal Dialysis, Dialysis Efficacy, Serum Creatinine, Peritonitis.

1. INTRODUCTION

End-stage renal disease (ESRD) represents the terminal stage of progressive chronic kidney dysfunction and is characterized by severe loss of renal function with accumulation of metabolic waste and disturbances of fluid, electrolyte and acid–base balance. Dialysis is a major renal replacement therapy for patients who require treatment and in whom transplantation is not feasible. The source thesis describes two principal modalities—hemodialysis (HD), in which blood is circulated through an extracorporeal dialyzer, and peritoneal dialysis (PD), in which the peritoneal membrane serves as the dialysis interface.

The two modalities have different treatment characteristics. HD can provide relatively rapid removal of uremic solutes and excess fluid during an intermittent treatment, whereas PD provides a more continuous process through repeated exchanges or automated cycling. These differences may influence biochemical clearance, blood pressure and volume stability, residual renal function, infection risk and patient convenience.

Previous studies summarized in the thesis have reported mixed findings. Some have suggested better hemodynamic stability and preservation of residual renal function with PD, whereas other observational studies have reported comparable or better survival with HD in selected populations. The literature also emphasizes that comorbidity, age, diabetes, patient preference, access to dialysis services and local practice patterns can influence modality outcomes.

The present study was therefore undertaken to compare the efficacy and safety of HD and PD in patients with ESRD, with particular attention to pre- and post-dialysis biochemical parameters, vital signs and dialysis-related infections.

2. MATERIALS AND METHODS

2.1 Study design and setting

The study was described in the thesis as a hospital-based, prospective observational study conducted in the inpatient Department of Nephrology at King George Hospital (KGH), a tertiary-care government hospital in Visakhapatnam. The study period was six months, from July to December 2024.

2.2 Study population and eligibility

The study population comprised male and female patients diagnosed with ESRD and undergoing either HD or PD. Inclusion criteria were willingness to participate, maintenance dialysis with either HD or PD, and admission during the study period while undergoing one of the two modalities. Patients with a transplanted kidney and patients unwilling to participate were excluded.

2.3 Data collection and outcomes

Demographic information and clinical observations were collected. Renal function indicators included serum creatinine and BUN, while the study protocol also specified urea and nutritional indicators such as hemoglobin and serum albumin. Measurements were recorded before and after dialysis. Dialysis-related complications, including hypoalbuminemia, cardiovascular or cerebrovascular events and peritoneal infection, were also considered. Kt/V was specified in the protocol as a measure of dialysis adequacy; however, numerical Kt/V results were not reported in the results tables available in the thesis.

2.4 Statistical analysis

Data were planned to be entered into an Excel sheet and analyzed using applicable statistical methods in SPSS. Continuous variables were expressed as mean $\pm$ standard deviation and compared using t-tests. Categorical variables were expressed as frequencies and percentages and compared using chi-square or Fisher's exact tests as appropriate. A two-sided p-value <0.05 was considered statistically significant. Patient records were to be de-identified and analyzed anonymously.

2.5 Ethics

The protocol states that Institutional Human Ethics Committee approval from King George Hospital was to be obtained before initiation of the study. The supplied thesis text does not provide an approval number or date; these details should be inserted before journal submission if available.

3. RESULTS

The reported demographic data showed a mean age of 60.5 ± 10.2 years in the HD group and 58.1 ± 9.8 years in the PD group, with a reported p-value of 0.045. Men constituted 65% of the HD group and 55% of the PD group; the reported gender comparison was not statistically significant. Mean weight was 70.3 ± 12.5 kg in HD and 68.5 ± 11.8 kg in PD ($p=0.08$).

Table -1: Demographic characteristics of the study population

Variable	Hemodialysis	Peritoneal dialysis	P-value
Age, years	60.5 ± 10.2	58.1 ± 9.8	0.045
Male, %	65	55	0.12
Female, %	35	45	0.12
Weight, kg	70.3 ± 12.5	68.5 ± 11.8	0.08

Before dialysis, mean blood pressure was $140/95 \pm 15/10$ mmHg in HD and $138/88 \pm 12/8$ mmHg in PD, with no statistically significant difference ($p=0.07$). Mean temperature was $37.3 \pm 0.6^\circ\text{C}$ versus $37.2 \pm 0.5^\circ\text{C}$ ($p=0.12$), and mean weight was 71.0 ± 13.0 kg versus 69.0 ± 12.0 kg ($p=0.09$), respectively.

Table -2: Pre- and post-dialysis vital signs

Parameter	Hemodialysis	Peritoneal dialysis	P-value
Pre-dialysis BP, mmHg	$140/95 \pm 15/10$	$138/88 \pm 12/8$	0.07
Temperature, $^\circ\text{C}$	37.3 ± 0.6	37.2 ± 0.5	0.12
Weight, kg	71.0 ± 13.0	69.0 ± 12.0	0.09
Post-dialysis BP, mmHg	$140/90 \pm 15/10$	$135/85 \pm 12/8$	0.09
Post-dialysis temperature, $^\circ\text{C}$	37.2 ± 0.5	37.1 ± 0.4	0.15
Post-dialysis weight, kg	70.3 ± 12.5	68.5 ± 11.8	0.08

Biochemical results demonstrated reductions in urea, BUN and serum creatinine in both groups. In HD, urea decreased from 120 ± 25 to 45 ± 15 , BUN from 60 ± 18 to 20 ± 10 , and serum creatinine from 8.5 ± 2.1 to 3.1 ± 1.2 mg/dL. In PD, corresponding values were 110 ± 20 to 50 ± 18 , 55 ± 16 to 25 ± 12 , and 7.8 ± 1.9 to 4.2 ± 1.3 mg/dL. The reported p-values for the between-group comparisons were 0.03 for pre-urea, 0.07 for post-urea, 0.05 for pre-BUN, 0.06 for post-BUN, 0.04 for pre-creatinine and 0.02 for post-creatinine.

Table -3: Pre- and post-dialysis biochemical parameters

Parameter	Hemodialysis	Peritoneal dialysis	P-value
Pre-urea	120 ± 25	110 ± 20	0.03
Post-urea	45 ± 15	50 ± 18	0.07
Pre-BUN	60 ± 18	55 ± 16	0.05
Post-BUN	20 ± 10	25 ± 12	0.06
Pre-creatinine, mg/dL	8.5 ± 2.1	7.8 ± 1.9	0.04
Post-creatinine, mg/dL	3.1 ± 1.2	4.2 ± 1.3	0.02

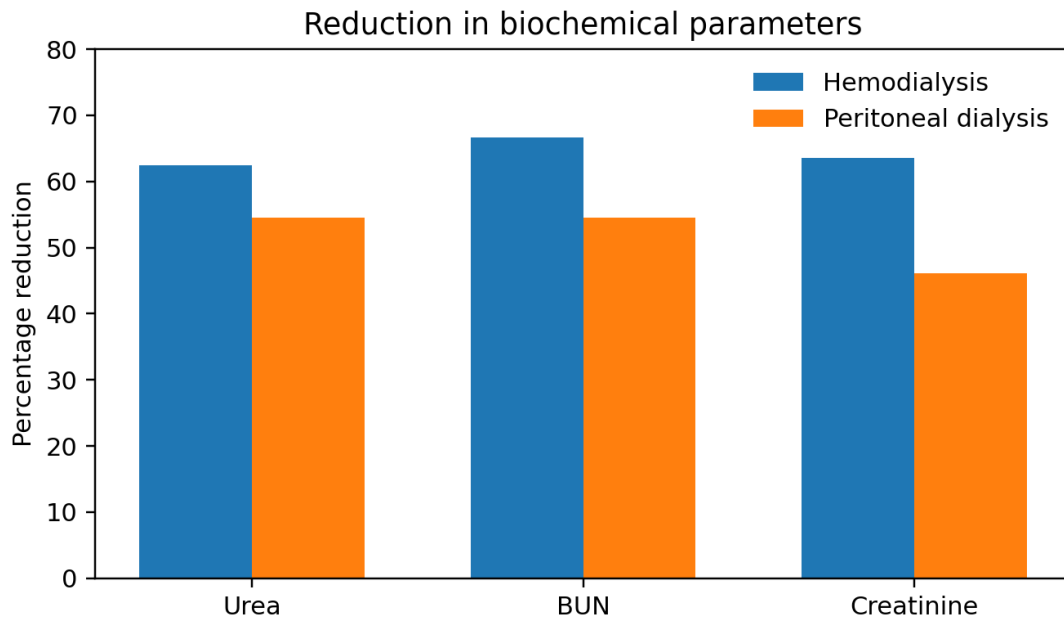


Figure -1: Calculated percentage reduction in reported biochemical parameters from pre- to post-dialysis values.

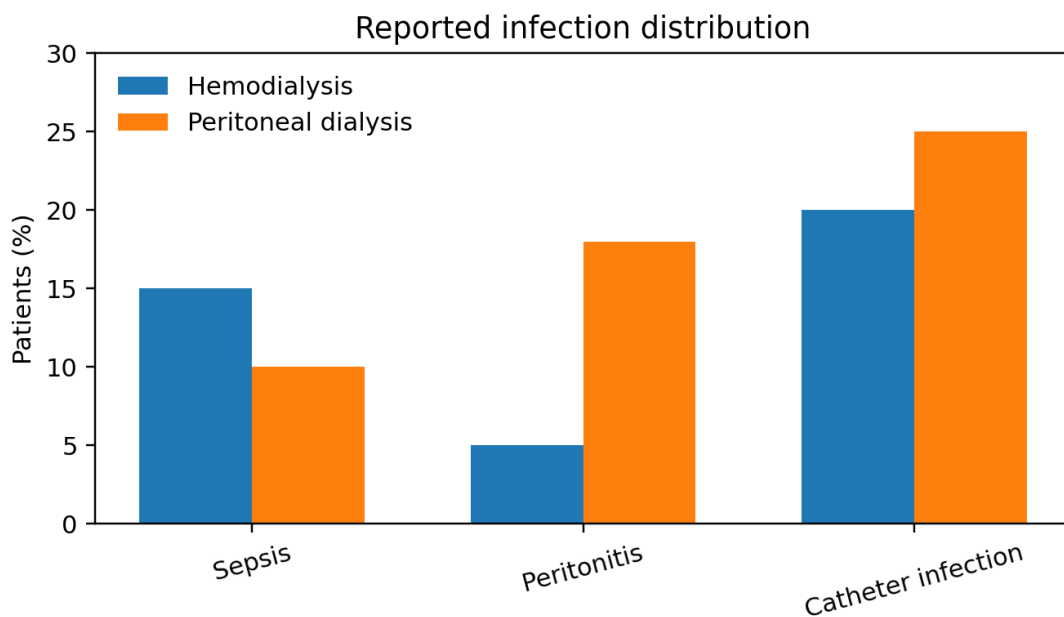


Figure -2: Reported distribution of sepsis, peritonitis and catheter infection.

Infection patterns differed by modality. Sepsis was reported in 15% of HD patients and 10% of PD patients ($p=0.08$). Peritonitis occurred in 5% of HD patients and 18% of PD patients, a statistically significant difference ($p=0.002$). Catheter infection was reported in 20% of HD and 25% of PD patients ($p=0.12$).

Table -4: Reported dialysis-associated infections

Infection	Hemodialysis (%)	Peritoneal dialysis (%)	P-value
Sepsis	15	10	0.08
Peritonitis	5	18	0.002
Catheter infection	20	25	0.12

4. DISCUSSION

The present observational study demonstrates that both HD and PD were associated with improvement in measured biochemical parameters after treatment. The most prominent between-modality difference reported in the thesis was serum creatinine: post-dialysis creatinine was 3.1 ± 1.2 mg/dL with HD compared with 4.2 ± 1.3 mg/dL with PD, with a reported p-value of 0.02. The thesis interprets this finding as evidence of more efficient or rapid toxin clearance with HD. The corresponding reductions in urea and BUN were also numerically greater with HD, although the reported post-treatment comparisons were not statistically significant.

The vital-sign findings suggest broadly similar short-term stability. Pre-dialysis blood pressure, temperature and weight did not differ significantly between groups. Post-dialysis blood pressure and temperature were also similar by the reported t-tests. The thesis nevertheless describes somewhat greater blood-pressure fluctuation with HD, consistent with the more rapid fluid shifts of intermittent extracorporeal treatment, whereas PD was described as producing gentler, more continuous fluid and solute removal.

The safety profile showed a modality-specific infection pattern. Peritonitis was substantially more frequent among PD patients and was the only infection outcome with a statistically significant between-group difference. This is clinically relevant because PD depends on an indwelling abdominal catheter and repeated exchanges, making aseptic technique and patient training important components of safe treatment. Conversely, the thesis reports a higher numerical frequency of sepsis among HD patients, although this difference was not statistically significant. Catheter infections were also numerically more frequent with PD but without a significant difference.

These findings are broadly consistent with the mixed evidence summarized in the thesis. Prior work cited in the thesis has described PD as having advantages in hemodynamic stability and preservation of residual renal function, while other studies have reported similar or better survival with HD in selected populations. The literature therefore does not support a universal superiority of one modality. Instead, modality choice should account for clinical stability, comorbidity, residual kidney function, infection risk, vascular or peritoneal access, availability of dialysis facilities and patient preference.

An important consideration when interpreting the present findings is that the study was observational and conducted at a single centre. The groups were not randomized, and the thesis acknowledges that comorbidities, nutritional status and socioeconomic factors were not adjusted for. In addition, the study primarily examined short-term pre- and post-dialysis outcomes and did not provide long-term survival or quality-of-life comparisons. The reported Kt/V was included in the protocol as an efficacy measure, but numerical Kt/V data were not presented in the available results, limiting assessment of formal dialysis adequacy.

5. CONCLUSION

Both HD and PD produced reductions in urea, BUN and serum creatinine in patients with ESRD. Within the reported results, HD was associated with lower post-dialysis serum creatinine and was interpreted as providing more rapid biochemical clearance. PD was associated with generally stable short-term vital signs and a more continuous dialysis approach, but peritonitis was significantly more frequent in the PD group. Thus, neither modality can be considered universally superior on the basis of these data. Individualized selection, accompanied by appropriate infection prevention, vascular/peritoneal access care and patient education, remains essential.

6. LIMITATIONS

The thesis identifies several limitations: relatively small sample size, single-centre data, short-term follow-up, lack of adjustment for important confounders such as diabetes and hypertension, nutritional status and socioeconomic factors, and potential under-reporting or misclassification of infections, particularly among patients receiving PD at home. Longitudinal multicentre studies with larger cohorts, standardized dialysis-adequacy measures, patient-reported quality-of-life outcomes, comorbidity adjustment and economic evaluation would provide stronger evidence for comparative modality selection.

7. ACKNOWLEDGEMENT

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8. CONFLICT OF INTEREST

The thesis reports no financial conflict of interest and states that the project was self-funded and was not submitted to any funding agency.

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