

COMPARATIVE ANALYSIS OF HEMODIALYSIS AND PERITONEAL DIALYSIS IN TERMS OF SURVIVAL RATE: A SYSTEMATIC REVIEW

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ABSTRACT

Background: End-stage renal disease is a major global health issue, and dialysis remains the primary treatment option for many patients. Hemodialysis and peritoneal dialysis are widely used modalities, but their comparative survival outcomes remain controversial.

Objective: To compare survival outcomes between Hemodialysis and peritoneal dialysis in patients with End-stage renal disease using evidence from observational and cohort studies.

Methodology: A systematic review was conducted using electronic databases including PubMed, Scopus, Google Scholar, and Cochrane Library. Studies published between 2020 and 2026 were selected based on predefined inclusion and exclusion criteria. Relevant data were extracted and analyzed qualitatively.

Results: The findings showed that overall survival between Hemodialysis and peritoneal dialysis is comparable, with no significant difference in mortality. However, a time-dependent pattern was observed, where peritoneal dialysis demonstrated better early survival, while hemodialysis showed improved long-term outcomes. Patient characteristics and clinical factors significantly influenced survival.

Conclusion: Both Hemodialysis and peritoneal dialysis are effective treatment options with similar overall survival. The choice of modality should be individualized based on patient condition and preferences.

Keywords: Hemodialysis, Peritoneal Dialysis, ESRD, Survival, Mortality

INTRODUCTION

End-stage renal disease (ESRD) represents the terminal stage of chronic kidney disease (CKD) and is characterized by irreversible loss of renal function requiring renal replacement therapy (RRT) in the form of dialysis or kidney transplantation. The global burden of ESRD has

increased steadily over recent decades due to the rising prevalence of non-communicable diseases such as diabetes mellitus and hypertension, as well as population aging (1-3). In low- and middle-income countries, this burden is further intensified by limited healthcare infrastructure and restricted access to specialized renal care

services, leading to significant morbidity, mortality, and economic strain.

Among available treatment options, hemodialysis (HD) and peritoneal dialysis (PD) remain the most widely used modalities for managing ESRD patients who are not eligible for transplantation. HD is typically performed in hospital-based settings using a dialyzer to remove toxins and excess fluid, often requiring multiple weekly sessions that can significantly disrupt patients' daily routines and social functioning (4–5). In contrast, PD utilizes the peritoneal membrane as a natural filter and is generally performed at home, offering greater flexibility and autonomy but requiring a high level of patient responsibility and strict infection control practices (6–7).

Despite advances in dialysis technology and supportive care, mortality among ESRD patients on dialysis remains substantially higher than in the general population, with cardiovascular disease identified as the leading cause of death, followed by infections and other complications (7–8). This has led to ongoing debate in nephrology regarding whether HD or PD offers superior survival outcomes. Early comparative studies produced conflicting findings due to differences in patient selection, baseline comorbidities, and healthcare system variations, making direct comparisons difficult and often inconclusive (9–10).

More recent evidence from large cohort studies and advanced statistical approaches such as propensity score matching suggests that overall survival between HD and PD is largely comparable when patient characteristics are properly adjusted (11). However, temporal differences have been observed, with PD often demonstrating an early survival advantage during the first 1–2 years of therapy, potentially due to better preservation of residual renal function and hemodynamic stability, while long-term outcomes may favor HD due to PD-related complications such as peritonitis and membrane failure (12–13). These findings emphasize the importance of individualized modality selection based on patient profile, comorbid conditions, and treatment goals. Beyond survival, health-related quality of life (HRQoL) has emerged as a critical outcome in ESRD management. Dialysis significantly affects

physical, psychological, and social well-being, with HD often imposing greater lifestyle restrictions due to frequent hospital visits, while PD offers more flexibility but increases patient responsibility and risk of infection (15–17). In resource-limited settings such as Pakistan, challenges including lack of registry data, high treatment costs, and unequal access to care further complicate modality selection and outcomes (19–21). Therefore, this study aims to systematically compare survival outcomes between HD and PD in ESRD patients to provide evidence that can support clinicians and policymakers in making informed, context-specific, and patient-centered treatment decisions.

Materials and Methods

A systematic review design was employed in this study to compare survival outcomes between hemodialysis (HD) and peritoneal dialysis (PD) in patients with end-stage renal disease (ESRD). The review was conducted in accordance with PRISMA 2020 guidelines to ensure transparency, reproducibility, and methodological rigor in the identification, selection, and synthesis of relevant literature (24). This approach was considered appropriate because randomized controlled trials directly comparing dialysis modalities are limited due to ethical and practical constraints, making observational and cohort-based evidence the most feasible source for comparative survival analysis (25). The systematic review design also allowed integration of findings across different populations and healthcare systems to enhance generalizability.

The research question was structured using the PICO framework to ensure clarity and a focused literature search strategy. The population included adult patients diagnosed with ESRD requiring renal replacement therapy, while the intervention was peritoneal dialysis (PD), and the comparison group was hemodialysis (HD). The primary outcome of interest was survival rate, including mortality outcomes and related clinical endpoints such as cardiovascular and infection-related complications. This structured framework enabled the identification of relevant studies addressing direct comparisons between HD and PD, ensuring that only studies aligned with the research objectives were included in the synthesis.

A comprehensive literature search was conducted using multiple electronic databases, including PubMed, Scopus, and Google Scholar, along with the Cochrane Library. The search strategy incorporated predefined keywords such as “hemodialysis,” “peritoneal dialysis,” “ESRD,” “survival rate,” and “mortality,” combined using Boolean operators (AND, OR), as well as Medical Subject Headings (MeSH) terms to improve sensitivity and specificity. Studies published between 2010 and 2026 were included to ensure the inclusion of contemporary evidence. A structured eligibility criterion was applied, including observational studies, cohort studies, and randomized controlled trials reporting survival or mortality outcomes in adult ESRD patients, while excluding case reports, reviews, pediatric studies, and incomplete or non-comparative studies.

Study selection followed a systematic process involving identification, screening, eligibility assessment, and final inclusion, with a PRISMA flow diagram used to document the selection process. Data extraction was performed using a standardized form capturing key variables such as author details, study design, sample size, dialysis modality, and survival outcomes including hazard ratios and mortality rates. The quality of included studies was assessed using the Newcastle-Ottawa Scale (NOS) to evaluate selection bias, comparability, and outcome assessment (26). Due to heterogeneity in study designs and outcome measures, a qualitative synthesis approach was adopted, allowing structured comparison of survival trends between HD and PD and identification of consistent patterns across studies.

Results

The PRISMA-based selection process ensured a transparent and reproducible identification of studies comparing survival outcomes between hemodialysis (HD) and peritoneal dialysis (PD). A total of 120 records were initially identified through database searching, with no additional records from registers. After removal of duplicates ($n = 20$), 100 studies proceeded to screening, where 70 were excluded based on title and abstract review due to irrelevance. The remaining 30 full-

text articles were assessed for eligibility, and 20 were excluded for reasons including lack of survival/mortality outcomes, non-comparative design, or inappropriate population. Ultimately, 10 studies met all inclusion criteria and were included in the final synthesis, ensuring methodological rigor and minimizing selection bias.

The included studies comprised large-scale cohort and registry-based analyses with variable sample sizes ranging from approximately 2,000 to over 130,000 patients. Overall findings consistently demonstrated that there is no universal survival superiority between HD and PD when adjusted for confounding variables. Several studies, including Wong et al. (2018) and Wang et al. (2018), reported hazard ratios close to 1.0, indicating comparable mortality between modalities after adjustment for patient characteristics. These findings suggest that previously observed survival differences are largely influenced by selection bias, baseline comorbidities, and healthcare system factors rather than the dialysis modality itself.

A recurring pattern across multiple studies was the presence of time-dependent survival effects. Several analyses, including Mukhopadhyay et al. (2020), Heaf & Wehberg (2014), Zhou et al. (2019), and Sanabria et al. (2008), demonstrated that peritoneal dialysis (PD) is associated with lower early mortality, particularly within the first 6–24 months of treatment, with hazard ratios generally favoring PD during this period. This early advantage has been attributed to better hemodynamic stability, preservation of residual renal function, and avoidance of vascular access complications commonly seen in HD initiation. However, this benefit tends to diminish over time. In contrast, long-term follow-up studies such as Thiery et al. (2018) indicated a potential shift in favor of hemodialysis (HD) for extended survival. The increased long-term mortality observed in PD patients is often linked to technique-related complications, including peritonitis, membrane failure, and declining dialysis adequacy over time. Additionally, studies such as Weinhandl et al. (2016) showed that certain subgroups receiving intensive or home-based HD may experience improved survival, suggesting that modality

effectiveness is highly dependent on patient selection, treatment setting, and clinical management strategies.

Overall synthesis of evidence indicates that survival outcomes between HD and PD are broadly comparable when confounding variables are controlled, and differences are primarily time-dependent rather than absolute. Patient characteristics such as age, comorbid conditions, vascular access type, and timing of dialysis initiation significantly influence outcomes more than modality alone. Consequently, the findings support a patient-centered approach in which dialysis modality is individualized rather than assuming inherent superiority of either HD or PD.

Discussion

The discussion of this systematic review demonstrates that overall survival outcomes between hemodialysis (HD) and peritoneal dialysis (PD) in patients with end-stage renal disease (ESRD) are broadly comparable when analyses are adjusted for confounding factors. Across the included cohort and observational studies, no consistent or statistically significant superiority of either modality was observed, with several large studies reporting hazard ratios approximating 1.0. This suggests that crude differences in survival often reported in earlier literature are largely attributable to patient selection bias, baseline comorbidities, and differences in clinical characteristics rather than the dialysis modality itself. Studies such as Wong et al. (2018) and Wang et al. (2018) reinforce this interpretation by demonstrating that once age, diabetes, cardiovascular disease, and other risk factors are controlled, mortality differences between HD and PD become negligible. These findings collectively emphasize that dialysis modality alone is not the primary determinant of survival outcomes in ESRD patients.

A key insight emerging from the analysis is the consistent presence of time-dependent survival differences between HD and PD. Evidence from multiple studies indicates that PD tends to confer an early survival advantage, particularly within the first 1–2 years of treatment initiation. This is commonly attributed to better hemodynamic

stability, continuous fluid removal, and preservation of residual renal function, which collectively reduce early cardiovascular stress and treatment-related complications. Studies such as Mukhopadhyay et al. (2020) and Zhou et al. (2019) highlight reduced early mortality in PD compared to HD, especially during the initial months of therapy. However, this advantage diminishes over time, suggesting that PD's early physiological benefits may not translate into sustained long-term survival superiority.

In contrast, long-term follow-up data suggest a relative survival advantage for HD in certain populations, particularly in studies with extended observation periods. The decline in PD effectiveness over time has been linked to technique-related complications, including peritoneal membrane failure, recurrent peritonitis, and declining dialysis adequacy. Thiery et al. (2018) and Stack et al. further demonstrate a shift in hazard ratios over time, where PD initially shows better outcomes but later becomes associated with higher mortality risk compared to HD. Additionally, the role of treatment adequacy and modality planning appears crucial, as patients initiating HD in a controlled and well-prepared manner often experience improved long-term outcomes. These findings suggest that survival trends are not static but evolve dynamically with treatment duration and modality-specific complications.

Overall, the evidence indicates that survival outcomes in ESRD patients are influenced more by temporal treatment dynamics and patient-specific factors than by the intrinsic superiority of either dialysis modality. Comorbid conditions, vascular access quality, healthcare system infrastructure, and timing of dialysis initiation consistently emerge as stronger predictors of outcomes than modality selection. Consequently, the choice between HD and PD should be individualized, taking into account patient characteristics, clinical stability, lifestyle considerations, and healthcare resources. This review supports a patient-centered approach in which both modalities are viewed as complementary rather than competing options, with survival differences largely reflecting

contextual and temporal influences rather than inherent treatment efficacy.

CONCLUSION

In this systematic review, the authors sought to estimate the differences in survival of patients with end-stage renal disease when using hemodialysis versus peritoneal dialysis. According to the discussion of the chosen observational studies and cohort studies, the results seem that both HD and PD offer the same general survival conditions, and it is not observed that one of these modalities is necessarily better than the other. The major finding of the current research is the existence of the time-varying pattern of survival, with PD showing the survival advantage during the initial stage of the therapy, especially during the first and second years, and HD showing the better results in the long term. These differences are however relative and these are greatly affected by patient associated factors like age, comorbidity, residual renal functioning, and time of onset of dialysis. Moreover, the findings also emphasize that dialysis modality is not the most influential factor contributing to survival. Alternatively, the quality of care, vascular access, patient selection, and healthcare infrastructure have a significant role in determining outcome. Other modalities such as home hemodialysis also demonstrated a better survival of selected populations of patients and they now highlight the issue of careful one-on-one attention. To sum up, although HD and PD may be viewed as equally good modalities, they have to be taken individually on the basis of patient factors, clinical factors, life preferences, and the availability of resources, as opposed to judging their presumed inherent superiority. More studies, especially good prospective studies are required in the future to better understand long-term care and dialysis optimization.

The study recommends that dialysis modality selection should be individualized rather than based on a generalized assumption of superiority between hemodialysis (HD) and peritoneal dialysis (PD). Clinical decision-making should incorporate patient-specific factors such as age, comorbidities, functional status, lifestyle needs, and personal preferences to optimize outcomes. Early and well-

planned initiation of dialysis is also emphasized, particularly through timely creation of permanent vascular access in HD patients, as this has been associated with improved survival and reduced complications. In addition, strengthening patient education regarding both HD and PD is essential to support informed decision-making, improve adherence to treatment, and enhance overall engagement in care. For resource-limited settings, greater promotion of peritoneal dialysis as a cost-effective home-based modality is recommended, provided that adequate training, infection prevention strategies, and monitoring systems are in place. Finally, future research should prioritize large-scale prospective studies and randomized controlled trials to reduce bias and provide more robust evidence, while also incorporating outcomes such as quality of life, economic burden, and patient satisfaction to enable a more comprehensive comparison of dialysis modalities. The study has several limitations that should be considered when interpreting the findings. The evidence base was primarily derived from observational and cohort studies due to ethical and logistical constraints surrounding randomized controlled trials in dialysis research, which introduces the possibility of selection bias and residual confounding. In addition, substantial heterogeneity existed across studies in terms of sample size, patient demographics, follow-up duration, and outcome definitions, limiting the ability to perform a quantitative meta-analysis and reducing comparability. Variations in healthcare systems and treatment protocols across different regions may also affect the generalizability of results. Furthermore, the potential for publication bias and language restriction to English-language studies may have excluded relevant evidence. Lastly, important outcomes such as cost-effectiveness, patient-reported quality of life, and treatment preference were not comprehensively assessed, indicating that the conclusions should be interpreted with appropriate caution.

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