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Pharmacoeconomic profile of patients with chronic kidney failure undergoing hemodialysis at a regional public hospital at Toto Kabila Gorontalo, Indonesia

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ABSTRACT

Introduction: One of the non-communicable diseases that requires significant costs due to its long treatment duration and expensive equipment is chronic kidney disease (CKD). The high cost of treatment for patients with CKD undergoing hemodialysis drives the need for a pharmacoeconomic review, as individuals face limited resources and treatment costs continue to rise over time.

Objectives: The aim of this study is to determine the total costs for CKD patients undergoing hemodialysis, analyze the minimal costs and cost-effectiveness, and to assess the utility of hemodialysis patients.

Patients and Methods: This study is an observational study using secondary data obtained from patient's medical records and hospital financial data, as well as primary data through interviews and questionnaires. The entire population was taken as a sample, consisting of 34 CKD patients undergoing hemodialysis. The cost of illness (COI) was determined by calculating the total costs, minimal costs by calculating fixed and variable costs, cost-effectiveness by calculating average cost effectiveness ratio (ACER) and incremental cost effectiveness ratio (ICER), and also cost-utility analysis (CUA) using the EQ-5D-5L and visual analog scale (VAS) questionnaires.

Results: The research results showed that the COI for hemodialysis patients was USD 3884.27. The antihypertensive drug amlodipine was the more cost-minimizing and most cost-effective option compared to candesartan. The average utility value for hemodialysis patients was 0.692 (feeling fairly healthy), and the VAS utility score was 72.3 (moderately healthy health status).

Conclusion: The pharmacoeconomic profile, including COI, cost minimization analysis (CMA), cost-effectiveness analysis (CEA), and CUA, are interrelated. The costs incurred by patients, along with the financial and health-related losses due to illness, impact the quality of life of CKD patients undergoing hemodialysis.

Implication for health policy/practice/research/medical education:
This study is a step to understand the pharmacoeconomic profile in a referral hospital in Gorontalo. Through this study, it is expected to contribute to the development of better strategies for managing kidney failure with hemodialysis by minimizing economic impact. It can also serve as a clinical practice guideline to assist physicians and pharmacists in selecting treatments that are not only clinically effective but also economical. More importantly, this research helps healthcare system managers, particularly BPJS (Health Social Insurance Administration Organization), to allocate funds more optimally.

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Introduction

A disease, whether infectious or non-communicable, will increase the burden on a population or nation. Non-communicable diseases had surpassed infectious diseases in terms of prevalence (incidence rate) in Indonesia, which was previously dominated by infectious diseases. Non-communicable diseases will burden the country with an increasing number of cases (1). Furthermore, the

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prevention and control of such diseases require significant costs due to their prolonged treatment and expensive equipment. Chronic kidney disease (CKD) is one of non-communicable diseases that demands substantial expenses for its prolonged treatment and expensive equipment, and thus categorized as a serious problem throughout the world (2).

Kidney failure remains a global health issue. In Indonesia alone, the prevalence of CKD based on data from the 2018 is 0.38% (3). Given Indonesia's population of 252 124 458 meaning 713 783 individuals suffering from this disease (4). In Gorontalo province, the percentage of the disease was 3.8% (5). Kidney failure is a long-term condition where the kidneys no longer function properly. In the medical field, kidney failure is categorized into acute kidney failure and chronic kidney failure (6) CKD is defined as a decrease in kidney function with an estimated glomerular filtration rate [eGFR] <60 mL/min/1.73 m^2, and often indicated by the appearance of proteinuria for three months (7).

Chronic kidney disease, like other illnesses, gradually progresses to a worse condition and can lead to complications for the patient (8). Several potential complications in patients with CKD include hypertension, hyperkalemia, heart disease, anemia, and bone disease (9). This disease has two main causes, one of which is hypertension. This is in accordance with the finding that hypertension is very common in CKD, especially in patients with end-stage renal disease and undergoing hemodialysis (10). So far, there are three treatment interventions applied to CKD patients, namely hemodialysis, kidney transplantation, and peritoneal dialysis. The most frequently chosen replacement procedure for this disease throughout the world, including Indonesia, is hemodialysis (5).

Various therapies are used for CKD, considering both cost factors and pharmacoeconomic evaluations, including cost of illness, cost minimization analysis (CMA), cost effectiveness analysis (CEA), and cost utility analysis (CUA) (11). As more treatments are used, costs increase, making pharmacoeconomic analysis crucial to aid in decision-making for therapy (12). In pharmacoeconomic studies, cost is always an important consideration because of the limited resources of each individual, especially in terms of funds. Therefore, pharmacoeconomic studies are a commonly used method to determine the economic impact of alternative drug therapies or other health interventions, including the medications used (13).

The high cost of treatment is an interesting thing because medical costs are increasing over time. Therefore, the application of pharmacoeconomic principles in drug use is important (14). Pharmacoeconomics can be described as the science that identifies, measures, and compares the costs and therapeutic outcomes of drugs and pharmaceutical services. It assesses whether the extra cost of an intervention is worth its added benefits. Pharmacoeconomics is important for determining the value of high-cost treatments (15).

The economic burden on CKD patients can be determined from the cost of treatment for one year or a lifetime, the cost of productive days lost due to treatment, and the cost of dealing with disease complications and premature death (16). Therefore, this study aimed to determine the pharmacoeconomic profile including cost of illness, CMA, CEA, and CUA of CKD patients undergoing hemodialysis at the Toto Kabila regional general hospital. It is hoped that the results of this research can be a source of insight in choosing priority treatment strategies which provide more rational drug treatment outcomes, the best therapeutic recommendation, as well as providing information about the benefits of the intervention (17).

In general, previous studies only analyzed one of all the parameters of the pharmacoeconomic method for a particular patient, for example only studying cost of illness (COI), or CEA, while current study analyzes the parameters as a whole, namely COI, CMA, and CUA, which are very important to see their influence on the perspective of health providers and the perspective of the patients themselves.

Objectives

This study aims to determine the total costs for CKD patients undergoing hemodialysis (COI), analyze the minimal costs (CMA) and cost-effectiveness (CEA), and assess the utility of hemodialysis patients (CUA). The objective of this study was to determine the pharmacoeconomic profile including COI, CMA, CEA, and CUA of CKD patients undergoing hemodialysis at the Toto Kabila regional general hospital.

Patients and Methods

Study design

This study was an observational investigation using secondary data from patient medical records and hospital financial data, where the data collected through interviews and questionnaires. The study population consisted of 34 CKD patients undergoing hemodialysis, with the entire population serving as the sample. The researchers compared the use of oral drugs amlodipine and candesartan, the hemodialysis methods using Erythropoietin (Epodion and Hemapo brands) (18).

The COI determination relied on direct and indirect cost data by calculating fixed costs (costs of hemodialysis procedures and medical service costs) and variable costs (costs of antihypertensive drugs and laboratory costs). The CMA and CEA were conducted using direct cost data obtained from the hospital's finance department where CEA is determined by calculating the average cost effectiveness ratio (ACER) and incremental cross effectiveness ratio (ICER) values (19,20). The utility cost analysis was derived from the results of the EuroQol-Five dimensions (EQ-5D-5L) and visual analog scale (VAS) questionnaires (21,22).

Statistical analysis

The analysis used for this study includes descriptive analysis for COI and CMA to calculate fixed costs and variable costs, CEA using the ACER and ICER, and CUA using mean and standard deviation based on the EQ-5D-5L instrument.

Results

Demographics of hemodialysis patients

The demographic data of patients with CKD undergoing hemodialysis at Rumah Sakit Umum Daerah (RSUD) Toto Kabila regional general hospital is as presented in Table 1.

Direct medical and direct non-medical costs of hemodialysis patients

The direct medical and direct non-medical costs of patients with CKD undergoing hemodialysis at RSUD Toto Kabila regional general hospital is as presented in Table 2.

Indirect medical costs of hemodialysis patients

The indirect medical costs of patients with CKD undergoing hemodialysis at RSUD Toto Kabila regional general hospital is as presented in Table 3.

Cost of illness of hemodialysis patients

The COI of patients with CKD undergoing hemodialysis at RSUD Toto Kabila regional general hospital is presented in Table 4.

The effectiveness of anti-hypertension medication of hemodialysis patients

The effectiveness of anti-hypertension medication of patients with CKD undergoing hemodialysis at RSUD Toto Kabila regional general hospital is as presented in Table 5.

Cost minimization of hemodialysis patients

The average cost of the direct medical of patients with CKD undergoing hemodialysis at RSUD Toto Kabila regional general hospital is as presented in Table 6.

ACER and ICER calculation results of hemodialysis patients

The ACER and ICER calculation results of hemodialysis patients with CKD undergoing hemodialysis at RSUD Toto Kabila regional general hospital is as presented in Table 7.

Table 1. Demographic data of patients with CKD undergoing hemodialysis

Demographics		Number of patients	Percent
Gender	Male	22	65
	Female	12	35
Age (y)	26-35	2	6
	36-45	4	12
	46-55	15	44
	56-65	10	29
	>65	3	9
Educational background	Elementary school	7	21
	Junior high school	7	20
	Senior high school	13	39
	Diploma/bachelor	7	20
Employment status	Employed	20	58
	Unemployed	14	42

Table 2. Direct medical and direct non-medical costs of patients with CKD undergoing hemodialysis

Cost components		Total costs (USD)	Average (USD)
Direct non-medical cost	Transportation	75.43	2.22
Direct medical cost	Administration	153.97	4.53
	Specialist doctor	207.85	6.11
	Laboratory	415.72	12.23
	Pharmacy	554.29	16.30
	Technician	692.86	20.38
	Attending physician	207.85	6.11
	Nurse	803.72	23.64
Total costs		3036.64	89.31

Table 3. Indirect medical costs of patients with CKD undergoing hemodialysis

Indirect medical cost components	Total cost (USD)	Average (USD)
Patient's lost income	400.12	11.77
Caregiver's lost income	372.63	10.96
Total cost	772.7	22.73

Table 4. Analysis results of the cost of illness of patients with CKD undergoing hemodialysis

Cost of illness	Total costs (USD)
Direct costs	3.115
Indirect costs	774
Total costs	3.889

EQ-5D-5L and EQ-VAS utility scores of hemodialysis patients

The EQ-5D-5L and EQ-VAS utility scores of hemodialysis patients with CKD undergoing hemodialysis at RSUD Toto Kabila regional general hospital is as presented in Table 8.

Discussion

Demographics of hemodialysis patients

The data in Table 1 shows that the number of male patients is greater than that of female patients. This is because men's lifestyles are more at risk of experiencing CKD due to lack of drinking water, smoking habits and drinking alcoholic beverages. This is in accordance which states that 56% of male patients (17 133 patients) were more than female patients, which was only 44% (13 698 patients). Men are more at risk of developing CKD due to their low levels of the hormone estrogen which functions as protection for the kidney blood vessels, as well as high protein intake and smoking (15,23).

The study results showed that the majority of patients undergoing hemodialysis therapy at RSUD Toto Kabila regional general hospital were in the age range of 46-55 years. This trend is attributable to the fact that individuals in this age group often exhibit unhealthy dietary patterns and a lack of physical exercise. This finding is in line with the data from the (9), which indicated that in 2014, the highest percentage of hemodialysis patients fell within the 45-54 years and 55-64 years age groups, each comprising 31%. This distribution is consistent with the general demographic of CKD patients in Indonesia. Clinically, individuals over the age of 40 years are 2.2 times more likely to develop chronic kidney failure compared to those under 40 years. Aging contributes to a decline in kidney function, characterized by a reduced GFR and deteriorating tubular function. The increased incidence of CKD with advancing age is primarily due to the natural decline in GFR associated with the aging process (24).

The results of the study showed that the educational background of most patients was high school, male patients by 27% and female patients by 12%. This is due to the patient's lack of knowledge, where the higher the patient's knowledge, the smaller the risk of kidney failure. The results of this study are in line with the results

Table 5. The effectiveness of antihypertensive medication of patients with CKD undergoing hemodialysis

Antihypertensive medication	Patients as users		Effectiveness	
	Total	Percent	Reaching target	Percent
Amlodipine	20	59	11	55
Candesartan	14	41	6	42.85

Table 6. Direct medical cost average of patients with CKD undergoing hemodialysis

Antihypertension medication	Total direct medical cost (USD)	Average of antihypertension medication price (USD)	Average of hemodialysis cost (USD)	Average of laboratory cost (USD)	Average of medical services cost (USD)	Average of total cost (USD)
Amlodipine	113,294.27	62.65	4672.00	28.13	901.93	5664.71
Candesartan	81,251.71	201.63	4672.00	28.13	901.93	5803.69

Table 7. ACER and ICER calculation results

Antihypertensive Medication	Total cost per patient (USD)	Effectiveness	ACER	ΔC	ΔE	ICER (ΔC/ΔE)
Amlodipine	5664.71	55	1,683,964.89	-2272.320	12.15	-187.022
Candesartan	5803.69	42.85	2,214,478.16			

Table 8. List of EQ5D5L and VAS Score value responses

Dimension	Level (%)				
	1	2	3	4	5
Mobility	84	6	2	2	6
Self-care	71	20	4	2	3
Usual activities	54	28	12	5	1
Pain or discomfort	21	39	30	10	0
Anxiety or depression (sadness)	70	20	10	0	0
Average value of utility			0.692		
VAS score			72.3		

of research conducted by which stated that of the 35 respondents with chronic kidney failure at PMI (Palang Merah Indonesia) Bogor city hospital, less than half of 13 respondents (37%) had a high school education (25).

Based on the employment status, data from the study results showed that most patients were employed (58%). Busy working and losing track of time causes a lack of water consumption. The 35 respondents with chronic kidney failure at PMI city hospital, 66% (23 respondents) were employed. Different types of work can impact the frequency and distribution of diseases. It's not widely recognized that certain job/occupations can lead to kidney failure, such as office workers with prolonged sitting, which can compress the ureter in the kidneys. Additionally, daily activities like working in hot temperature environment and engaging in strenuous labor, where sweating is common, can increase the risk of dehydration. Dehydration can lead to concentrated urine, potentially causing kidney disease (26,27).

Direct medical and direct non-medical costs of hemodialysis patients

The costs in this study were categorized into direct costs and indirect costs. Direct costs referred to all expenses related to medical service provision from the perspective of the healthcare provider, namely the health social insurance administration organization (known as BPJS Kesehatan). These included administrative costs, specialist doctor fees, laboratory fees, pharmacy costs, technician fees, attending physician fees, and nursing fees. Indirect costs, on the other hand, were expenses incurred by the patient. These included transportation costs, lost patient income, and lost income of the caregiver (28,29).

Table 2 shows that the largest direct medical cost is the nursing cost, amounting to 804.80 USD while the lowest cost is the administrative cost, amounting to 154.18 USD. The direct non-medical costs consist of transportation expenses, total amounting to 75.54 USD. In this aspect, the direct medical costs amount to 3040.35 USD. The average expenditure for all patients per month during hemodialysis therapy was 2.22 USD per patient, with a total of 34 patients undergoing therapy in the hospital's hemodialysis unit amounting to 3040.35 USD. Comparing with the research finding of the total direct medical and non-medical costs amount to 12842.39 USD The substantial difference was attributed to the varying doctor fees and transportation costs across provinces, leading to a significant disparity (9,28–30).

Indirect medical costs of hemodialysis patients

Indirect costs are a number of costs associated with the loss of productivity due to suffering from an illness, including the cost of lost productivity, the cost of companions (family members who accompany the patient) (31) The assessment of lost productivity needed to measure the extent of income loss during illness. Our study results showed that the patient's lost income of 400.61 USD with an average of 11.78 USD and caregiver's lost income of 373.09 USD with an average of 10.97 USD. The total indirect cost component is 773.70 USD with an average of 22.76 USD. When compared with the results of research by Alaklobi et al (12), indirect costs were on average 14.06 USD per patient care episode. The loss of income of 22.76 USD is very significant because the average income per person in Gorontalo province is still very low, which means that the loss of income of 22.76 USD is a burden for them.

Cost of illness of hemodialysis patients

According to the Indonesian Ministry of Health, healthcare-related costs generally be classified into direct costs and indirect costs where direct costs include the price of medication and medical supplies, doctor consultations, nursing services, hospital facility usage, laboratory tests, informal services, and other health-related expenses; while indirect costs comprise lost productivity and the costs incurred by caregivers (family members accompanying the patient) (32).

The data in Table 4 shows that direct medical cost is 3115.89 USD while indirect medical cost is 773.70 USD. If calculated, the value of direct medical cost and indirect medical cost is 3889.59 USD, then the value of the COI is 3889.59 USD. In this study, the direct medical cost is greater than indirect medical cost. The direct medical cost is greater than indirect medical cost. However, this is not in accordance with research conducted which states that indirect medical cost is greater than the medical direct cost (21).

The effectiveness of antihypertension medication of hemodialysis patients

Based on the research conducted at the hospital, it was found that hemodialysis was performed twice a week, with antihypertensive medication administered weekly. The types of anti-hypertensive used by patients were amlodipine from the calcium channel blocker (CCB) class and candesartan from the angiotensin receptor blocker (ARB) class. The antihypertensive agents used align with the guidelines of the eight joint national committee on hypertension 2014 (33). The antihypertensive treatment for CKD patients with hypertension is expected to effectively lower blood pressure. In this study, the effectiveness or outcome measured was the reduction in blood pressure after treatment. The target blood pressure for CKD patients with hypertension is <140/90 mm Hg.

The use of amlodipine by 20 patients with a target achievement percentage of 55%, while candesartan was used by 14 patients with a target achievement percentage of 42.85%. It can be inferred that the therapy effectiveness of the amlodipine group is higher compared to candesartan. This research result aligns with where the effectiveness percentage of amlodipine was higher (63.64%), than the effectiveness percentage of candesartan (56.25%). Similarly, the research by Aisara et al stated that the effectiveness percentage of amlodipine was 80.64% compared to candesartan at 35.48% (15). Amlodipine is a CCB class. This drug works by inhibiting the entry of calcium ions into the blood vessels and heart, resulting in vasodilation and lowering blood pressure (16). This agent is the most commonly prescribed drug in hemodialysis patients. It has unchanged pharmacokinetics in patients with end-stage renal disease on hemodialysis. Amlodipine is one of the most widely prescribed drugs because it has a renoprotective effect by reducing renal vascular resistance and increasing blood flow to the kidneys without changing glomerular filtration rate and is slightly eliminated in the kidneys (17). Amlodipine has been shown to be well tolerated in renal impairment and the half-life in patients with renal failure does not change, hence once-daily amlodipine can be used for all degrees of renal function and dose adjustment is not required (18). Candesartan belongs to the ARB group. This group is a group of drugs that are antagonistic to angiotensin II, Therefor it has a working mechanism, namely occupying the angiotensin II receptor which has vasoconstrictive properties (34). Therefore, blood pressure can be lowered. Candesartan is the second most widely used ARB drug because it has good renal hemodynamic effects by increasing renal blood flow and maintaining or increasing the glomerular filtration rate while reducing renal vascular resistance and filtration fraction (35). The first line therapy in CKD patients undergoing hemodialysis with hypertension is the ARB drug class. However, ARB (candesartan) is given when the patient cannot or is contraindicated with ACE-I. Meanwhile, based on the eight joint national committee of hypertension 2014 guidelines, it states that in hypertensive patients with kidney disease, initial antihypertensive therapy should include the ARB or ACE-I group to improve kidney outcomes. This applies to all CKD patients with hypertension (36).

Cost minimization of hemodialysis patients

The total cost is the total cost of patient therapy for twelve months of hemodialysis, which includes; the cost of antihypertensive drugs, the cost of hemodialysis, the cost of medical services and laboratory costs. The total direct medical costs are incurred by the health service provider, namely BPJS Kesehatan, for twelve months. The cost of antihypertensive drugs is calculated by multiplying the number of antihypertensive therapy uses over 12 months. Meanwhile, the cost of medical includes the incentives for doctors and nurses on duty at the hospital (15).

The data in Table 6 shows the average direct medical costs for patients undergoing hemodialysis using health insurance services (known as BPJS Kesehatan) at the hospital. The average costs were obtained by dividing the total overall costs for all patients over twelve months by the number of patients in each drug group. The results obtained for the antihypertensive therapy group with amlodipine were 5665.00 USD, while for the candesartan therapy group, it was USD 5803.69, indicating that the average direct medical costs in the candesartan group are higher than amlodipine. It indicates that amlodipine has lower costs compared to candesartan. The higher price of candesartan was influenced by the difference in drug prices, where the price of amlodipine 10 mg per strip was 1.31 USD while the price of candesartan 8 mg per strip was 4.20 USD. The difference in total therapy costs from direct medical costs is due to the different types of antihypertensive medication used, as well as the presence of comorbidities that may affect other financing aspects. This is consistent with the findings where the average use of candesartan antihypertensive was higher (2.14 USD) compared to amlodipine (0.12 USD). This is attributed to the difference in drug prices per unit (35,37).

ACER and ICER calculation results of hemodialysis patients

Cost-effectiveness analysis is a way to select and assess the best program or drug when there are several options with the same goal (20). Cost-effectiveness analysis is carried out by determining the ACER. The implementation of the study was based on the perspective of the BPJS Kesehatan services, and hence the direct medical costs was calculated. Direct medical costs include the cost of antihypertensive drugs, the cost of hemodialysis procedures, laboratory costs, and medical service costs.

The ACER value in the amlodipine therapy group was 103.03 USD with 11 patients reaching the blood pressure target (out of 20 patients). The ACER value in the candesartan therapy group was 135.45 USD with

6 patients reaching the blood pressure target out of (14 patients). Thus, it can be concluded that the amlodipine antihypertensive group is more cost-effective compared to the candesartan therapy group. The smaller the ACER value, the more cost effective the alternative drug is based on the ICER calculation results, a negative result was obtained, namely -187.022. The incremental cost-effectiveness ratio is the cost that must be incurred to increase effectiveness by switching from one treatment to another. The ICER value in this study was obtained from a comparison between the difference in total direct medical costs for each group and the difference in clinical outcome (target blood pressure), or from the amount of additional costs required to obtain the outcome per unit. The negative results from the ICER calculation indicate that antihypertensive therapy with amlodipine in chronic renal failure patients undergoing hemodialysis provides more cost-effective results compared to candesartan antihypertensive therapy. The therapy can be said to be more effective and cheaper if the ICER value produces negative or close to negative results (38).

In order to strengthen the results of the ACER value calculations that have been obtained, a comparison of cost effectiveness was carried out as presented in Figure 1.

Figure 1 shows that, in the quadrant I column, there is no placement of antihypertensive therapy used in chronic renal failure patients with hypertension. The cost-effectiveness diagram can be interpreted as: if an alternative is more expensive and more effective than the standard comparator, then the point is in quadrant I; if the alternative is cheaper and more effective, then the point will be in quadrant II. In this study results, the quadrant II column was occupied by amlodipine antihypertensive therapy. Amlodipine antihypertensive is considered to be more effective because it has a high effectiveness with a percentage of 55% with an ACER value of 103 USD If an alternative is cheaper but less effective, then the point will be in quadrant III. In this study results, the quadrant III column also did not have any placement of antihypertensive therapy used in antihypertensive patients. But, if it is more expensive and less effective, then the point will be in quadrant IV, therefore, this column was occupied by candesartan antihypertensive therapy because candesartan antihypertensive had an ACER value of 135.44 USD, which was higher than amlodipine with a percentage effectiveness of 42.85%, which was lower than amlodipine. Therefore, it can be concluded that based on the quadrant II column, the use of antihypertensive amlodipine can be the main choice because it has higher effectiveness with the lowest cost. In addition, quadrant IV was not chosen as the main choice because if a health intervention offers lower effectiveness with higher costs, then it is not worthy of being chosen as an alternative therapy (31).

EQ-5D-5L and EQ-VAS utility scores of hemodialysis patients

In this study, utility or patient satisfaction measurements were also carried out with CKD using the EQ5D5L and EQ-VAS questionnaires with the aim of seeing patient satisfaction after receiving hemodialysis intervention, considering that CKD patients experience a heavy burden during treatment (30). Table 8 showed that the average value of utility for CKD patients undergoing hemodialysis at the hospital was 0.692, indicating that patients feel relatively healthy with renal replacement therapy, where utility measurement uses a scale of 0 = dead and 1 = healthy. From the data, it was found that patients mostly experience problems in the pain and discomfort dimension due to high uric acid levels in the blood serum caused by kidney damage, leading to a decrease in patients' quality of life as they have to change their daily habits. The EQ-5D VAS score of 72.3 indicates that the health status experienced by the patients is at a satisfactory level, approaching optimal health, which is represented by a score of 100. The EQ-VAS records respondents' self-

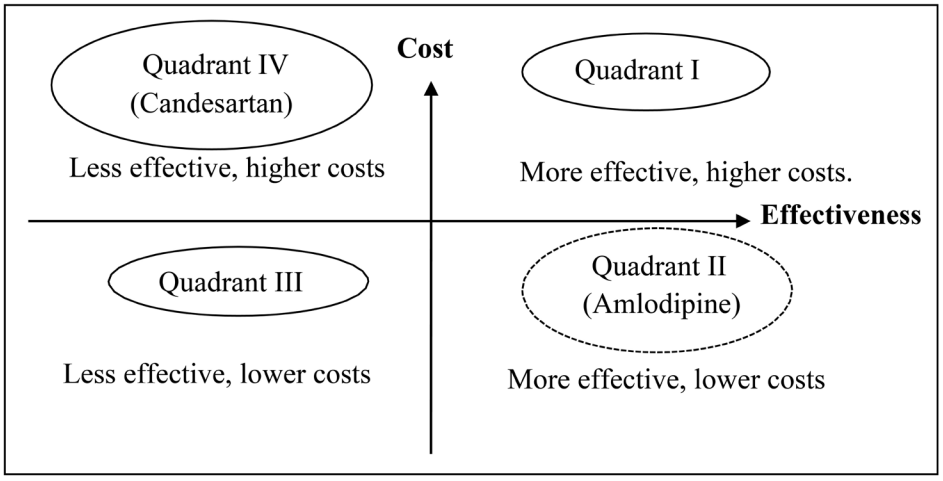

Figure 1. Cost-effectiveness diagram of antihypertensive therapy.

health assessment on a visual analog scale from 0 to 100, where 0 represents the worst health imaginable by the patients, and 100 represents the best health imaginable by CKD patients. The study which obtained an average EQ-VAS score of 74.3, indicating that the quality of life of CKD patients is relatively good. The utility value of hemodialysis patients at RSUD Aloe Saboe Gorontalo had an average value of 0.673 and a VAS score of 71.4 (20,21).

Analysis results of COI, CMA, CEA and CUA provide an overview that the COI for the Gorontalo area is relatively lower compared to other areas in Indonesia; the CMA and CEA parameters shows that drugs that are more expensive are not necessarily cost effective for the treatment of hypertension patients undergoing hemodialysis. The study shows that lost costs are high in the Gorontalo area, which impacts patient satisfaction. Despite this, patients feel relatively healthy, as indicated by their VAS scores which shows that the patient's health status is quite healthy.

Conclusion

Based on study of the pharmacoeconomic profile of patients with CKD undergoing hemodialysis, it can be concluded that the direct medical cost is greater than indirect medical cost, the average utility cost indicating a fairly health status, the VAS utility value indicating a fairly healthy status, and amlodipine emerged as the cost-minimizing and most cost-effective choice of anti-hypertensive drugs compared to candesartan.

Limitations of the study

The limitation of this study is that it only examines one government-owned hospital with a limited sample size, which may only represent the pharmacoeconomic profile of CKD patients undergoing hemodialysis in one province in Indonesia

Authors' contribution

Conceptualization: Madania Madania.
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Visualization: Siti Nur Maghfira.
Writing–original draft: All authors.
Writing–review & editing: All authors.

Conflicts of interest

The authors declare that they have no competing interests.

Ethical issues

The research conducted in this study adhered to the principles outlined in the Declaration of Helsinki and was approved by the Ethics Committee of Universitas Negeri Gorontalo (Ethical code #008A/UN47.B7/KE/2024). Prior to any intervention, all participants provided written informed consent. The study was extracted from COI in Hemodialysis Patients at RSUD Toto Kabil Cost-Effectiveness Between Amlodipine and Candesartan in Hemodialysis Patients at RSUD Toto Kabila thesis in the department of Pharmacy Universitas Negeri Gorontalo. The authors have fully complied with ethical issues, such as plagiarism, data fabrication, and double publication.

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