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ORIGINAL ARTICLE

Peritoneal dialysis–first initiative in India: a cost-effectiveness analysis

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ABSTRACT

Background. The increasing burden of kidney failure (KF) in India necessitates provision of cost-effective kidney replacement therapy (KRT). We assessed the comparative cost-effectiveness of initiating KRT with peritoneal dialysis (PD) or haemodialysis (HD) in the Indian context.

Methods. The cost and clinical effectiveness of starting KRT with either PD or HD were measured in terms of life years (LYs) and quality-adjusted life years (QALYs) using a mathematical Markov model. Complications such as peritonitis, vascular access–related complications and blood-borne infections were considered. Health system costs, out-of-pocket expenditures borne by patients and indirect costs were included. Two scenarios were considered: Scenario 1 (real-world scenario)—as per the current cost and utilization patterns; Scenario 2 (public programme scenario)—use in the public sector as per Pradhan Mantri National Dialysis Programme (PMNDP) guidelines. The lifetime costs and health outcomes among KF patients were assessed.

Results. The mean QALYs lived per KF person with PD and HD were estimated to be 3.3 and 1.6, respectively. From a societal perspective, a PD-first policy is cost-saving as compared with an HD-first policy in both Scenarios 1 and 2. If only the costs directly attributable to patient care (direct costs) are considered, the PD-first treatment policy is estimated to be cost-effective only if the price of PD consumables can be brought down to INR70/U.

Conclusions. PD as initial treatment is a cost-saving option for management of KF in India as compared with HD first. The government should negotiate the price of PD consumables under the PMNDP.

Keywords: chronic kidney disease, continuous ambulatory peritoneal dialysis, haemodialysis, peritoneal dialysis

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For Scenario II, the health system cost was determined as per the published PMNDP guidelines [8]. In case of PD, the cost incurred on PD consumables is obtained from the guideline while the rest of OOPE (such as medicines, dressings, cost of OPD visits, etc.) is determined from primary data. The cost parameters used in Scenario II are presented in Supplementary Appendix S1.

All costs are reported in INR and I$ using the average conversion of I$1 = INR21.2 in 2019 [22] and were adjusted for inflation to 2019 prices using the World Bank Group gross domestic product (GDP) deflator [23].

Indirect costs

The indirect cost due to productivity loss was estimated using the human capital approach [24]. We used the average national wage rate (INR247/day) as a proxy of daily productivity in economic terms [25, 26]. The productivity of a patient with KF was considered at 80% compared with a healthy individual [25]. In case of PD, the patient is assumed to be 80% productive on all the days of the year, except on the OPD days or in case of any hospitalization (due to peritonitis), wherein the patient would incur complete wage loss for those days [25]. Similarly, in the case of HD, the patient is assumed to incur complete wage loss on the days of HD procedure and hospitalization (if any) and 80% on the rest of the days. These productivity losses were measured for the duration between the development of disease and the average age of retirement in India (60 years) or death, whichever occurs earlier [27]. Besides productivity losses due to illness, lost productivity due to premature mortality was also estimated.

Valuation of consequences

The outcomes were assessed in terms of LYs and QALYs. The rates of transition of a patient with KF to the subsequent health states were obtained from the published literature and converted into annual transition probabilities using standard methods (S1) [28]. It was assumed that one-third of the patients on PD develop peritonitis within 1 year [29], ∼70% of whom recover, while the rest may switch to HD or die [30]. In case of HD, it was assumed that no patient will die just due to AV fistula failure. The fistula would be revised or repaired or the patient will switch to PD. Age-specific all-cause mortality rates from each health state were obtained from the sample registration system life tables [31].

To measure health-related quality of life, the European Quality of Life 5-Dimensions questionnaire (EQ-5D), comprising the five-level EQ-5D descriptive system and the EuroQol visual analogue scale (EQ-VAS), was administered to 115 HD and 77 PD patients. As the tariff values are not available for India, the profiles were converted to their corresponding utility scores using the tariff values from Thailand [32]. The choice of the Thailand value set to calculate index utility scores was based on the recommendations of the draft Indian reference case for undertaking HTAs [33]. The quality of life (QoL) scores were adjusted as per the various sociodemographic characteristics such as age, gender, Rrligion, education status, caste and locality of the patient with respect to the type of treatment (HD or PD) using multilinear regression analysis. The factor (B-value) obtained was then used to calculate the utility score of PD with respect to HD.

The comparative cost-effectiveness was assessed in terms of incremental cost per QALY gained. The incremental cost-effectiveness ratio (ICER) was estimated as the ratio of the difference in costs and the difference in effectiveness between the PD and HD treatment arms.

$$\text{ICER(QALY)} = \frac{\text{Total lifetime cost of PD} - \text{Total lifetime cost of HD}}{\text{Total lifetime QALY for PD} - \text{Total lifetime QALY for HD}}$$

Sensitivity, threshold and scenario analyses

The impact of changing the parameter values on the results was analysed by applying a probabilistic sensitivity analysis (PSA). The probability of the PD-first programme to remain cost-effective at a willingness-to-pay threshold equal to per capita GDP was estimated using the societal perspective. The per capita GDP of India in 2019 was INR148 171 (I$6986) [34].

For undertaking PSA, we used a gamma distribution for parameters related to cost and a beta distribution for parameters related to risk of complications and overall survival. For the rest of the parameters we used uniform distribution to simulate random values. Upper and lower bounds were computed from the standard error estimated in the primary data or estimates provided in the literature sources. Wherever the upper and lower bounds were not provided in the literature, we assumed a variation of 20% on either side of the base estimate for clinical parameters and 30% variation for risk of mortality, treatment patterns and cost parameters. The Monte Carlo method was used for simulating the results and the number of iterations was restricted to 1000 times. The median was computed along with the 2.5th and 97.5th percentiles to estimate the 95% confidence interval.

Since PD hass not yet been introduced under the PMNDP programme (Scenario 2), we undertook multiple PSAs at different prices for consumables (PD solution and mini-caps) in order to assess the probability of PD to be cost-effective at different prices for PD consumables. This analysis was undertaken from a health system perspective. The cost-effectiveness threshold (the maximum amount a decision maker is willing to pay for 1 U of health outcome) was considered to be equal to per capita GDP, as advocated by the HTAIn [14, 35].

ETHICAL CONSIDERATIONS

The study protocol was approved by the Institute Ethics Committee of the Post Graduate Institute of Medical Education and Research, Chandigarh, India (NK/5376/Study/052).

RESULTS

Costs

The health system bears a cost of INR1595 (I$75) per dialysis session for providing HD under the PMNDP. The OOPEs incurred by the patient were calculated at INR1173 (I$55) per session. Therefore the total annual direct cost for HD treatment at a secondary level was estimated to be INR332 196 (I$15 662). The total costs for management of AV fistula failure and one episode of CRBSI were INR6120 (I$288) and INR11 347 (I$535), respectively. The annual indirect cost incurred on an HD patient without complications for 1 year was estimated at INR41 743 (I$1968).

The one-time health system cost and OOPEs of PD initiation were INR17 054 (I$804) and INR34 978 (I$1649), respectively, and the recurrent average daily OOPE was INR1329 (I$63). The annual health system cost and OOPEs incurred on PD were estimated as INR6550 (I$309) and INR478 303 (I$22 551), respectively.

The total cost of treating one episode of peritonitis was estimated to be INR7219 (I$340). The indirect cost for PD treatment initiation was estimated to be INR2470 (I$116) and the total recurrent annual indirect cost for a patient receiving PD without complications was estimated to be INR23 366 (I$1102).

Cost-effectiveness

We estimated that the KF patients treated with PD and HD have an overall mean survival of 5.05 and 2.6 LYs, respectively. After factoring in the quality of life, this would translate into 3.3 and 1.6 QALYs, respectively. From a societal perspective, the policy of PD first is a cost-saving strategy, as it yields an increase in QALYs and is less costly as compared with the policy of HD first in both the scenarios. If KRT is initiated with PD instead of HD, a KF patient will be living an additional 1.7 QALYs, and in the real-world scenario, the patient will save INR92 105 (I$4342) during his/her lifetime. If KF patients seek treatment as per the public programme scenario (Scenario 2: PMNDP scenario), then the average lifetime cost savings was found to be INR697 000 (I$32 862).

The detailed results for the study cohort are presented in Table 2.

Sensitivity analyses

If the consumables used in the PD exchange are purchased at a price of INR70/U, which is 65% less than the NHSRC recommended price (INR200/U), the OOPEs of a KF patient will decrease to INR195 999 (I$9241) per year. At this price, even if only direct costs of treatment are considered, there is a 75% probabil-

Table 2. Discounted costs, consequences and cost–effectiveness of the study cohort of PD-first treatment policy as compared with HD-first treatment policy

Health outcomes	Scenario 1		Scenario 2	
	PD-first, median (95% CI)	HD-first, median (95% CI)	PD-first, median (95% CI)	HD-first, median (95% CI)
LYs	5053 (5017–5095)	2635 (2325–2974)	5053 (5018–5096)	2635 (2338–2944)
QALYs	3296 (2750–3754)	1591 (1404–1796)	3296 (2777–3736)	1591 (1410–1777)
Health systems cost (million INR)	68.7 (65.5–72.5)	165 (133–204)	69.9 (64.1–76.5)	488 (433–544)
OOPEs (million INR)	2416 (2398–2434)	829 (692–979)	1692 (1683–1701)	390 (432–348)
Indirect cost (million INR)	3092 (3077–3107)	4674 (4407–4915)	3092 (3078–3106)	4674 (4435–4906)
Total cost (million INR)	5577 (5563–5591)	5669 (5482–5832)	4854 (4848–4861)	5551 (5412–5687)
Incremental values				
LYs	2418 (2121–2691)	–	2418 (2152–2677)	–
QALYs	1705 (1346–1960)	–	1705 (1366–1958)	–
Total cost (million INR)	−92.1 (−241–75.5)	–	−697 (−826 to −564)	–
Incremental cost per LY gained (INR)	−38 091 (−94 555–40 641)	–	−288 315 (−310 441 to −260 279)	–
Incremental cost per QALY gained (INR)	−54 025 (−137 819–57 303)	–	−408 918 (−582 966 to −309 737)	–

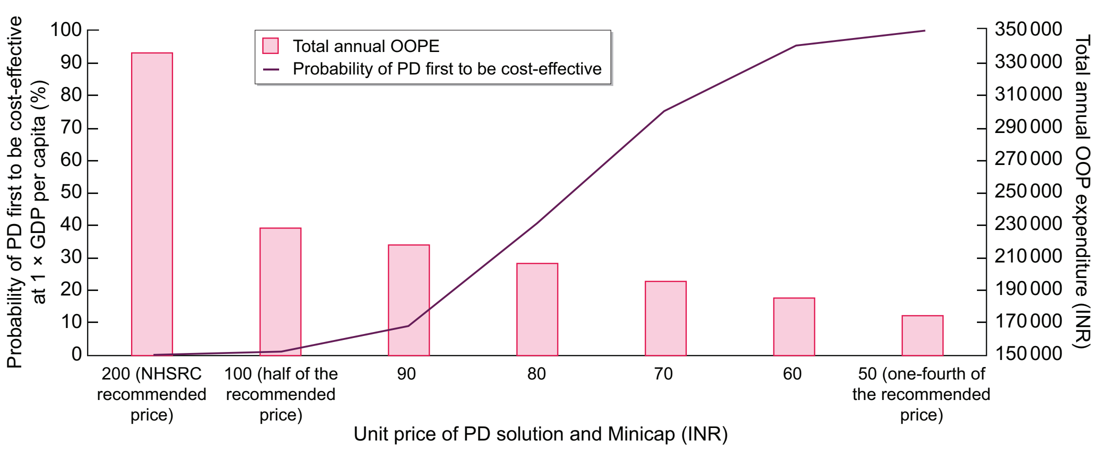

FIGURE 2: Threshold price analysis for PD consumables prices in Scenario 2 (PMNDP scenario).

ity for PD to be cost-effective (at a threshold of per-capita GDP) (Figure 2).

DISCUSSION

Our analysis indicates that the proposed intervention of PD-first treatment is cost saving as compared with the HD-first approach in India from a societal perspective. If the prices of PD consumables can be reduced by 65%, the use of a PD-first policy has a 75% probability to be cost-effective from a health system perspective. This is likely to happen if there is bulk procurement through a public system. In view of this, our study findings recommend the adoption of a PD-first policy in the national PMNDP.

Model validation

The findings of our model are in concurrence with existing epidemiological studies. Our model estimates show the overall survival for CKD patients with PD at 5 and 7 years to be 39.5 and 26.3%, respectively, similar to studies by Prasad *et al.* [36] and Lasfar *et al.* [37] that reported similar long-term survival of 39% at 5 years and 30% at 7 years. In the case of HD, the annual disease-related mortality of 23.2% as per our model correlates well with a population-based study that reports that 22.4% of patients die in 12 months [38].

As per current practice, almost all of the cost for PD is borne by patients as OOPEs. This is in concurrence with the findings of previous studies reporting that in low- and middle-income countries, the cost of PD is higher due to the higher price of PD supplies and the lack of government aid [39, 40]. Given the way HD and PD are currently financed in India, it is not appropriate to report the ICERs from the health systems' perspective. This is mainly because the price of HD is already highly controlled in India. So, from the perspective of the PMNDP, the scenario analyses help us to estimate the probable reduction in the prices of PD consumables that will make the PD-first policy a cost-effective option with uniform public funding for both dialysis modalities. There is existing evidence showing that government procurement of medical devices and pharmaceuticals results in a substantial reduction in prices. This will be aided by the promotion of domestic production of PD consumables as compared with importing them at higher prices [41, 42].

Findings in context of the existing evidence

Analyses in countries like Thailand, Singapore and Indonesia have shown that the PD-first policy is important for achieving universal coverage of dialysis care. In most of these studies, PD and HD were compared with modalities such as transplant, palliative care etc. [43, 44]. While we reported 3.26 QALYs in the PD-first scenario, Yang *et al.* [25] reported 3.27 QALYs in the CAPD arm. However, the QALYs gained with HD are not similar, as the relative QoL for HD and PD move in opposite directions as compared with our study. There is, however, a comparable difference between the QoL scores reported by our study and other published analyses [5, 44].

Our study is the first to report the cost-effectiveness of dialysis modalities in the Indian context. We used a Markov model that is based on the current understanding of the disease and its outcomes. As far as possible, we used Indian evidence on epidemiology, clinical effectiveness in terms of survival, complication rates and cost of care. Primary data were collected to estimate OOPEs and quality of life; national programme data from the PMNDP were used to assess the health system costs of HD. We also incorporated in our analyses private-sector utilization and costs. Hence our findings are generalizable and should be used for policymaking.

However, there are certain limitations of this analysis. First, we only considered the two common dialysis modalities and did not include the costs and complications associated with kidney transplant. Because of the lack of donors and legal machinery, the number of transplants being performed in India is low compared with the demand. Second, due to the lack of robust registry and clinical data, the parameters were obtained from cross-sectional studies rather than systematic reviews. There is limited population-based survival evidence with regard to HD and PD in the Indian context. The study takes into consideration only CAPD, and not automated cycler-assisted PD, because CAPD in patients is cheaper, more popular and likely to be the preferred policy option. The study also does not incorporate indirect costs incurred by the caregivers or patients' families due to the illness.

CONCLUSIONS AND POLICY IMPLICATIONS

There are a few important implications of our findings. First, the PD-first policy is a cost-saving policy. Second, if the PD-first policy is utilized in the PMNDP, it should result in lower prices for PD consumables, which will make PD even more efficient. Third, since the cost of providing PD is largely currently being borne by patients, subsidized treatment under the PMNDP will result in reduced financial hardships. Finally, since most of the HD facilities are located in urban and well-connected cities [4], introduction of the PD-first policy linked to primary healthcare services is likely to improve access to treatment for patients in rural and remote areas, thereby making outcomes more equitable. Moreover, with augmentation of the primary healthcare capacity in India through creation of the Health and Wellness centres [45], a functional linkage of community-level primary healthcare services with PD services for CKD patients should also be considered.

SUPPLEMENTARY DATA

Supplementary data are available at ckj online.

FUNDING

No specific funding was obtained to carry out this research.

CONFLICT OF INTEREST STATEMENT

The results presented in this article have not been published previously in whole or part, except in abstract format. V.J. reports grants from BSK, Baxter Healthcare and Biocon and personal fees from AstraZeneca, Baxter Healthcare and NephroPlus, outside the submitted work. All funds go to his institution. All other authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

All data relevant to the study are included in the article or uploaded as supplementary information.

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