Kidney Medicine

# The Cost-effectiveness of Peritoneal Dialysis Is Superior to Hemodialysis: Updated Evidence From a More Precise Model

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Chronic kidney disease (CKD) is a major health care burden with an estimated global prevalence of 9.1% in 2017 (697.5 million cases), with China and India contributing to nearly a third of the total cases. The age-standardized rate of CKD has been increasing 1.2% per year since 1990.[1] Approximately 1.2 million deaths are attributed to CKD, and it is the 12th leading cause of death globally. Although the global prevalence of dialysis was 0.04% in 2017, the incidence has grown by 43% since 1990.[1] Despite improved access to kidney replacement therapy in the most recent decades, the global age-standardized kidney disease mortality rate has not substantially changed. This contrasts with mortality associated with cardiovascular diseases and malignancies, for which age-standardized mortality rates have improved during the same time frame.[1] Barriers to accessing safe and reliable kidney replacement therapy worldwide may explain part of this overall disparity. In the United States, Medicare has provided coverage to dialysis patients who are Medicare eligible since 1973. Before this, dialysis was accessible to only a fraction of patients with kidney failure due to cost and limited resources.[2] Consistent with this availability, the dialysis population in the United States has increased to nearly 550,000, albeit at high cost, with Medicare fee-for-service spending more than $31 billion for the care of dialysis patients in 2018.[3]

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Dialysis is a complex and costly procedure. In 1983, Medicare introduced the initial dialysis payment bundle, a capitated dialysis payment rate, to control increasing costs. This payment bundle was further expanded to include dialysis drugs, laboratory tests, and other end-stage kidney disease–related services in 2011, with the quality incentive program also added at this time, further motivating cost containment, albeit with greater attention to meeting specific quality indicators.[4] In the United States, where peritoneal dialysis (PD) traditionally has cost dialysis providers less than in-center hemodialysis (HD), home modality use increased following the introduction of the expanded payment bundle.

PD is the dominant home-based modality, and several studies from different countries with different payment systems have consistently demonstrated the potential cost savings associated with PD as compared with in-center HD.[5-8] Lower staffing needs and overhead costs largely contribute to the cost difference between in-center HD and PD. Lower medication and hospitalization costs in PD patients may contribute to cost reductions as well, but it is unclear whether this is due to factors specifically associated with PD as a modality or due to patient selection.[9] The HD:PD cost ratio can vary considerably by country, and countries with a greater human development index (an index summarized by 3 key dimensions of human development, including life expectancy, education, and gross national income index) and a higher number of PD patients per capita tend to have lower PD costs when compared with HD.[5] Nonetheless, the evidence supporting home-based modalities is heterogeneous and might not account for certain factors that potentially affect cost estimation, such as modality transfers and hospitalization related to kidney failure treatment.[7,8]

In this issue of *Kidney Medicine*, Ferguson et al[10] provide contemporary insight into cost-effectiveness among dialysis modalities using a national Canadian database. The main objective was to create a detailed economic model by accounting for modality history and transition using real-world national Canadian data. This study includes adult incident maintenance dialysis patients in Canada (except patients from Quebec due to privacy laws) who received either maintenance in-center HD or PD during a 10-year period from 2004 to 2013. Data were extracted from the Canadian Organ Replacement Register (CORR), which captures all incident cases of maintenance dialysis and kidney transplantations in Canada. The authors used a decision-analytic Markov model to create a model of cost simulation. Cost-effectiveness outcomes consist of survival, utility (quality-adjusted life-years [QALYs]), modality mix (proportion of dialysis modalities over time), and cost-utility ratios. The authors explored the modality mix in the first 3 years after the commencement of dialysis and used real-world data from CORR to predict the probability of modality transitions. Infection and hospitalization rates were abstracted from a national database and published studies. Although there were 6 different dialysis modalities in the cohort (thrice weekly in-center HD, home HD, frequent in-center HD, intensive home HD, PD, and transplantation), they only included PD and thrice weekly in-center HD in the analyses. The number of modality transitions was limited to 3 occurrences because more than 3 transitions was rare. The authors also assessed internal validity by comparing the predicted survival rate with the actual survival rate from CORR data.

To inform the cost analysis, the authors included dialysis-related costs (labor, equipment, drugs, and overhead) and hospitalization cost related to dialysis. Modality costs were derived from the Ontario Renal Network. Notably, sensitivity analysis was performed to assess any parameters that could significantly influence cost estimation if the input parameters greatly varied. Essentially, despite meticulous adjustments, the model mainly provides cost-effectiveness from the payer's perspective. Societal cost, patient expenses, and economic impact, albeit pertinent and important, were not included in the model. Therefore, the model is unable to estimate cost-effectiveness from a societal or patient perspective.

Among 39,318 dialysis patients, 79% received in-center HD and 21% received PD; of note, PD use in Canada is significantly greater than in the United States, where the rate was only 11% in 2018.[3] PD patients in this cohort had significantly fewer comorbid conditions than those receiving in-center HD. The total 10-year average cost of all dialysis (both in-center HD and PD) was $350,774, and PD cost $16,000 less than in-center HD ($336,309 vs $352,712). Additionally, PD was associated with 10-year mean QALYs of 3.86 versus 3.25 years for in-center HD. Cost-utility demonstrates a similar trend, with PD more cost-effective than in-center HD ($87,127/QALY vs $108,527/QALY). The predicted survival rate was higher with PD than in-center HD at both the 5 and 10 year marks.

There are several reasons that PD is a less expensive modality. PD patients mainly perform dialysis at home, resulting in lower dialysis staff labor costs and facility overhead costs that comprise most dialysis costs. Nonetheless, PD may have high supply costs, including dialysate, cyclers, and injectable medications. While in more developed nations this still is below costs associated with in-center HD, in certain developing countries with scarce resources, PD may be less cost-effective than HD due to higher dialysate cost and low labor costs.[5]

PD may provide other benefits, including better clinical outcomes, although generally the mortality rates of PD and HD are comparable in well-designed studies.[11] Nonetheless, PD may harbor an early survival benefit over HD patients initiating with a catheter due to fewer central venous catheter–related infections, whereas HD patients who initiate dialysis with an arteriovenous graft or fistula have comparable early outcomes to those initiating with PD.[12] Furthermore, PD better preserves residual kidney function than HD, a factor that may improve mortality and volume management, reduce hospitalizations. and improve cardiovascular health, particularly early in a patient's dialysis course.[13] Quality of life and patient satisfaction tend to be better in PD than in HD.[13] However, the glucose load associated with PD may exacerbate weight gain and affect glycemic control, and with PD, it can be more difficult to deliver adequate dialysis and ultrafiltration when residual kidney function diminishes.

Despite several appealing features, PD remains underused, particularly in the United States, where the prevalent PD rate is ∼11%.[3] There are several barriers that may prevent the growth of PD use, such as lack of PD awareness among patients with CKD, failure of timely referral, skepticism from providers, and certain patients' clinical and socioeconomic characteristics.[14] Moreover, some financial incentives favoring HD over PD may discourage nephrologists from initiating PD despite potential longer term cost benefit.[14] Health care providers should become familiar with PD indications and individualized benefits, PD prescriptions, and how to treat PD-related conditions to improve PD use. Efforts to enhance PD experience and education are pivotal and need to be core elements of nephrology training.[15] In July 2019, President Trump signed the Advancing American Kidney Health executive order, with 1 major goal to enhance comprehensive kidney care by increasing home dialysis and kidney transplantation rates. Under this initiative, the Center for Medicare and Medicaid Innovation implemented new kidney care models in 2021 that create strong financial incentives for increasing home dialysis use in the United States.[16]

In summary, this study demonstrated superior cost-effectiveness of PD as compared with in-center HD using a model with multiple advantages compared with prior studies, including the incorporation of dynamic modality changes that are common among maintenance dialysis patients and incorporation of the simultaneous risk for mortality and infection. The model also provides more flexibility because the cost estimation can be adjusted based on changing baseline characteristics, enabling its use in changing populations. However, some limitations persist, potentially affecting cost estimates. Despite an effort to include important parameters into the model, factors such as cost incurred to patients and their families (transportation, caregivers, and utilities) and economic impact (employment and productivity) were not accounted for in the model. Additionally, no information can be gleaned about other dialysis modalities beyond PD or in-center HD. Importantly, given the model's many strengths, including the use of national broadly generalizable data in Canada, this model could be adapted to other populations to inform policy makers regarding the cost-effectiveness of dialysis modalities. In addition, given that a randomized controlled trial comparing PD and in-center HD is unlikely to ever occur in this situation, future refinement of models to account for these and other patient-centric factors may provide an opportunity to explore potential societal advantages of home dialysis therapies.

## ARTICLE INFORMATION

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