



ORIGINAL ARTICLE

Peritoneal dialysis versus hemodialysis: cost differences in a public center in Lima, Peru

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Keywords:

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ABSTRACT

Objective. To compare the monthly per-patient costs of peritoneal dialysis (PD) and hemodialysis (HD) in a public renal health center in Peru during 2024. **Methods.** A cost-minimization study was conducted. Five cost items were analyzed: health personnel costs, procedure costs for vascular or peritoneal access, diagnostic support costs, costs of medical supplies and drugs, and equipment and maintenance costs. Costs were estimated in Peruvian soles and converted into U.S. dollars. For hemodialysis, the monthly cost was calculated based on the equivalent of thirteen sessions. **Results.** The cost of PD was determined mainly by dialysis solutions. In HD, personnel costs were 2.67 times higher than in PD. Overall, the cost of PD was higher than that of hemodialysis. **Conclusions.** PD entails higher supply costs, whereas HD shows higher human resource costs. In the center studied, the cost of PD is higher than that of HD.

Diálisis peritoneal versus hemodiálisis: diferencias de costos en un centro público de Lima, Perú

Palabras clave:

diálisis peritoneal; hemodiálisis; costos de la atención en salud; terapia de reemplazo renal; insuficiencia renal crónica (fuente: DeCs-BIREME).

RESUMEN

Objetivo. Comparar los costos mensuales por paciente entre diálisis peritoneal (DP) y hemodiálisis (HD) en un centro público de salud renal en Perú durante el 2024. **Métodos.** Se realizó un estudio con enfoque de minimización de costos. Fueron analizados cinco ítems: costo de personal de salud, costos de procedimientos para acceso vascular o peritoneal, costo de ayuda diagnóstica, costo de materiales sanitarios y fármacos, y costo de equipos y mantenimiento. Los costos fueron estimados en soles y convertidos a dólares. Para la hemodiálisis el costo mensual fue calculado con el equivalente a trece sesiones. **Resultados.** El costo de la DP estuvo determinado principalmente por las soluciones para diálisis. En la HD, el costo de personal fue 2,67 veces mayor que en la DP. En general, el costo de la DP resulta más alto que el de la hemodiálisis. **Conclusiones.** La DP presenta mayor costo por insumos, mientras que la HD registra mayor costo en recursos humanos. El costo de la DP, en el centro estudiado, es más alto que el de la HD.

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INTRODUCTION

Chronic kidney disease (CKD) is defined as a persistent reduction in kidney function, an estimated glomerular filtration rate below 60 mL/min/1.73 m², or an albumin-to-creatinine ratio greater than 3 mg/mmol for more than three months ⁽¹⁾. Currently, 10% of the world's population, approximately 850 million people, have kidney disease of various etiologies ⁽²⁾. According to a report from the Regional Office for the Americas of the World Health Organization ⁽³⁾, approximately a quarter of a million deaths due to kidney diseases occurred in 2019. On average, 15.6 deaths per 100,000 population were estimated, with rates ranging from 73.9 per 100,000 population in Nicaragua to as low as 5.0 per 100,000 population in Canada. These figures reflect marked differences associated with quality of life and social conditions.

In Peru, Herrera-Añazco et al. ⁽⁴⁾ reviewed the main causes of chronic kidney disease at Hospital Nacional Dos de Mayo, where diabetes ranked first, accounting for 44% of cases, followed by chronic glomerulonephritis at 23% and obstructive uropathy at 15%. According to the EsSalud National Dialysis Registry Report ⁽⁵⁾, 9,331 patients received hemodialysis (HD) in 2023, of whom 74.7% received outsourced care and only 19.8% were treated using institutional resources at EsSalud centers. In contrast, peritoneal dialysis (PD) accounted for only 13% of patients receiving dialysis.

When loss of kidney function becomes incompatible with life, renal replacement options include kidney transplantation, HD, and PD. Kidney transplantation is considered the best option, although access is limited by the difficulty of obtaining donors, according to the systematic review by Nyokabi ⁽⁶⁾, which included 13 studies; in addition, kidney transplantation is the most cost-effective option. HD was found to be less cost-effective than PD, except in one study conducted in Brazil, where continuous ambulatory peritoneal dialysis (CAPD) was considered less cost-effective than HD ⁽⁷⁾.

However, some studies have reported markedly different findings across countries. Karopadi ⁽⁸⁾, in a review of 78 articles comparing annual HD and PD costs in 46 countries, found substantial variation in costs. In most developed countries, the cost of HD was between 1.25 and 2.35 times higher than that of PD, whereas in eight developing countries, HD cost between 0.22 and 0.9 times less than PD.

In addition, economic evaluations such as that conducted by Bavanandan ⁽⁹⁾ in Malaysia concluded that increasing the proportion of patients receiving PD and reducing the proportion receiving HD would generate future cost savings for the government. Similarly, in 2025, Assanatham ⁽¹⁰⁾ compared the costs of automated peritoneal dialysis (APD) with those of continuous ambulatory peritoneal dialysis (CAPD) in Thailand and concluded that, although APD offers advantages in terms of greater autonomy and facilitates children's education, it is not cost-effective under current conditions in that country.

It is important to note that these studies use different methodologies: cost analyses estimate the expenditure associated with each therapy, whereas cost-effectiveness and cost-utility analyses incorporate measures of clinical benefit or quality of life. The present study was limited to a cost analysis using a cost-minimization approach, assuming, based on the available evidence, that clinical outcomes are equivalent between the two modalities.

The objective of this study was to compare the costs of peritoneal dialysis and hemodialysis at a public renal health center in Peru during 2024.

METHODS

Study design and area

A quantitative cost analysis was conducted, specifically a cost-minimization study, from the perspective of the dialysis service provider and resource payer. The study setting was a public renal health center of the Social Health Insurance system (EsSalud) in Lima, Peru, during fiscal year 2024.

EsSalud is a social security system financed by employers and workers but administered by the State. It provides healthcare services to workers and their immediate family members. It is not directly under the Ministry of Health but rather the Ministry of Labor.

Population and sample

The unit of analysis was the monthly cost per patient receiving PD or HD. Because this was a cost study based on aggregated institutional data and unit prices, no patient sample was used; instead, all cost information provided by the administrative and clinical departments of the center during the study period was analyzed. Therefore, no sampling procedures or patient selection criteria were applied.

Variables and data collection instruments

The main variable was the monthly cost per patient for each dialysis modality (PD and HD). This variable was disaggregated into five items: 1) healthcare personnel costs, 2) procedure costs for vascular or peritoneal access, 3) diagnostic support costs, 4) costs of medical supplies and medications, and 5) equipment, maintenance, and depreciation costs. No psychometric measurement instrument was used; data were obtained directly from institutional records. For depreciation of HD equipment, the straight-line method was applied, assuming a standard useful life of five years (60 months).

Data collection techniques and procedures

Unit prices for supplies, medications, and medical materials were obtained from the institution's Pharmacy, Logistics, and Clinical Laboratory departments. Healthcare personnel salaries were calculated based on institutional salary scales, and the cost per patient-month was determined according to the monthly number of sessions or patient encounters.

Peritoneal dialysis catheters were provided at no direct cost by the company supplying the dialysis solutions as part of its commercial bundling strategy. Therefore, this item was recorded as zero in the PD cost structure. In contrast, vascular access for HD, including arteriovenous fistulas and catheters, was included at the actual acquisition and placement cost. This asymmetry in accounting for access costs should be considered when interpreting the results.

For currency conversion, costs expressed in Peruvian soles (S/) were converted to U.S. dollars (USD) using the official average exchange rate for 2024 (S/ 3.75 per USD 1), published by the Central Reserve Bank of Peru, taking into account that supplies are purchased several months in advance. No inflation adjustment was applied because all costs corresponded to the same annual period (2024).

The study used an institutional microcosting approach, whereby the resources used to provide each dialysis modality were individually identified, quantified, and valued. This approach differs from the *top-down* method, which allocates overall institutional costs to units of analysis, because microcosting allows identification of the specific components that determine the cost structure. This made it possible to compare costs per patient-month and to perform sensitivity analyses of the main cost drivers.

To estimate costs per patient-month, the annual remuneration of each team member, including the nurse, physician, and nursing assistant, was considered, together with the number of patients treated per month for each dialysis modality. For HD, the cost per session was estimated and multiplied by 13 sessions per patient. For PD, the remuneration of the nurse and nursing assistant was divided among 20 patients treated per month. To estimate the monthly physician remuneration cost, a part-time allocation of 50% per month was considered.

Data analysis

A descriptive cost analysis was performed by calculating the total monthly cost per patient for each dialysis modality. Because the study was based on deterministic values obtained from institutional sources rather than on a sample with statistical variability, no statistical significance tests or confidence intervals were applied.

To evaluate the uncertainty associated with the main determinant of PD cost, namely dialysis solutions, a one-way sensitivity analysis was performed. This analysis consisted of progressively reducing the price of peritoneal dialysis bags from 0% to 50%, recalculating the total monthly cost per patient receiving PD for each scenario, and comparing it with the fixed cost of HD. Calculations were performed using an electronic spreadsheet.

Ethical considerations

The Research Ethics Committee of Hospital Almenara, as the only research ethics committee within the Almenara Network and because the investigator works within that network, determined that the project did not require formal ethical review because it was an economic study without human participation (Letter No. 01 CIEI-OlyD-GRPA-ESSALUD-2026). The confidentiality of the institutional data used in the study was maintained.



RESULTS

Monthly per-patient costs were evaluated for continuous ambulatory peritoneal dialysis (CAPD) and institutional hemodialysis (HD), considering five main components. In PD, costs were determined primarily by supplies, particularly PD solutions, which accounted for the largest proportion of total monthly expenditure, approximately 79% of the total cost

Table 1. Monthly cost of peritoneal dialysis supplies per patient

Supply	Unit of measure	Unit price (S/)	Monthly units	Monthly cost (S/)	Monthly cost (USD)
1.5% peritoneal dialysis solution × 2 L	BTL†	38.64	120	4,637.00	1,236.48
Plastic cap for extension set	UNIT ‡	2.90	120	348.00	92.80
Extension set	UNIT	86.30	1	86.30	23.01
Total				5071.30	1,352.30

* Peritoneal catheters are provided by the dialysis solution supplier and therefore represent a cost not invoiced to the institution (hidden cost). Blank cells indicate that the supply is not routinely used or is included in the standard package.
† BTL: bottle. ‡ UNIT: unit.

(Table 1). Catheters were provided by the supplier of the dialysis solution bags as part of the supply package (hidden cost).

In HD, the predominant component was healthcare personnel cost (Table 2), which was substantially higher than in PD (Table 3) because of the greater demand for nursing care and technical support per session. This component accounted for approximately 76% of the total HD cost. The ratio of healthcare personnel costs between HD and PD was HD/PD = 2.67.

This difference in the composition of costs (Table 4) explains the variability observed in the total monthly cost per patient between the two renal replacement therapy modalities. At EsSalud, centralized procurement results in similar prices throughout the country; therefore, it can be inferred that, overall, the cost of PD exceeds that of HD by S/ 2,134.44, making PD 51% more expensive.

To explore variability in the main cost driver, a sensitivity analysis was performed (Table 5). A 20% reduction in the cost of PD solution bags decreased the total monthly cost from S/ 6,314.36 to S/ 5,314.53,

although it remained higher than the cost of HD (S/ 4,179.92). Even with a 40% reduction, PD remained more expensive. A 43% reduction in the cost of each PD solution bag would be required for the costs of both techniques to become similar.

DISCUSSION

There are three main forms of renal replacement therapy: HD, PD, and kidney transplantation. Several studies have concluded that kidney transplantation is clearly the most cost-effective option and is associated with longer survival. During the first year, costs are high because of the surgical procedure and intensive immunosuppression; however, transplantation becomes highly cost-effective in subsequent years ^(11,12).

However, the use of kidney transplantation remains limited because of cultural factors that limit consent for deceased organ donation. Comparing the costs of two healthcare interventions requires their outcomes to be similar; otherwise, a cost comparison is not appropriate. The outcomes to be considered include clinical outcomes and quality of life ⁽¹³⁾. Regarding

Table 2. Healthcare personnel cost per patient-month for HD

Professional category	Cost per session (S/)	Cost per session (USD)
Physician	61.0	16.26
Nursing staff	109.6	29.22
Technician	73.8	19.68
Cost per session	244.4	65.17
Cost per patient-month*	3,177.20	847.25

* Monthly cost per patient based on 13 sessions.

Table 3. Healthcare personnel cost per patient-month for PD

Professional category	Monthly cost (S/)	Monthly cost (USD)
Physician	349.4	93.17
Nursing staff	502.4	133.97
Technician	338.4	90.24
Total	S/ 1,190.2	USD 317.39

Table 4. Comparative monthly cost per patient between PD and HD (in Peruvian soles and U.S. dollars)

Category	PD (S/)	PD (USD)	HD (S/)	HD (USD)
Personnel	1,190.2	317.38	3,177.2	847.25
Pharmaceutical products	4,999.16	1,333.11	643.8	171.67
Diagnostic tests and support	125.00	33.33	125.00	33.33
Equipment and maintenance	0	0	34.32	9.15
Access (catheter/fistula)	0 ¹	0 ¹	199.6	53.23
Total	6,314.36	1,683.82	4,179.92	1,114.63

* Peritoneal catheters are provided by the dialysis solution supplier and therefore represent a cost not invoiced to the institution (hidden cost).

whether the outcomes of hemodialysis and peritoneal dialysis are comparable, a systematic review compared outcomes between peritoneal dialysis (PD) and hemodialysis (HD) at dialysis initiation. This Cochrane review ⁽¹⁴⁾ evaluated two randomized controlled trials and 82 observational studies addressing the advantages and disadvantages of both dialysis modalities.

It should be noted that the present study did not calculate cost-effectiveness ratios or estimate quality-adjusted life years (QALYs). Therefore, its findings should not be interpreted as evidence of cost-effectiveness, but rather as an estimate of direct monthly costs per patient within a specific institutional context.

The outcomes compared included residual kidney function, mortality, cardiovascular events, infections, hospitalizations, and quality of life. Regarding the assessed glomerular filtration rate, the meta-analysis

was unable to establish an advantage of one modality over the other because the certainty of the evidence was very low. Outcomes related to progression to anuria favored peritoneal dialysis. Lang et al. ⁽¹⁵⁾ evaluated preservation of kidney function and found an advantage of PD over HD in reducing the risk of loss of residual kidney function (anuria); however, this difference was rated as low-certainty evidence in the aforementioned Cochrane review.

Regarding mortality, a meta-analysis of 42 studies in adults yielded a relative risk (RR) of 0.87 (95% CI: 0.77–0.98) for all-cause mortality, favoring peritoneal dialysis. However, these findings were also considered to be of very low certainty because results varied substantially across studies, preventing firm conclusions from the pooled estimates. Jaar et al. ⁽¹⁶⁾ compared mortality risk between PD and HD cohorts and, after stratified analysis, found no difference in mortality risk between the two dialysis modalities.

Table 5. Sensitivity analysis: reduction in the cost of PD solution bags and its effect on total monthly cost

Reduction (%)	New pharmaceutical cost (S/)	New total PD cost (S/)	Difference: PD vs HD (S/)	Interpretation
0	4,999.16	6,314.36	2,134.44	PD remains more expensive
10	4,499.24	5,814.44	1,634.52	PD remains more expensive
20	3,999.33	5,314.53	1,134.61	PD remains more expensive
30	3,499.41	4,814.61	634.69	PD remains more expensive
40	2,999.50	4,314.70	134.78	PD remains more expensive
50	2,499.58	3,814.78	-365.14	PD becomes less expensive than HD

* The analysis considers only reductions in the price of peritoneal dialysis solution bags, while all other cost components are held constant.

When the total number of bacteremia episodes was analyzed, the evidence suggested that PD may reduce the number of episodes compared with HD (RR: 0.44; 95% CI: 0.27–0.71). This evidence was also rated as low certainty. According to the same review, there was no significant difference in QALYs between the two modalities. Wu et al.⁽¹⁷⁾ conducted a study comparing perceived quality of life among 698 patients receiving HD and 230 receiving PD and obtained no consistent findings; some aspects were better among patients receiving hemodialysis, whereas others were better among those receiving peritoneal dialysis. Similar findings were reported by Jung et al.⁽¹⁸⁾

In Peru, Guzmán-Ventura et al.⁽¹⁹⁾ studied mortality in cohorts of patients receiving HD and PD at a hospital in Trujillo, with follow-up from 2015 to 2019. Survival was estimated using Kaplan–Meier curves and included 368 patients receiving HD, of whom 129 (35.1%) died, and 172 patients receiving PD, of whom 66 (38.4%) died. The probability of survival at 60 months was 30% for HD and 37% for PD. The authors concluded that there were no differences in mortality or survival between the two dialysis modalities. Therefore, according to the current scientific evidence, the superiority of one modality over the other cannot be established, making a cost-minimization analysis appropriate, although the choice of modality should be individualized and based on shared decision-making with a well-informed patient.

Nevertheless, cost evaluations have produced differing results. Arrieta⁽²⁰⁾, at a hospital in Spain, conducted a cost study of renal replacement therapies, estimating annual costs per patient. For HD, three weekly sessions were considered, corresponding to 156 annual sessions at a cost of EUR 25.55 per session. For PD, a daily cost of EUR 58.46 was estimated, equivalent to EUR 21,340.55 annually. In contrast, Torales et al.⁽²¹⁾ conducted a comparative study of renal replacement therapies in Argentina, Uruguay, and Costa Rica. Among these three countries, Costa Rica had a high proportion of kidney transplantation, approaching 60%; HD was the least frequently used modality, whereas PD exceeded 30%. In Argentina and Uruguay, PD was used in only 4.2% and 6.1% of patients, respectively. Among their conclusions, the authors recommended increasing organ donation rates to enable more transplants and “increasing the proportion of patients receiving PD, which is more cost-effective than HD and is currently underused in both countries”⁽²¹⁾.

In Iran, PD is used in only 3% of cases, compared with 97% for HD. Furthermore, an article published in 2024⁽²²⁾ concluded that, although PD was more expensive, “its greater effectiveness in terms of quality of life justifies the investment,” and that a distribution of 70% PD and 30% HD was the most cost-effective option. As shown in the results tables, cost differences were mainly related to healthcare personnel remuneration, which was 2.46 times higher for HD than for PD.

Equipment and maintenance costs were also higher for HD; however, the high cost of dialysis solution bags substantially increased the total monthly cost of PD. When complications, hospitalizations, mortality, and other outcomes were assessed, no significant differences were found, although the available evidence was rated as low certainty.

In the Peruvian context, Arellan-Bravo et al.⁽²³⁾ conducted a direct cost analysis within the EsSalud Junín Healthcare Network, comparing the three renal replacement therapy modalities. Using a methodology similar to that of the present study, including the provider perspective and costing of supplies and personnel, they found that PD was the most expensive modality (S/ 49,680 annually), followed by HD (S/ 39,000 annually), and finally kidney transplantation (from the second year onward, S/ 23,400 annually). These findings are consistent with those of the present study in Lima, where PD was also more expensive than HD. The consistency between the two studies, conducted in different regions of the country and using data from different periods (2016–2021 for Arellan-Bravo et al. and 2024 for the present study), suggests that the greater economic burden of PD within the Peruvian public healthcare system is not an isolated phenomenon.

An additional factor with substantial economic impact that should be considered in this comparison is hepatitis C virus (HCV) infection. Among the general Peruvian population, Cabezas et al.⁽²⁴⁾, in a screening study involving 5,183 participants from 25 regions, reported an anti-HCV antibody seroprevalence of only 0.1%. This low prevalence contrasts markedly with that observed among patients receiving HD. In a national study involving 174 patients receiving HD, active HCV infection was identified in 35 cases, demonstrating a substantially greater burden in this population⁽²⁵⁾. Globally, this trend has been confirmed by the meta-analysis of Kenfack-Momo et al.⁽²⁶⁾, who estimated an HCV infection prevalence of approximately 24% among patients receiving HD.

In this context, the economic impact associated with antiviral treatment should also be considered. At EsSalud, the cost of a complete sofosbuvir/velpatasvir regimen is approximately S/ 20,000 (around USD 5,400), according to information from institutional pharmacies ⁽²⁷⁾.

A strength of this study is the estimation of healthcare personnel costs per patient-month, which highlighted the substantial difference in nursing resource utilization. During one shift, a nurse provides care for four HD sessions, equivalent to approximately 100 sessions per month or fewer than nine patients per month. In contrast, in PD, one nurse may be responsible for the care of up to 20 patients per month.

It is also important to note that EsSalud procures supplies for both dialysis modalities centrally at the national level, which may allow the findings to be extrapolated to other centers within the institution.

A relevant methodological limitation is the asymmetric treatment of access costs between the two modalities. Whereas vascular access for hemodialysis was accounted for at its actual cost, peritoneal catheters were provided by the dialysis solution supplier and their value was therefore not reflected in the results. This commercial practice, known as *bundling*, means that the total cost of PD was partially underestimated relative to HD.

Another important limitation is related to the service provider perspective (EsSalud); therefore, social costs, such as those incurred by family members and caregivers, were not evaluated. Patients attending hemodialysis centers generally do not attend alone. An accompanying family member must devote time, either during or outside working hours, to take the patient to dialysis sessions two or three times per week. Likewise, the economic disadvantages affecting working-age patients were not estimated. These patients must be absent from work three times per week, interrupting their activities, unlike patients receiving peritoneal dialysis.

Based on studies showing similar clinical outcomes between the two modalities, the present study was limited to a cost-minimization approach. Nevertheless, the findings indicate that the current cost of PD solutions is a major driver of cost differences between the two modalities and that, in this setting, reductions of approximately 40%–50% would be required for PD to become cost-competitive with HD. Because the

costs used in this study were deterministic values obtained from institutional sources, including logistics, pharmacy, human resources, and maintenance, rather than measurements derived from a sample with statistical variability, inferential tests and statistical significance calculations were not applicable.

Conclusions

In peritoneal dialysis (PD), dialysis solution bags represented the largest cost component (79%) and were the main driver of total expenditure. In hemodialysis (HD), personnel remuneration was the largest cost component (76%), with investment in human resources approximately 2.67 times higher than in PD. Overall, unlike in many other countries, PD at EsSalud was 51% more expensive than HD. In addition, according to the sensitivity analysis, only a 43% reduction in the cost of each PD solution bag would make the total cost of PD comparable to that of HD.



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HDV-C: Conceptualization, investigation, and writing.

LP-G: Supervision and methodological guidance.

FP-V: Investigation.

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Conflict of interest statement

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