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Cost Analysis of Haemodialysis in Chronic Kidney Disease: The Role of Patient Characteristics in a Regional Indonesian Hospital

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ABSTRACT: Haemodialysis (HD) is the primary treatment for end-stage renal disease in Indonesia and heavily strains the national health insurance. This study examined how patient characteristics influence the direct medical costs of CKD patients receiving HD at Dr. R. Goeteng Taroenadibrata Regional General Hospital. A retrospective cross-sectional analysis was conducted using secondary data from medical, pharmacy, and financial records between July and December 2023. The study included 85 patients who met the inclusion criteria. Statistical analyses were performed using IBM SPSS Statistics, and cost differences across patient characteristics were analysed using nonparametric tests. The total cost over six months reached IDR 2.64 billion, averaging IDR 654,758 per HD visit. While no significant cost differences were observed across patient characteristics such as age, gender, comorbidities, or HD frequency ($p > 0.05$ for all), descriptive data indicated higher average costs in older patients, in patients receiving HD weekly, and in patients with CKD due to non-hypertensive etiologies. These findings suggest that standard reimbursement rates may overlook variations in resource utilization, highlighting observed cost variations that suggest the need for more tailored health financing approaches. Broader, multicenter studies are recommended to improve resource allocation in CKD management.

Keywords: **chronic kidney disease; cost analysis; haemodialysis; patient characteristics; health financing.**

Introduction

Chronic kidney disease (CKD) represents a growing global health burden, with increasing prevalence, high treatment complexity, and significant economic implications. The Global Burden of Disease Study has identified CKD as one of the top 10 causes of death worldwide, and its incidence continues to rise due to population aging, lifestyle-related diseases, and limited access to early detection and treatment services [1,2]. In 2023, the United States Renal Data System (USRDS) reported that the prevalence of end-stage renal disease (ESRD) requiring renal replacement therapy, such as haemodialysis (HD), has been steadily increasing, contributing to soaring healthcare expenditures [3,4]. Patients with CKD who progress to ESRD require life-sustaining treatments like HD, which must be administered regularly and indefinitely, placing a considerable financial strain on health systems, patients, and families[5–7].

In Indonesia, CKD has become a critical public health concern. The Indonesian Renal Registry (IRR) noted a sharp rise in haemodialysis patients, with more than 140,000 patients registered by 2022, a significant increase from previous years. This trend is driven in part by the increasing burden of non-communicable diseases such as hypertension and diabetes, which are major contributors to CKD progression [8,9]. From a healthcare provider and payer perspective, haemodialysis represents one of the most resource-intensive chronic therapies due to its lifelong nature, frequent treatment schedules, and substantial medication requirements. Within Indonesia's national health insurance system (BPJS Kesehatan), haemodialysis services are reimbursed through a bundled payment mechanism (INA-CBGs), placing significant financial pressure on hospitals to deliver standardized care under fixed reimbursement rates. The introduction of Indonesia's national health insurance program, BPJS Kesehatan, has improved access to dialysis services. However, this access comes with a high economic cost, particularly in government-funded hospitals that manage large volumes of patients within a fixed-cost INA-CBG reimbursement

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system[10–13].

Several local studies have examined the financial burden of haemodialysis, consistently indicating that CKD treatment involves substantial direct medical costs, particularly for medications and consumable supplies[14,15]. Evaluations of inpatient haemodialysis expenses have emphasized the financial challenges faced by public hospitals in sustaining these services [16,17]. Furthermore, analyses that integrate cost data with quality of life measures, such as the EQ-5D instrument, have underscored the dual impact of financial burden and diminished patient well-being [18,19]. However, these studies primarily focused on total cost estimation or inpatient settings, with limited emphasis on the variation of HD-related costs based on patient characteristics. Few studies have examined how demographic and clinical factors such as age, gender, comorbidities, cause of disease, or HD frequency may influence total direct medical costs in outpatient HD settings, especially within regional hospitals. This gap is crucial to address to inform policy decisions, optimize resource allocation, and improve health system efficiency under universal coverage frameworks.

This study aims to analyze the effect of patient characteristics on the total direct medical cost of CKD patients undergoing haemodialysis in the Indonesian Regional General Hospital. By examining cost variability across patient profiles, this research contributes to a more nuanced understanding of cost drivers in CKD care and supports evidence-based decision-making for sustainable healthcare financing in Indonesia.

Methods

Study Design

This study employed a retrospective cost analysis with a descriptive-analytic design, conducted at Dr. R. Goeteng Taroenadibrata Regional General Hospital in Indonesia. The economic evaluation was conducted from a healthcare provider (payer) perspective, focusing on direct medical costs incurred during haemodialysis treatment. A cross-sectional approach was utilized, and data were collected retrospectively from secondary sources, specifically patient medical records. The study population consisted of adult patients diagnosed with stage 5 chronic kidney disease (CKD) who received haemodialysis (HD) treatment between July and December 2023. Located in one of Central Java Province's densely populated regencies, this hospital is recognized as the largest healthcare facility in Purbalingga Regency. It serves as the primary referral center for residents of Purbalingga and its surrounding regions, with a total population exceeding 1 million.

Study Population and Data Sources

The study population consisted of adult patients with CKD stage 5 (end-stage renal disease) undergoing maintenance haemodialysis at Dr. R. Goeteng Taroenadibrata Regional General Hospital during the study period between July and December 2023. A total sampling approach was applied. Patients were included if they were aged 18 years or older, received outpatient haemodialysis during the study period, and had complete medical, pharmaceutical, and financial records available for analysis. Patients were excluded if they discontinued haemodialysis, were referred to another facility, or died during the study period, as these conditions could result in incomplete follow-up and inconsistent cost data. Data were extracted retrospectively from medical records, pharmacy databases, and hospital financial records. Collected variables included demographic characteristics (age and gender), clinical characteristics (underlying disease etiology and comorbidities), haemodialysis frequency, type of health financing, medication use, and direct medical costs related to haemodialysis treatment.

Measures

The primary outcome of interest was the total direct medical cost, defined as drug-related expenditures incurred from a healthcare provider (payer) perspective during the study period. Drug costs were calculated based on hospital pharmacy records and financial databases, reflecting the actual acquisition costs incurred by the hospital and reimbursed through the national health insurance system. These cost components were aggregated to represent the total direct medical cost per patient**,** and no separate subgroup analysis was conducted for each component. Independent variables included patient demographic and clinical characteristics, such as age, gender, underlying disease etiology, number of comorbidities, frequency of haemodialysis, and type of health financing.

Statistical Analysis

Data were analysed using IBM SPSS Statistics. Descriptive statistics summarized patient characteristics and cost distributions. Continuous variables were presented as mean and standard deviation, while categorical variables were expressed as frequencies and precentages. Inferential analysis was conducted to examine differences in total direct medical costs across patient characteristics. Given the non-normal distribution of cost data and the relatively

small sample size, the Kruskal-Wallis test was applied to compare costs between groups based on gender, age category, disease etiology, number of comorbidities, financing type, and frequency of haemodialysis. Inferential statistical tests were applied to explore associations between patient characteristics and drug-related expenditures. The level of statistical significance was set explicitly at $\alpha = 0.05$, and p-values < 0.05 were considered statistically significant. Missing data were present in the initial dataset; patients with incomplete medical, pharmaceutical, or financial records were excluded from the analysis. Therefore, the final analysis was conducted using complete-case analysis, including only patients with fully available data.

Ethical Considerations

Ethical approval was granted by the Health Research Ethics Committee of Universitas Harapan Bangsa (Approval Number: B.LPPM UHB/215/03/2024). All procedures were carried out in accordance with ethical principles, ensuring confidentiality and secure handling of patient data.

Result and Discussion

A total of 85 patients with stage 5 chronic kidney disease (CKD) undergoing haemodialysis (HD) were included in the analysis, after excluding 22 patients due to incomplete records, death, or discontinuation of treatment during the study period. Patients who died or discontinued haemodialysis were excluded to ensure consistency in cost measurement over the six-month study period and to avoid incomplete or truncated cost data that could bias cost estimates. As shown in **Table 1**, the gender distribution was nearly equal, with 50.6% of the patients being female and 49.4% male. The largest age group was 45–64 years (55.3%), followed by the 25–45 year group (25.9%) and those older than 64 years (18.8%). (BPJS), with only one patient (1.2%) self-financing. Nearly all patients (89.4%) underwent HD twice weekly, and 100% used elective dialyser reuse.

The total direct medical cost for CKD with HD over the six-month period from July to December 2023 was IDR 2,639,982,958.00, based on 4032 HD visit episodes. As shown in **Table 2**, this corresponded to an average six-month cost per patient of IDR 31,113,765.12 and an average cost of IDR 654,758 per haemodialysis visit. All cost estimates presented in this study reflect expenditures accrued during the six-month observation period and were not annualized. This figure underscores the substantial economic burden that CKD with HD imposes on the healthcare system, particularly within the framework of Indonesia's national health insurance scheme (BPJS), which covered 98.8% of patients in this study [14,20,21]. The consistent cost structure across patients reflects the standardized hospital reimbursement rates under the INA-CBG's system, a bundled payment model that offers little flexibility in tailoring costs to patient complexity [22]. While such systems promote efficiency and administrative simplicity, they may inadvertently obscure the heterogeneity in actual resource utilization among different patient groups.

An analysis was conducted to determine whether patient characteristics were associated with differences in total direct medical costs. As shown in **Table 3**, statistical analysis using the Kruskal-Wallis test revealed no significant association between total costs and gender ($p = 0.909$), age group ($p = 0.751$), disease etiology ($p = 0.267$), number of comorbidities ($p = 0.844$), type of financing ($p = 0.095$), or frequency of haemodialysis ($p = 0.110$). Although no statistically significant influence of patient characteristics including age, gender, comorbidity profile, underlying disease cause, financing type, or frequency of HD on the total direct medical costs incurred during treatment [23–25], notable trends included higher average costs among patients aged over 64 years (IDR 34,055,140.12), likely reflecting greater clinical complexity and increased polypharmacy needs associated with aging [21,26,27], those whose CKD was caused by conditions other than hypertension or diabetes (IDR 32,725,397.00), and those undergoing HD once a week (IDR 35,899,230.37) which may indicate late initiation of therapy, inadequate dialysis adequacy, or emergency interventions that increase medication load [28]. Although higher average costs were observed among patients undergoing haemodialysis once weekly and the single self-financed patient, these findings should be interpreted with caution. Given the very small sample sizes in these subgroups, the observed cost differences are exploratory in nature and are presented for descriptive purposes only. Patients covered by BPJS had an average cost of IDR 31,372,570.01, while the single patient who financed treatment independently incurred a substantially lower total cost. These patterns align with global findings that suggest older CKD patients often require intensified care, and irregular HD schedules can paradoxically escalate episodic costs due to compensatory medical needs [25].

Hypertension emerged as the leading cause of CKD among study participants (55.3%), which contrasts with international data where diabetes mellitus (DM) often dominates [29,30]. This is, however, consistent with

Table 1. Characteristics of CKD patients with Haemodialysis.

Characteristics	Frequency (N=85)	Percentage (%)
Gender		
Female	43	50.6%
Male	42	49.4%
	85	100%
Age		
>64 years	16	18.8%
45 – 64 years	47	55.3%
25 – 45 years	22	25.9%
	85	100%
Cause		
Diabetes Mellitus	16	18.8%
Hypertension	47	55.3%
Other	22	25.9%
	85	100%
Comorbidities		
>2 comorbidities	20	23.5%
2 comorbidities	4	4.7%
1 comorbidity	60	70.6%
Unknown	1	1.2%
	85	100%
Financing		
BPJS	84	98.8%
General	1	1.2%
	85	100%
Frequency		
1x/month	1	1.2%
1x /week	8	9.4%
2x/week	76	89.4%
	85	100%
Dialyser		
Re-use elective	85	100%
	85	100%

national data from the Indonesian Renal Registry, which reported hypertension as the primary cause in 35% of HD cases [31]. Patients with "other" etiologies, including kidney stones, gout, and benign prostatic hyperplasia, incurred the highest average costs an observation that may stem from the need for additional pharmacologic or procedural interventions. Although comorbidities were prevalent with over 98% of patients having at least one, no cost correlation was found between on the number of comorbid conditions and the cost. This finding may reflect the uniform medication protocols applied under national guidelines, regardless of the complexity of comordibities [32].

The dominance of BPJS as a payer is particularly noteworthy. Although a slight difference in mean cost was observed between BPJS-funded and self-funded patients, this was not statistically significant. This an be attributed to the consistent clinical pathway and cost containment

Table 2. Total Direct Medical Cost for CKD with HD period from July-December 2023.

Description	Visit Episode	Total Cost (IDR)	Average Cost		
			/year (IDR)	/mont(IDR)	/visit (IDR)
Hospital Cost	4032	2.639.982.958,00	31.113.765,12	5.185.627,52	654.758.900,00
INA-CBG's Cost	4030	2.554.247.256,00	30.049.967,72	5.008.327,95	633.808,00

mechanisms enforced by national health financing regulations, which ensure that reimbursement rates remain fixed across patient categories [33]. Nonetheless, the outlier cost for the single general-financed patient may indicate broader disparities in out-of-pocket expenditures not fully captured by our sample.

This study has several limitations. First, it was conducted in a single regional hospital with a relatively small sample size, which may limit the generalizability of the findings to other healthcare settings or regions. Second, only direct drug-related medical costs were evaluated; indirect costs (such as transportation, productivity loss,

Table 1. Characteristics of CKD Patients with HD Measures on Total Costs.

Patient Characteristics	Total Cost		
	Avg Cost (IDR)	Standard Deviation (IDR)	P-value
Gender			
Female	30.255.288,16	11.624.077,07	0.909
Male	31.881.084,92	15.305.677,84	
Age (years)			
25-45	31.576.735,00	12.477.915,74	0.751
45-64	29.796.011,61	11.563.566,03	
>64	34.055.140,12	19.477.982,90	
Cause			
Hypertension	26.472.192,25	15.445.634,84	0.267
Diabetes Mellitus	31.839.769,10	13.181.735,26	
Other	32.725.397,00	12.608.061,92	
Comorbidities			
1 comorbidity	31.345.031,96	13.010.350,80	0.844
2 comorbidities	31.497.988,00	6.864.938,90	
>2 comorbidities	30.505.494,84	16.803.919,15	
Unknown	26.842.343,00	8.829.614,09	
Financing			
BPJS	31.372.570,01	13.277.502,77	0.095
General	4.687.077.00	-	
Frequency of HD			
1x/month	6.600.907	-	0.110
1x/week	35.899.230,37	15.425.439,25	
2x/week	30.436.627,25	13.356.880,04	

*Continuous data are presented as mean ± standard deviation. Statistical comparisons of total direct medical costs between two independent groups (gender and financing type) were performed using the Mann Whitney U test, while comparisons among three or more independent groups (age category, disease etiology, number of comorbidities, and haemodialysis frequency) were conducted using the Kruskal Wallis test. All statistical tests were two-tailed, with the level of significance set at $\alpha = 0.05$

and caregiver burden) and non-drug healthcare expenses (e.g., laboratory tests, dialysis sessions, hospital stays) were not included, which likely underestimates the true economic burden. Third, the cross-sectional design using retrospective data limited our ability to assess the dynamic progression of the disease and it's long-term cost implications. Fourth, clinical severity, treatment adherence, and patient-reported outcomes were not measured, which could serve as important cost drivers. Future research should aim to incorporate broader cost components, larger and multicenter samples, and consider cost-effectiveness modeling to inform resource allocation within Indonesia's evolving universal health coverage framework

From a policy perspective, the findings highlight potential limitations of standardized INA-CBG reimbursement in capturing variations in resource utilization among haemodialysis patients. Although no statistically significant cost differences were observed, the descriptive variation across patient subgroups suggests that patient complexity may influence drug-related expenditures. Potential strategies to address this issue could include the incorporation of case-mix or risk-adjustment mechanisms within the INA-CBG framework, such as adjusting reimbursement based on patient age, comorbidity burden, or underlying disease etiology. Alternatively, supplementary or add-on payments for patients with higher clinical complexity may help reduce financial pressure on healthcare providers while maintaining equitable access to haemodialysis services. These approaches may improve the alignment between reimbursement and actual resource use, particularly in high-volume public hospitals operating under fixed payment systems.

Conclusion

This study highlights that while patient characteristics such as age, gender, comorbidities, underlying disease cause, and frequency of haemodialysis do not significantly affect direct medical costs, notable cost variations still exist across subgroups of CKD patients undergoing HD. The findings underscore the substantial financial burden of CKD treatment, predominantly borne by Indonesia's national health insurance system (BPJS), and emphasize the need for more nuanced cost assessments that account for patient complexity. Future research should expand on these results using multicenter data, broader cost components, and pharmacoeconomic modeling to support more equitable and efficient resource allocation.

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