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Economic assessment of hemodialysis patients in tertiary and charitable hospitals: A prospective multicenter study in India

Gangadhar Naik Jarupala[1], Sreedhar Dharmagadda[2]*, Siddharam Virendra Ligade[2], Shankar Prasad Nagaraju[3], Vasudeva Guddattu[4], Manunath Kulkarni[5]

[1]Department of Pharmaceutical Regulatory Affairs and Management, Manipal College of Pharmaceutical Sciences, Manipal Academy of Higher Education, Manipal, India.
[2]Department of Regulatory Affairs and Management, Manipal College of Pharmaceutical Sciences, Manipal Academy of Higher Education, Manipal, India.
[3]Department of Nephrology, Kasturba Medical College, Manipal Academy of Higher Education, Manipal, India.
[4]Department of Data Science, Prasanna School of Public Health, Manipal Academy of Higher Education, Manipal, India.
[5]Deparment of Nephrology, Father Muller Medical College, Rajiv Gandhi University of Health Sciences, Mangalore, India.

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ABSTRACT

End-stage renal disease (ESRD) is becoming more common in India, and the treatment options for ESRD are, e.g., hemodialysis (HD) or kidney transplantation. In the current situation, many individuals can only afford HD. More research is needed to estimate the exact cost of HD because it varies across the country. The study aims to investigate the cost of HD in a tertiary and charitable hospital in South India. A multicentric prospective observational study was conducted in tertiary care hospitals. The study included patients who are on HD regularly at these hospitals. Patients' data and cost information were collected for 1 year. Overall cost evaluation of HD patients was done. Cost categories were calculated based on their cost of HD per session, monthly expense, and cost per annum. This includes HD cost per session, ward cost, consultation physician cost, overall medication cost, laboratory cost, the cost for blood transfusion, transportation cost, accompanying person's cost, and food costs. More studies on costs and outcomes are required to examine the benefits and drawbacks of renal replacement treatment and improve the quality of life of ESRD patients. As the treatment costs are higher, the government can develop schemes that provide insurance or compensation to needy people.

INTRODUCTION

Hospitals and healthcare providers face more significant challenges with the increased demand for renal replacement therapy (RRT) caused by the end-stage renal disease (ESRD) issue across the globe. Medical professionals must continue finding innovative solutions to address this growing problem and provide better patient care. These conditions are particularly dire in underdeveloped nations with few health resources [1]. ESRD is becoming more common in India every day, and the only treatments available are hemodialysis (HD) and transplantation. In the present era, HD is the only form of therapy that ordinary individuals can afford because transplantation is too expensive. Research is required to determine the precise cost of HD because prices vary nationwide. Pharmacoeconomic assessments have become essential in therapeutic decision-making, particularly for chronic illnesses when resources are scarce. According to the International Society for Pharmacoeconomics and Outcomes Research definition, pharmacoeconomics is an academic field that investigates the behaviors of individuals, groups, and markets concerning the utilization of medical products, services, and initiatives, emphasizing the analysis of costs and outcomes [2].

Medical advancements have paved the way for developing cutting-edge diagnostic and therapeutic techniques, resulting in improved management of chronic illnesses such as

*Corresponding Author
Sreedhar Dharmagadda, Department of Regulatory Affairs and Management, Manipal College of Pharmaceutical Sciences, Manipal Academy of Higher Education, Manipal, India.
E-mail: d.sreedhar @ manipal.edu

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diabetes, hypertension, and renal failure. Consequently, human life expectancy has increased. Nevertheless, it is crucial to recognize that chronic kidney disease (CKD) is emerging as a growing concern, particularly in economically disadvantaged nations. According to Levey *et al.* [3] CKD is one of the major global healthcare issues because of its prevalence, epidemic financial impact, and low standard of living. Over the past 15 years, the majority of CKD has doubled worldwide, and it is anticipated to continue over the next 15 years as the illness advances to end-stage disease [4,5]. According to global data, more than one million people with ESRD are receiving renal replacement treatment, even though another two million require it [6,7].

Pharmacoeconomics is a vital tool for social and economic research of the global medical system, especially in developing countries [8–10]. No published study provided exact information on the entire cost of HD from the patient's perspective in India. The cost of ESRD can only be fully comprehended once the expenditures are viewed from the patient's perspective. This research was taken up to determine HD's direct and indirect costs at two private hospitals and one non-profit hospital in the Udupi, Mangalore districts of Karnataka, India. It is crucial to evaluate the effectiveness of the treatment and the standard of life because several variables, including age, the frequency of dialysis, infections/inflammations, concomitant diseases, and so on, might impact them. This study presents comprehensive information on HD costs in the private sector from the patient's perspective. According to reports, several variables in India contribute to the rapid development of CKD to ESRD, including a shortage of healthcare facilities, inadequate risk factor management, and postponed referrals to healthcare practitioners. According to estimates, there are 7,852 and 1,870 cases of CKD and ESRD per million people, respectively [11,12].

Estimates suggest that only around 20,000 out of the projected 1,00,000 Indians with (ESRD) receive treatment yearly. More than 3/4 of ESRD patients, especially those residing in rural areas, do not receive proper treatment. This could be attributed to factors such as limited awareness of the condition, lack of access to available therapies, low income, inadequate compensation for chronic illnesses, and the absence of insurance coverage, which pose significant challenges in financing their healthcare needs [13,14]. The number of patients choosing renal replacement treatment rises by around 10% yearly [15]. Most dialysis facilities are private HD sessions that cost between INR 1,200 and INR 2,000 in India. They also must pay for erythropoietin, iron injections, phosphate binders, a laboratory test, a consultation charge, and other costs. For the average Indian who cannot pay the fee, this becomes a nightmare. Several of them purposely stop attending the sessions, and their health deteriorates tremendously [16]. Studies have shown that kidney disease affects more males than women. This suggests that unhealthy lifestyle choices, such as smoking and drinking too much alcohol, play a critical role in the progression of the illness [17,18]. ESRD may develop at a young age if the progression of renal failure is not stopped by early diagnosis or proper therapy. The cost of HD therapy varies considerably, especially in areas with limited resources [19]. Numerous comorbidities are frequently present in patients with ESRD. A significant financial burden is placed on patients due to the rising cost value of the resources utilized to develop HD treatments [20,21]. Because of this, every healthcare system globally will face a significant resource demand. HD in hospitals is the most popular kind of RRT in low-income countries, and its delivery is exceedingly tricky. Due to a lack of funds or insurance to cover the high costs of the continually increasing number of patients, most countries cannot provide treatment for everyone [22,23]. One of the most expensive medical conditions to treat worldwide, CKD is a serious public health issue with multiple adverse effects on health. CKD patients often delay seeking treatment due to the lack of apparent indications of renal illness and disregard for these symptoms. Consequently, this frequently leads to declining kidney function, ultimately culminating in ESRD. The most prevalent treatment option for ESRD, HD, could be utilized more cost-effectively by incorporating an accurate estimate of the procedure's cost for patients with ESRD [24]. Due to high out-of-pocket expenses (OOPEs), RRT is a costly treatment option in India because it is primarily a private healthcare program. Only a tiny percentage of patients in India can sustain long-term HD because of the significant OOPEs [25].

The burden of CKD is increasing and is a significant cause for concern due to the high rates of morbidity and mortality it causes. The cost of treating CKD is relatively high for healthcare systems. There are very few public dialysis and kidney transplant facilities in India. These are only available in metropolitan healthcare hospitals. In India, patients spend a lot of their own money on healthcare. To the best of our knowledge, India only has a scheme that covers some of its citizens' medical expenses, according to the most recent data available from the World Bank. Only 4% of India's gross domestic product is spent on health, and only 32% of all healthcare costs are covered by the government. Patients with CKD may have many comorbidities upon presentation, necessitating various drugs. Patients with ESRD not only need to take many medicines, but they also need dialysis. The expense of therapy rises because of additional considerations like dialysis and an increasing medication burden. Treatment for CKD is complex due to a lack of insurance or reimbursement mechanisms. It has been observed that individuals with CKD who need erythropoietin to treat anemia cannot afford the medication. The most frequent cause of non-adherence to dialysis in India is high costs. It is realistic to expect that many people may perish due to their inability to afford the required therapy [26,27].

ESKD was one of the leading causes of morbidity and mortality globally. People with ESKD were treated with expensive but life-saving RRT through dialysis or kidney transplantation (KT). The number of persons getting RRT was predicted to reach 5.439 million globally by 2030, with Asia experiencing the most significant absolute rise, from 0.968 million in 2010 to a projected 2.162 million by 2030 [28].

METHODOLOGY

This multicentric observational prospective cross-sectional research was performed in two private hospitals and one charitable hospital. The study recruited a total of 385 patients. Over 1 year, patient and financial information were gathered, and 10,155 dialysis sessions were analyzed.

For the cost analysis, the patient's perspective was used. The patient's socioeconomic situation was also investigated. The study participants were those who visited on an outpatient basis. Patients were assigned to different shifts in the morning, afternoon, evening, and night, depending on their choices.

Data collection process

Prospective data on patients receiving HD were gathered using a data collection form. Face-to-face interviews were used to collect the data, and clinical information such as the number of medicines prescribed, comorbidities, and problems was gathered by looking over the patient's medical record cards. Then, a patient interview and a chart review were used to collect information on expenses. The patients were informed of the research's purpose and that they had the right to decline and withdraw at any time. Before beginning the actual data collection, each participant provided their written consent. Non-personal identification throughout the investigation ensured research individuals' anonymity and confidentiality. The relevant data were entered into case record forms. Interviews were used to gather information on the funding source. To complete the data, case files and the hospital's computerized database were also evaluated. Data on clinical comorbidities was retrieved from the HD units' computer databases. Direct patient interviews are used to get information on indirect costs associated with transportation and lost pay. Expenses were estimated monthly, including direct, indirect, and total fees. The patient data were gathered by direct patient interviews and using a patient data collection form. The data collection form included sufferers' demographic information, financial situation, concomitant sickness status, treatment cost, frequency of HD, and other information. When required, medical professionals, nurses, and dialysis personnel were consulted. To evaluate regularity, affordability, clinical condition, and satisfaction, outcomes between patients of various socioeconomic classes were compared. For a total of 385 patients, HD cost, ward cost, consultation physician cost, overall medication cost, laboratory cost, the cost for blood transfusion, transportation cost, accompanying persons cost, and food costs were calculated. All the parameters were calculated for HD, each session cost, monthly fee, and yearly cost. Finally, we analyzed the patient percentage of the cost of HD/Session INR 1,500–2,000 ($18.06–24.08), cost of HD/Session INR 2,001–2,500 ($24.09–30.10), cost of HD/Session INR 2,501–3,000 ($30.11–36.12), cost of HD/session INR 3,001–3,500, ($36.13–42.14), cost of HD/session INR 3,501–4,000, ($42.14–48.15), monthly cost (INR) <15,000 ($ < 180.61), monthly most INR 15,000–20,000, ($180.61–240.76), monthly cost INR 20,001–25,000 ($240.77–300.95), the monthly cost INR 25,001–30,000 ($300.96–361.07), monthly cost INR >30,000 ($ > 361.07), cost per annum INR <1,50,000 ($1,805.30), cost per annum INR 1,50,001–2,00,000 ($1,805.31–2,406.41), cost per annum INR 2,00,001–2,50,000 ($2,406.43–3,007.72), cost per annum INR 2,50,001–3,00,000 ($3,007.73–3,609.26), cost per annum INR >3,00,000 ($ > 3,609.26).

Intangible expenses and opportunity costs were not included in the total cost. The cost calculation did not include costs associated with linen and laundry, electricity, water, sanitation, buildings after depreciation and maintenance, and equipment capital costs after depreciation and maintenance.

Inclusion criteria

All patients older than 18 have received HD for over 3 months.

Exclusion criteria

1. Those who visited twice throughout the data collection period and were gravely sick or unable to reply to the interview were excluded.
2. Refusal or inability to get informed consent.
3. Refusal of the attending doctor's advice or a lack of cooperation on the patient's side or his accountable family member during the evaluation visits.
4. Psychiatric patients, patients who passed away while hospitalized, and patients who were highly sick were excluded from the research.
5. Patients with serious illnesses, such as severe cardiac or neurological issues, were excluded from participating.
6. Patients receiving dialysis as inpatients.

Cost analysis

To analyse the cost component from the patient's perspective, information was gathered directly from the patient. Cost analysis for HD patients is classified into three types.

1. Direct costs for healthcare.
2. Direct cost for non-healthcare.
3. Indirect cost.

Direct healthcare costs

These parameters were analyzed under this category. Costs of HD, doctor consultations, laboratory investigations, overall medications, Arteriovenous fistula, blood transfusion, X-rays, and other expenses directly associated with patient medical expenses are referred to as direct medical expenditures.

The direct cost for non-healthcare

"Direct non-medical cost" refers to expenses, such as transportation, food, and others, that patients and their loved ones spend directly connected to non-medical costs.

Indirect cost

Accompanying the person's worth, lost wages due to absence from work, and additional expenses such as hospital stays and other fees were also considered. The monthly productivity loss for patients and their careers is calculated from the time required for treatment.

The cost of care annually was computed. Only Indian rupees were used for all computations: direct non-medical expenditures and indirect costs gleaned through questionnaire-based patient interviews. Thus, specific laboratory tests were run monthly, while others were run quarterly or annually. Based on the patient reports, this analysis included the cost of transportation. The main modes of transport were the railway, bus, taxi, ambulance, and private vehicles. For trains and buses,

the number of journeys monthly was multiplied by the price of the tickets.

Statistical analysis

Mean, average, and standard deviation were computed for descriptive data analysis. Quantitative descriptions were used and mentioned in percentages and tabular formats to display the patients' characteristics and the HD expenses.

RESULTS

Overall cost evaluation of HD patients was done. Cost categories were calculated based on their cost of HD/session, monthly expense, and cost per annum. HD charges are mentioned in Tables 1 and 2. Evaluation cost for HD patients at Dr TMA Pai Hospital, KMC Manipal, and Father Muller Medical College Hospital, Mangalore, shown in Table 3. Different types of costs that were calculated are HD cost, ward cost**,** consultation physician cost, overall medication cost, laboratory cost, cost of blood transfusion**,** transportation cost, accompanying person's cost, and food costs.

Percentages of costs involved in three hospitals each session, monthly, and annual expenses are included in Table 3. Evaluation cost for HD patients in KMC Hospital for HD/Session INR 2,001–2,500 ($24.09–30.10) (39.2%), monthly cost INR 20,001–25,000 ($240.77–300.95) (40.4%), cost per annum INR 2,00,001–2,50,000 ($2,406.43–3,007.72) 99 (39.6%). In TMA Pai Hospital Udupi, the cost of HD/Session INR 2,501–3,000 ($30.11–36.12) (31.81%), monthly cost INR 20,001–25,000 ($240.77–300.95) (45.45%), cost per annum INR 2,50,001–3,00,000 ($3,007.73–3,609.26) (59.09%), In FMMCH Mangalore cost of HD/Session INR 2,001–2,500 ($24.09–30.10) (48.88%), monthly Cost INR 15,000–20,000 ($180.61–240.7651) (37.77%), cost per annum INR 2,00,001–2,50,000 ($2,406.43–3,007.72), 44 (32.59%). Hematological drugs, such as erythropoietin alpha injection, darbepoetin alpha injection, and iron injection, as well as phosphate binders such as sevelamer carbonate, calcium acetate, and sucroferric oxyhydroxide, were found to be expensive drugs for HD patients. In this study, we observed variations in the utilization of HD sessions among patients based on the cost per HD session. Specifically, most HD patients, comprising 44.15%, utilized sessions with a cost range of INR 2,001–2,500 ($24.09–30.10). This was followed by 27.27% of patients using sessions costing INR 2,501–3,000 ($30.11–36.12), 14.28% utilizing sessions in the INR 3,001–3,500 ($36.13–42.14) range, and 8.83% utilizing sessions costing INR 1,500–2,000 ($18.06–24.08). A smaller percentage of patients, 1.81%, used sessions with a cost exceeding INR 4,000 ($48.15). Figure 1 shows the overall utilization percentage of each session cost at a tertiary care hospital.

This study revealed variations in the utilization of HD sessions among patients, which were associated with the monthly cost of HD treatment. Most HD patients, accounting for 141 individuals (36.62%), were classified under the monthly cost category of INR 20,001–25,000 ($240.77–300.95), signifying a high utilization level. This was followed closely by 137 patients (35.58%) in the INR 15,000–20,000 ($180.61–240.76) category, indicating another significant segment of patients. In addition, 70 patients (18.18%) fell into the INR 25,001–30,000 ($300.96–361.07) range, demonstrating a substantial but relatively minor group. A smaller portion of patients, 21 individuals (5.45%), had monthly costs exceeding INR 30,000 ($361.07). Finally, 16 patients (4.15%) incurred monthly costs below INR 15,000 ($180.61), potentially due to the utilization of healthcare schemes designed to support HD patients. Figure 2 shows the overall utilization percentage of the monthly cost of HD at tertiary care hospitals.

This research unveiled variations in the overall utilization percentage of annual costs among HD patients. Most patients, constituting 137 individuals (35.58%), fell within the

Table 1. Rates are available at Father Muller Medical College Hospital, Mangalore, for HD patients.

Sl. No	FMMCH hospital	Rates
1.	Single HD	INR 1,200 ($14.45)
2.	Single-use dialyzer	INR 600 ($7.23)
3.	Multiple dialyzer (12 times per year)	INR 900 ($10.84)
4.	Single HD + single-use dialyzer	INR 1,800 ($21.68)
5.	Single HD + multiple dialyzer	INR 2,100 ($25.29)

INR = Indian rupee; $ = dollar.

Table 2. Rates are available for HD patients at KMC Hospital, Manipal, and Dr. TMA Pai Hospital, Udupi.

Sl. No	KMC Hospital, Manipal and Dr, TMA Pai Hospital, Udupi	Rates
1.	Single HD	INR 1,320 ($15.90)
2.	Special dialysis unit	INR 1,850 ($22.27)
3.	Single-use dialyzer	INR 600 ($7.23)
4.	Multiple dialyzer (12 times per year)	INR 900 ($10.84)
5.	Single HD + single-use dialyzer	INR 1,800 ($21.68)
6.	Single HD + multiple dialyzer	INR 2,100 ($25.29)

Table 3. Evaluation cost for HD patients at KMC Manipal, Dr TMA Pai Hospital, and Father Muller Medical College Hospital, Mangalore.

SI. No	Parameters	KMC Hospital, Manipal (*n* = 228)	Dr TMA Pai Hospital, Udupi (*n* = 22)	FMMCH Hospital, Mangalore (*n* = 135)
1.	Cost of HD/Session INR 1,500–2,000 ($18.06–24.08)	12 (5.26%)	2 (9.09%)	20 (14.81%)
2.	Cost of HD/Session INR 2,001–2,500 ($24.09–30.10)	98 (42.98%)	6 (27.27%)	66 (48.88%)
3.	Cost of HD/Session INR 2,501–3,000 ($30.11–36.12)	64 (28.07%)	7 (31.81%)	34 (25.18%)
4.	Cost of HD/Session INR 3,001–3,500 ($36.13–42.14)	40 (17.54%)	5 (22.72%)	10 (7.40%)
5.	Cost of HD/Session INR 3,501–4,000 ($42.14–48.15)	10 (4.38%)	1 (4.54%)	3 (2.22%)
6.	Cost of HD/Session INR >4,000 ($ > 48.15)	4 (1.75%)	1 (4.54%)	2 (1.48%)
7.	Monthly cost INR <15,000 ($ < 180.61)	8 (3.50%)	-	8 (5.92%)
8.	Monthly cost INR 15,001–20,000 ($180.61–240.76)	81 (35.52%)	5 (22.72%)	51 (37.77%)
9.	Monthly cost INR 20,001–25,000 ($240.77–300.95)	91 (39.91%)	10 (45.45%)	40 (29.62%)
10.	Monthly cost INR 25,001–30,000 ($300.96–361.07)	42 (18.42%)	5 (22.72%)	23 (17.03%)
11.	Monthly cost INR >30,000, ($ > 361.07)	6 (2.63%)	2 (9.09%)	13 (9.62%)
12.	Cost per annum INR <1,50,000 ($ < 1,805.30)	3 (1.31%)	-	2 (1.48%)
13.	Cost per annum INR 1,50,001–2,00,000 ($1,805.31–2,406.41)	18 (7.89%)	1 (4.54%)	12 (8.88%)
14.	Cost per annum INR 2,00,001–2,50,000 ($2,406.430–3,007.72)	89 (39.03%)	4 (18.18%)	44 (32.59%)
15.	Cost per annum INR 2,50,001–3,00,000 ($3,007.73–3,609.26)	72 (31.57%)	13 (59.09%)	42 (31.11%)
16.	Cost per annum INR >3,00,000 ($ > 3,609.26)	46 (20.17%)	4 (18.18%)	35 (25.92%)

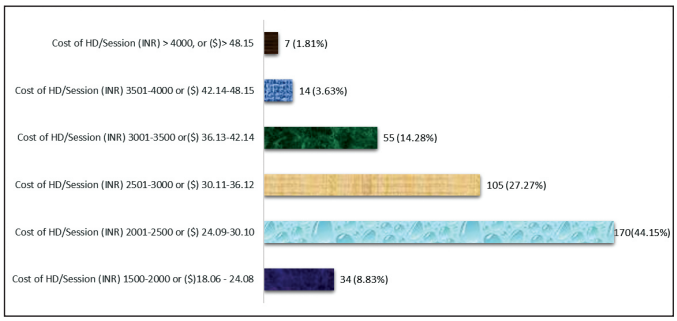

Figure 1. Overall utilization percentage of each session cost at tertiary care hospitals.

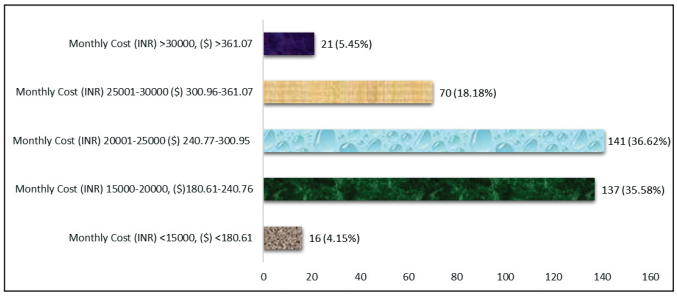

Figure 2. Overall utilization percentage of the monthly cost of HD at tertiary care hospital.

cost per annum range of INR 2,00,001–2,50,000 ($2,406.43–3,007.72), indicating the highest utilization segment. Following closely, 127 patients (32.98%) were categorized in the INR 2,50,001–3,00,000 ($3,007.73–3,609.26). An additional 85 patients (22.07%) recorded annual costs exceeding INR 3,00,000 ($3,609.26). A smaller but noteworthy group comprised 31

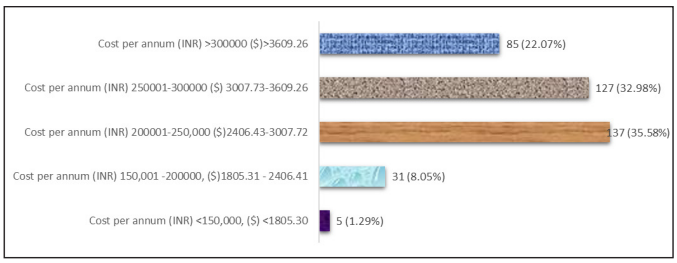

Figure 3. Overall utilization percentage of cost per annum HD at tertiary care hospital.

patients (8.05%) with annual fees ranging from INR 1,50,000 to 2,00,000 ($1,805.30–2,406.41). Finally, five patients (1.29%) incurred annual costs below INR 1,50,001 INR ($1,805.31). These findings shed light on the varying utilization patterns of cost per annum among HD patients. Figure 3 shows the overall utilization cost percentage per annum HD at tertiary care hospitals.

DISCUSSION

HD is a costly form of treatment. It was discovered that the average session cost was INR 4,692.5, which is expensive for the average citizen. The costs involved with treating the comorbid conditions might make matters worse. Even though diabetes and hypertension are the two leading causes of renal failure, they must be adequately treated from the early stages. Along with diabetes and hypertension, the lifetime management of renal failure dramatically increases patient burden and worsens prognosis. According to research by Rao *et al.* [29] diabetes is the primary factor contributing to poor outcomes associated with cardiovascular risk. The failure to implement preventative measures, late referral, and the delay in diagnosing renal illness may be the causes of the advancement

of renal failure. Jha and Chugh [30] show that 70% of dialysis facilities are private and open to higher-income people.

Many patients who require HD are forced to stop treatment due to its high cost. Kher's assessment found that 60% of patients discontinued their treatment after 3 months. This highlights the need for more affordable options and resources for those who require ongoing dialysis [31]. Only 4% of people can pay using their own money, 63% come from their occupations or charitable contributions, 30% sell their ornaments or personal items, and 20% borrow money, according to Mani's survey [12]. Another research by Abraham *et al.* [17] shows that the monetary value of HD is almost five times higher in low-income nations than in developed ones. This might result in dropout and disease-related complications [32]. Depending on the patient's socioeconomic status, patients of higher and moderate classes may use the HD facilities offered by the private sector. People with poor socioeconomic levels endure discomfort to manage the problems and receive frequent dialysis. They usually turn to public hospitals since they can not pay the high prices of private enterprises. Patients from middle-class households may struggle to afford the cost of controlling comorbid conditions in addition to the cost of dialysis. This will impact both the clinical results and the patient's treatment satisfaction. Middle-class people have several problems, but there is no significant difference in their severity or affordability.

Research is required in this domain to determine the price of therapy in private and charitable hospitals. Studies must be performed to compare the costs and results of HD sufferers attending private vs. charity hospitals. To determine the cost-effectiveness, it is also necessary to analyze the quality of life for patients at both hospitals. The government must take the initiative to open additional dialysis clinics in the public sector if patients have a higher quality of life in the public sector. In recent years, a variety of non-profit organizations, as well as charity trusts, have developed to provide more cost-effective management. Patients will benefit from free medications, particularly those for hematological, phosphate binders, diabetes, and hypertension, which will assist in lessening the overall burden of renal failure.

HD data are woefully lacking in India. It is difficult to determine the precise cost of RRT in underdeveloped nations since it depends on the prescription and how the unit is constructed. Although treatment costs are lower in developed countries due to lower staff salaries and drug prices, it is still 10–20 times more expensive than the gross national product per person. It is still out of the reach of most people who receive HD. A significant public health issue on a global scale is CKD. HD is one of India's most resource-intensive and expensive therapeutic interventions, even though renal transplant is a cost-effective therapy option for ESRD. In India, the price of a single HD session ranges from INR 150 ($1.8) at government hospitals to INR 2,000 ($24.06) at private hospitals. In India, a HD session costs, on average, INR 1,100 ($13.23). The average monthly prices are INR 12,000 ($144.36), and per year are INR 144,000 ($1,732.28). Even though it is the most affordable option, more than 90% of Indians cannot afford it [33].

Comorbid conditions are more common in people above 50 years of age and raise the direct medical costs for this specific age group. Most people had diabetes and hypertension, or either diabetes, hypertension, or cardiovascular disease. Renal artery stenosis, chronic pyelonephritis, and so on were minor concomitant conditions. The average fee for the sessions was INR 1,028.3 ($12.37) or around INR 12,339.6 ($148.44) per month. Suja *et al.* [2] reported that the average dialysis treatment cost was INR 4,500 ($54.13), of which 56% was a direct medical expense. The cost of non-medical expenses was 24% and 20%, respectively. According to different research by Fathima *et al.* [34], the average median direct medical cost was estimated to be INR 85,999 ($1,034.54), with non-medical costs coming in at INR 14,437 ($173.67). The average direct medical expense per in-person visit was INR 481.5 ($5.79) (INR 5,778 ($69.51) monthly). Nonetheless, they had to use their money to cover the direct non-medical and indirect costs, totaling INR 4,188 ($50.38) and INR 2,499.96 ($30.07), respectively. Most of the patients in this research were from lower socioeconomic backgrounds. Therefore, the predicted sum is a burden for them and their families. The price of HD in Anita *et al.* [35], varied from INR 1,200 to 2,000 ($14.44–24.06) per session. The average patient session cost was INR 980 ($11.79) [INR 1,100–900 ($13.23–10.83)] [34].

Arteriovenous fistula construction costs range from INR 6,000 to 20,000 ($72.18–240.59) at government and private hospitals of various calibers. Erythropoietin typically costs between INR 4,000 and 10,000 ($48.12 and 120.30) Indian rupees per month. As many of the patients were from lower and medium-class backgrounds, most could cover the costs with the support of family members, friends, and loans. Non-governmental organizations helped about 8% of them, while the remaining recipients paid with their own money from earnings and savings. Several pharmacoeconomic studies have been conducted to analyze dialysis patients' direct and indirect medical costs. Nonetheless, they were all carried out in private dialysis facilities. Most of the patients in our research are from people with low incomes and lower middle classes. Few are Below Poverty Line patients whose costs for laboratory tests and dialysis are half those of patients who are not BPL. Indirect medical costs alone will increase the financial burden on patients in the BPL and non-BPL categories. As a result, to lessen the burden on these patients, the government must either develop mobile dialysis centers or increase the number of dialysis centers at community health centers [36]. The study results demonstrated several economic and sociodemographic aspects, including increasing age, greater socioeconomic level, receiving more dialysis per month, anemia, and coexisting illnesses, which were parameters that highly increased the cost of HD therapy for ESRD sufferers. Studies from France, the UK, Brazil and Nigeria, demonstrated that prices vary by age and are disproportionately more significant for older age groups corroborate these findings. This might be explained by the fact that complications from chronic renal disease increase with age and that comorbid illnesses are more common, increasing the cost of HD therapy [37–40].

Compared to those with lesser wealth, receiving HD is 1.09 times more expensive for those with more exceptional income status. Furthermore, compared to patients who only

receive HD once per month, individuals who receive eight and twelve monthly visits spend 1.27 and 1.34 times more for their treatment, respectively. An Indian study found that patients with higher incomes were more willing to pay for HD therapy, which supports this finding [41]. This might be explained by the fact that people with more significant money could afford the expense of HD, especially the direct non-medical expenditures. Another reason might be that because the study's tertiary hospitals were in the state's center, where costs are likely to rise as visits do, patients may be forced to pay more when they visit more frequently. To enhance the availability of HD treatment services, the Indian health system should be altered to include general and primary hospitals. Patients with comorbidities who have ESRD are more likely to order various medications and treatments, which concurrently raises expenditures. However, the expense incurred varies between our study and other research [42].

HD creates a significant financial burden on the healthcare system when combined with other critical health conditions such as elevated maternal and newborn mortality, Human Immunodeficiency Virus/Acquired Immune Deficiency Syndrome, and undernutrition. Not withstanding government subsidies, roughly one-third of the overall cost is covered by patients' and their families' funds. This is very expensive, especially in the beginning when there are additional expenses for vascular access, medication, and hospitalization. Most of our patients, who are from the lowest socioeconomic level and frequently have no income, cannot afford this. Health insurance is essentially non-existent in our milieu. Research has revealed that even in sub-Saharan Africa nations where the state pays for dialysis, the cost is substantial, and most patients cannot afford it. As a result, morbidity and mortality are high [43].

In India, poverty is pervasive, and it is believed that most people live in rural regions and earn less than INR 750 per day of work. Given the steadily rising number of patients in India who require dialysis, it is critical to find cost-efficient methods to address the demand for renal treatments. Policymakers in low-income nations must seek strategies to lower the price of dialysis. Developing local manufacturing facilities for generic drugs and dialysis consumables and eliminating import taxes might be significant steps for governments. Reducing the number of people who develop ESRD is the most crucial aspect. The most efficient and long-lasting way to lower ESRD costs is to identify and treat CKD in high-risk populations, especially in settings with limited resources. Nevertheless, this approach is still in its infancy in most Dakshina Karnataka district hospitals, and the Indian government does not promote it.

According to decision-makers, the cost of dialysis supplies should be decreased using various methods; cost-cutting tactics include reusing dialyzers, price haggling, and lowering import duty taxes on dialysis supplies. To protect the caliber of dialysis, prudent cost-cutting measures must be used [44]. The methodologies utilized to estimate costs, variances in local import, medicine costs, laboratory test costs, consumable costs, and countries' yearly per capita income might all contribute to the cost discrepancy shown in the study [45]. Dialysis is one of the most resource-intensive therapy approaches to treating ESRD patients. RRT price tag has been estimated to be very high. Nevertheless, population-based cost studies are rare, both nationally and internationally. The issue of declining financial resources to deal with the rising expenditures of health care brought on by this life-saving RRT modality affects all nations, including industrialized ones [46].

CONCLUSION

The financial impact of HD therapy on ESRD patients and their families was made clear by this research, including the fact that for several households, the yearly revenue is insufficient to pay for HD. The cost of HD treatment for individuals with ESRD was significantly raised by factors such as anemia, comorbidities, more frequent monthly dialysis sessions, and worse aging circumstances.

Therefore, the medical system must work together to reduce the expenditures and the incidence of kidney illness sufferers by early detection to relieve the enormous financial burden of HD on patients. Furthermore, to minimize non-medical direct expenses, HD units should be established in the district hospitals to increase treatment accessibility. The Indian medical coverage system should also upgrade its service offerings to incorporate dialysis treatments to reduce overall medical expenditures. When managers and policymakers decide how to enhance a hospital's performance and distribute resources within or across hospitals, they require cost information.

Due to inadequate information systems and a need for more funding for hospital administration, regular data systems only sometimes provide cost data. With reliable cost data, it is feasible to develop accurate estimates, increase technical efficiency, regulate expenditure, and promote management responsibility. The effective operation of a hospital depends on the management's ability to meet these demands, which can only be done with the help of a scientific cost analysis for HD patients.

Most participants experienced catastrophic medical costs for HD patients in this study. The federal and state governments should focus on initiatives that help people who need dialysis and pay attention to measures that can reduce the occurrence of renal illness. CKD screening and prevention initiatives must be implemented, and this is still the only practical and affordable solution, particularly in developing nations. For people with ESRD, dialysis is still the treatment of choice. One of India's biggest problems is that fewer dialysis units are available in the public than in the private sector. Second is the absence of insurance or reimbursement schemes for dialysis patients. Due to its exorbitant cost, only people in the upper or middle classes can afford HD. The annual cost of RRT can be decreased in several ways. Reduce the number of patients with ESRD, which is the most crucial element in the long term. Hypertension and diabetes are the two conditions that cause ESRD most frequently in India. Early diagnosis and treatment of these illnesses are essential for preventing renal failure and, to a certain extent, delaying the requirement for RRT.

A clinical pharmacist can help to delay the advancement of HD by supplying patients with changes in lifestyle recommendations, providing the risk group with education, encouraging the individuals to obtain routine checkups, and implementing the prescribed course of action. Moreover, more HD units, insurance, and patient payment programs may improve patient outcomes in our nation. Long-term studies are required to evaluate the costs and effects of

the therapy options for ESRD patients. Early sickness detection and lifestyle modifications may decrease the onset of ESRD and minimize the fiscal and pharmacological impact of the condition on the patients.

The outcomes of this research may help health policymakers create a more equitable and convincing reimbursement system for dialysis services in the future. Changing how dialysis is delivered might result in better resource management. Methods to further reduce expenses are required, and suggestions are as follows:

1. Decrease the number of individuals with ESRD by treating diabetes, hypertension, glomerulonephritis, polycystic kidney disease, obstructive nephropathy, urinary tract infections, and vasculitis to prevent the emergence of these issues into chronic renal illness.
2. Continuous HD can be a cost-saving measure in a specific patient population.
3. The most cost-effective therapy for ESRD is KT, however, if the patients can afford the treatment.
4. Insurance reimbursements are a possibility for covering treatment costs, particularly in the case of kidney transplants; this will be very beneficial for the patient.
5. It can significantly reduce costs using satellite units, free-standing facilities, and charitable organization HD facilities.

This study revealed that among HD/Session costs falling within the range of INR 2,001–2,500 ($24.09–30.10), a total of 170 cases (44.15%) were characterized by high utilization. Similarly, in the context of monthly costs ranging from INR 20,001–25,000 ($240.77–300.95), 141 cases (36.62%) demonstrated a high utilization level. In addition, when examining cost per annum within the INR 2,00,001–2,50,000 range ($2,406.43–3,007.72), 137 cases (35.58%) of HD patients were identified as highly utilized. These findings highlight the cost distribution among highly used HD patients. This cost analysis might help to determine the cost-effectiveness of HD treatment in different types of hospitals (tertiary and charitable) in India. The primary endpoint could be comparing the cost per quality-adjusted life year gained between the two types of hospitals.

Patients undergoing HD who participate in this study may potentially experience various general benefits

Access to high-quality care

Patients in tertiary and charitable hospitals may benefit from high-quality HD treatment, which can help improve their overall health and well-being.

Monitoring and evaluation

Participation in the study may involve regular monitoring and evaluating their health status, potentially leading to better disease management and outcomes.

Financial assistance

Patients in charitable hospitals may receive financial assistance or subsidized care, which can alleviate the financial burden of chronic HD.

Contributing to research

Patients may have the opportunity to contribute to medical research, which can lead to advancements in the understanding and treatment of kidney diseases and HD.

Awareness and education

Participation in the study may involve educational sessions or materials to help patients better understand their condition and treatment options.

Potential for improved healthcare policies

The study's findings may contribute to policy changes that improve access to and affordability of HD treatment for patients in India.

Better informed decision-making

Patients can benefit from the study's findings by accessing information that can inform their treatment decisions, especially regarding costs and potential financial burdens.

Improved cost-effectiveness

If the study identifies cost-effective approaches to HD care, patients may benefit from more affordable treatment options or improved healthcare resource allocation.

Improved quality of life

Ultimately, the study may aim to assess and improve the economic and health-related quality of life for HD patients in India, which would significantly benefit the participants.

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LIST OF ABBREVIATIONS

ESRD	End-stage renal disease
ESKD	End stage kidney disease
HD	Hemodialysis
OOPEs	Out-of-pocket expenses
INR	Indian rupees
RRT	Renal replacement therapy
KT	Kidney transplantation
CKD	Chronic kidney disease
ISPOR	International Society for Pharmacoeconomics and Outcomes Research
$	United States dollar

AUTHOR CONTRIBUTIONS

All the authors significantly contributed to the conception and design, data acquisition, and analysis and interpretation of the data. They participated in drafting the article or critically revising it for substantial intellectual content. All authors provided consent for submission to the present journal, and they have granted final approval for the publication version. In addition, the authors collectively undertake accountability

for all dimensions of the work. Under the guidelines of the International Committee of Medical Journal Editors (ICMJE), all authors are eligible for authorship.

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CONFLICTS OF INTEREST

The authors report no financial or any other conflicts of interest in this work.

ETHICAL APPROVALS

The study was initiated after securing ethical approval from the Institutional Ethics Committee. All participants provided informed consent, ensuring privacy, confidentiality, and voluntary engagement. Rigorous measures were implemented to ensure data security and safeguard participants' identities throughout the study. Ethical clearance for the research was granted by Institutional Committees (IEC: 471/2019 from KMC Manipal, applicable to KMC Manipal and Dr TMA Pai Hospital Udupi; FMIEC/CCM/294/2021 from FMMCH, Mangalore). The study is registered with Clinical Trial Registration-India (CTRI) under registration number CTRI/2019/08/020874.

DATA AVAILABILITY

All the data is available with the authors and shall be provided upon request.

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