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A COST EFFECTIVENESS ANALYSIS OF SINGLE USE AND REUSE DIALYSER UTILIZATION IN HEMODIALYSIS SERVICES FOR KIDNEY FAILURE PATIENTS AT HOSPITAL X STABAT

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Abstract. The prevalence of Chronic Kidney Disease sufferers globally, including Indonesia, has increased every year. According to the 2018 Basic Health Research data, the prevalence of Chronic Kidney Disease in Indonesia is 0.38% of the population of Indonesia or around 713,783 people. The Indonesian Nephrology Association said that the use of reuse dialyzers is permitted with a maximum limit of 7 times of use, Indonesian 2 Renal Registry data shows that reuse dialyzers are mostly used with a frequency of 1-5 times. Manual cleaning of single-use and reuse dialyzers can have an impact on several aspects, including: dialysis adequacy and risk of infection. Putri Bidadari Hospital, Stabat has a problem with changing the reuse dialyzer to single use because if you use reuse, the used equipment is washed again. So by switching to single use, it is hoped that the output of hemodialysis will be better. However, by switching to single use, there is a possibility of additional/reduced costs per patient for each hemodialysis. This study aims to analyze the Cost Effectiveness of Using Single Use and Reuse Dialyzers for Hemodialysis Services for Kidney Failure Patients at Putri Bidadari General Hospital, a cross-sectional quantitative research design with a prospective and retrospective approach, involving 160 patients in 2023. Data were analyzed using Cost Effectiveness Analysis (CEA). The results of the analysis show that the cost efficiency of the Reuse dialyzer is proven to be lower than the Single Use dialyzer. While in producing changes in the outcome of creatinine, urea, and hemoglobin, the single use dialyzer is more effective than the reuse dialyzer. Hospitals also need to conduct an evaluation of the environmental impact of using both types of dialyzers, including medical waste and energy consumption.

Keywords: dialyzer; chronic renal failure; hemodialysis; pharmacoeconomics

I. INTRODUCTION

Chronic Kidney Failure Disease is a non-communicable disease (NCD) but has a major impact on high morbidity and mortality as well as socio-economics of the community because the cost of therapy is quite high and repeated [1]. The prevalence of Chronic Kidney Failure Disease sufferers globally, including Indonesia, has increased every year. According to the 2018 Basic Health Research (Riskesdas) data, the prevalence of Chronic Kidney Failure Disease in Indonesia is 0.38% of the population of Indonesia or around 713,783 people (Ministry of Health of the Republic of Indonesia, 2019b). Based on the results of a survey conducted by the Indonesian Nephrology Association [2], it is estimated that around 12.5% of the Indonesian population or 25 million people will experience decreased kidney function. Based on the 2021 [2]. the use of reuse dialyzers is permitted with a maximum limit of 7 times of use. Data from the Indonesian 2 Renal Registry (IRR) shows that reuse dialyzers are mostly used with a frequency of 1-5 times. Manual cleaning of single-use and reuse dialyzers can have an impact on several aspects, including: dialysis adequacy and Infection Risk. Single-use dialyzers are generally considered more effective in achieving dialysis adequacy because the cleaning process is more controlled and consistent. This can help ensure that patients receive optimal blood cleansing during hemodialysis. Reuse dialyzers the effectiveness of manual cleaning of reuse dialyzers can vary depending on the method and expertise of the person performing it. If not done properly, reuse dialyzers may not achieve the same level of cleaning as single-use dialyzers, which can result in suboptimal dialysis adequacy. Single-use dialyzers Have a lower risk of infection because the dialyzer is only used once and then discarded. This minimizes the possibility of cross-contamination between patients. Reuse dialyzers Carry a higher risk of infection because the dialyzer is used repeatedly.

Single-use dialyzer has a higher cost because a new dialyzer is used for each hemodialysis. Reuse dialyzers help save costs because the dialyzer can be used repeatedly. However, additional costs for sterilization, maintenance, and monitoring of the reuse dialyzer need to be considered. Environmental impact of single-use dialyzers Generates more medical waste because the dialyzer is discarded after one use. Reuse dialyzers can help reduce medical waste because the dialyzer is used repeatedly. The increase in the need for medical funds has a negative impact on access and quality of health services, so an alternative is needed to overcome this problem.

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In the era of National Health Insurance (JKN), health financing at Advanced Referral Health Facilities (FKRTL) has used the Indonesian Case Based Group (INA-CBGs) tariff, where its implementation is through a social insurance mechanism. However, real costs are often found to be greater than the INA-CBGs tariff [3]. The Ministry of Health of the Republic of Indonesia in 2017 stated that the total cost of hemodialysis in 2012 covered by PT Askes and other insurance was IDR 227 billion (US$ 15 million). This cost is one of the medical procedures that absorbs the largest portion, causing financial pressure on the national financial system (Kristina et al., 2021). The average cost of hemodialysis therapy covered by PT Askes reached IDR 56,501,237.90 and the average cost of hemodialysis therapy covered by each patient reached IDR 6,042,141.18 each year [4].

According to a 2017 study published in the Indonesian Public Health Journal, the average cost of one hemodialysis session in Indonesia is estimated at around IDR 23,732,520.02 ± IDR 19,142,379.09 for inpatients without surgery and IDR 12,800,910.61 ± IDR 6,409,290.00 for inpatients with surgery. Total Cost Estimate in 2023, Assuming an average cost of IDR 20,000,000 per hemodialysis session and 132,142 patients, the total estimated cost for hemodialysis in Indonesia in 2023 is IDR 20,000,000/session x 132,142 patients = IDR 2,642,840,000,000. Based on the results of an initial survey conducted at RS. Putri Bidadari, Stabat, the amount of costs and number of patients were found based on the Reuse and single use categories as shown in TABLE I. below.

Table 1. Total costs and number of patients based on the Reuse and single use categories at RSU Putri Bidadari Stabat in 2023

No	Month	Number Of Patients	Total Cost	Information
1	Jan-23	216	220,793,014	Reuse
2	Feb-23	186	192.070.735	Reuse
3	Mar-23	226	230,054,638	Reuse
4	Apr-23	240	251,550,327	Reuse
5	May-23	264	270,481,170	Reuse
6	Jun-23	256	265,834,541	Reuse
7	Jul-23	255	268,666,260	Reuse
8	Aug-23	291	315,610,482	Reuse
9	Sep-23	290	307,723,871	Reuse
10	Oct-23	290	365,422,275	Single Use
11	Nov-23	291	365.166.657	Single Use
12	Dec-23	307	395.257.905	Single Use
13	Jan-24	339	430.155.533	Single Use
14	Feb-24	336	550.202.224	Single Use
15	Mar-24	359	592,820,250	Single Use
16	Apr-24	346	592,804,186	Single Use
17	May-24	331	568,885,337	Single Use
18	Jun-24	301	502,888,017	Single Use

Based on an initial survey conducted at RS Putri Bidadari Stabat, the problems encountered through the interview method Changes from reuse to single use are because if you use reuse, the equipment that has been used is washed again. So, by switching to single use, it is expected that the output of hemodialysis will be better. However, by switching to single use, there is a possibility of additional/reduced costs per patient for each hemodialysis performed. Dialysis adequacy can be measured through the Kt/V value. Based on the NKF/K-DOQI recommendation, the targeted Kt/V value for patients on three-times-a-week hemodialysis is 1.2, but hemodialysis in Indonesia is generally performed twice a week.[5].

II. RESEARCH METHODS

This study used a cross-sectional design, using secondary data from medical records of chronic kidney failure patients undergoing hemodiliasis at Hospital X Stabat. Data collection was carried out retrospectively and prospectively. The research was conducted at the Hospital.X Stabat the population of this study was all patients with chronic kidney failure undergoing hemodialysis at Hospital X Stabat, totaling 160 people. The sampling technique in this study used Purposive Sampling, which is a sampling technique based on criteria determined by the researcher (inclusion criteria and exclusion criteria). The sample is the population of this study from January 2023 to December 2023 that meets the inclusion criteria and exclusion criteria consisting of 80 reuse patients and 80 single use patients.

Chronic kidney failure patients undergoing hemodialysis. Chronic kidney failure stage 5 patients, Patients aged ≥ 18 years, Patients undergo regular hemodialysis with a minimum frequency of twice a week., Use of reuse dialyzer 5 times

The number of samples that have met the inclusion and exclusion criteria is 120 patients. Divided into 30 patients using single-use A dialyzers and 30 single-use B patients, 30 reuse A dialyzer patients and 30 reuse B dialyzer patients during 2023. To determine the effectiveness of treatment data from both dialyzer uses, including collecting medical record data, collecting data in the finance department, collecting data in the pharmacy installation and direct interviews through questionnaires to patients to measure quality of life. Analysis of treatment effectiveness is carried out by looking at changes in creatinine, urea and hemoglobin values and how much direct costs are incurred during treatment at Hospital X Stabat. Measurement of quality of life (Quality of Life) using the European Quality of Life-5 Dimension-5 level (EQ-5D-5L) instrument which has been translated into Indonesian and has been previously validated, consisting of 5 dimensions, namely the mobility dialyser reuse dimension in addition to safety also reducing costs over a period of 12 months, dialyser reuse can be a safe alternative from the patient's perspective and dialysis cost savings from the perspective of hospital management [6]. (mobility), self-care, usual activity, pain/discomfort, and anxiety/depression.

III. RESULTS AND DISCUSSION

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Characteristics of Research Subjects The total number of patients with kidney failure undergoing hemodialysis is mostly female subjects with a total number of 41 people using single-use dialyzers (51%). While those using reuse dialyzers are mostly male, 47 people (59%). The highest age range of kidney failure patients is over 50 years old, namely those using single dialyzers as many as 51 people (63.7%) while those using reuse dialyzers are 52 people (65%). Based on the education of patients who experience kidney failure, the most educational background is junior high school, both those using single-use and reuse dialyzers. Based on the occupation of patients who experience kidney failure, the most who use single or reuse dialyzers work as housewives. The largest proportion of kidney failure patients are patients undergoing hemodialysis <1 year. (TABLE II)

Table 2. Characteristics of Research Subjects of Hemodialysis Patients Using Single Use and Reuse Dialyzer TypesBidadari Princess Hospital, Stabat.

Data	*Single Use*		*Reuse*	
Gender	N	%	N	%
Man	39	49%	47	59%
Woman	41	51%	33	41%
Total	**80**	**100%**	**80**	**100%**
Age				
20-29 years	3	3.8%	3	3.8%
30-39 years	7	8.8%	7	8.8%
40-49 years	19	23.7%	18	22.5%
>50 years	51	63.7%	52	65%
Total	**80**	**100%**	**80**	**100%**
Education				
Bachelor degree)	2	2.5%	6	7.5%
Elementary School (MI)	9	11.25%	14	17.5%
Junior High School/Islamic Junior High School	62	77.5%	38	47.5%
High School/Vocational High School	7	8.75%	22	27.5%
Total	**80**	**100%**	**80**	**100%**
Work				
Private sector employee	30	37.5%	28	35%
civil servant	5	6.25%	7	8.75%
Not yet working	3	3.75%	9	11.25%
Housewife	34	42.5%	28	35%
Farmer	8	10%	8	10%
Total	**80**	**100%**	**80**	**100%**
Hemodialysis Duration				
<1 year	74	92.5%	68	85%
1-3 years	3	3.75%	5	6.25%
>3 years	3	3.75%	7	8.75%
Total	**80**	**100%**	**80**	**100%**

The results of this study are in line with research conducted [7], which showed that the average age of hemodialysis patients at Cikini Hospital was 56.02 years. Based on data from the Indonesian [8], the proportion of patients with kidney failure was highest in the 45-64 year age group where in that age group there will be a decrease in kidney function. At that age, the glomerular filtration rate will decrease progressively to 50% of normal, there is a decrease in the ability of the renal tubules to reabsorb urine [9].

The gender criteria for dialyzer use are mostly women, which is 51.7%. [4] and Indonesian [10], the prevalence of kidney failure in men is higher than in women, where this proportion is in accordance with the profile of hemodialysis patients found in several other countries.

The criteria for the duration of hemodialysis patients is mostly more than 2 years. The length of dialysis history can be a factor that affects the administration of therapy and rHuEpo response as stated in the studies of [11][12][13]. In these studies, it was explained that hyporesponsive patients experienced resistance to rHuEpo therapy. Hyporesponsiveness experienced by patients can occur due to a lack of response to the erythropoietic reaction of rHuEPO. Common causes of rHuEPO hyporesponsiveness are related to inflammation and oxidative stress which are common in CKD patients and can be exacerbated by other comorbidities, including diabetes mellitus, infection and autoimmune disorders.

The effectiveness of therapy in kidney failure is determined by the levels of creatinine (Cr), urea and hemoglobin (Hb). In patients using single-use dialyzers, the average decrease in the final creatinine value is 5.1 mg/dl. The decrease in the final urea value using a single-use dialyzer is 145.7 mg/dl. For hemoglobin values, the average final value using a single-use dialyzer is 7.8 g/dl. (TABLE III) While patients using reuse dialyzers, the average decrease in the final creatinine value using reuse dialyzers is 4.3 mg/dl, the decrease in the final urea value using reuse dialyzers is 141.3 mg/dl. And the average increase in the final Hb value using reuse dialyzers is 7.98 g/dl (TABLE III). In accordance with previous studies, the levels of creatinine and serum urea in chronic kidney failure patients before undergoing hemodialysis therapy from all patients had high levels of creatinine and serum urea above normal values. The serum urea levels of patients who have undergone hemodialysis decreased by 63.4% and there were still high values of 36.6%. This shows that there is a decrease in serum creatinine and urea levels after undergoing hemodialysis therapy but not all of them are able to reach normal values and an increase in hemoglobin levels after the first 6 months in patients with chronic kidney failure undergoing hemodialysis.

The insignificant difference can be influenced by the dialyzer re-cleaning process. Reuse dialyzer cleaning using germicides such as formaldehyde or renalin will restore the dialysis quality to that of a single-use dialyzer.

This study has similarities with the study conducted by Purnama et al., (2013) where there was no significant difference in the Kt/V value in the use of each dialyzer ($p = 0.724$). The study also stated that the use of new or repeated dialyzers did not significantly affect the Kt/V value as a parameter of hemodialysis adequacy. In the study by Denny et al., (2014), it was stated that the United States Renal Data System (USRDS) reported no significant difference in mortality between the use of reuse and single use dialyzers, and it was also recommended to reuse dialyzers in facilities that take into account HD costs.

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Table 3. Outcome Values of Creatinine, Urea and Hemoglobin in Hemodialysis Patients Using Single Use and Reuse Dialysers

Effectiveness		Single Use		Reuse	
		beginning	end	beginning	end
Creatinine	Minimum	4.3	3.3	4	2
	Maximum	9.9	7.4	9.7	6.8
	Average	6.8	5.1	6.4	4.3
Urea	Minimum	66	55	110	14
	Maximum	413	300	304	230
	Average	184.1	145.7	177.1	141.3
Hemoglobin	Minimum	3.2	4.8	3.9	3.9
	Maximum	11.2	10.4	12.1	12.1
	Average	8.04	7.8	7.98	8.0

From a total of 160 hemodialysis patients using single-use and reuse dialyzers, the results of the assessment of the effectiveness of creatinine, urea and hemoglobin were seen after being evaluated for a period of 1 year. For patients using single-use dialyzers, the effective creatinine and urea values were 72 people (92%) and the effective hemoglobin values were 27 people (90%). While for patients using reuse dialyzers, the effective creatinine and urea values were 90% and the effective hemoglobin values were 27 people (86.7%). (TABLE IV) This effectiveness data is in line with previous studies showing significant changes in urea and creatinine levels in chronic kidney failure patients after undergoing hemodialysis therapy. In the study, most patients experienced a decrease in urea levels of up to 65% after hemodialysis. (Setyaningsih et al., 2013)

Table 4. Effectiveness of Creatinine, Urea and Hemoglobin Values During 1 Year Treatment Period at RSUStabat Fairy Princess.

Outcome	*Single Use*	*Reuse*
Decreased creatinine	92%	89.3%
Urea decreases	90%	88.7%
Hb Increases	86.7%	84.3%

Research by Malyszko et al., (2013) mentioned something different, where the transition of dialyzer usage (reuse to single use) for a year can affect the increase of Kt/V and URR values in patients. The study was conducted with a larger population and the results showed that dialyzer reuse can affect and interfere with dialysis dose administration. This occurs due to the loss of FBV (Fiber Bundle Volume) in the dialyzer.

Hemoglobin levels in patients can affect the administration of erythropoietin therapy used to treat the patient's anemia. If the patient's hemoglobin is more than the target, then erythropoietin therapy can be stopped and if the patient's hemoglobin level is less than the target, then erythropoietin therapy is still given for 3 months. Yokoyama et al., (2008) studied the effects of recombinant human erythropoietin (rHuEPO) administration on hemodialysis adequacy during the use of single-use and reuse dialyzers. In the use of each dialyzer, the biocompatibility and permeability of the dialyzer membrane can affect hemoglobin levels so that hemoglobin levels in single-use and reuse are the same. In the use of reuse dialyzers, the rHuEPO dose and hemoglobin levels remain unchanged when compared to the use of single-use dialyzers (Malyszko et al., 2014).

Based on the calculation table of efficiency of dialyzer selection used in hemodialysis patients. The treatment selection with the smallest total direct cost is a patient who uses a Reuse dialyzer of Rp. 1.195,322.91 Compared to patients using single-use dialyzers of Rp.1,535,580.54. (Table 5)

Table 5. Distribution of Average Direct Costs of Hemodialysis Patient Treatment at RSUStabat Fairy Princess.

No	Direct Cost Components	*Single Use*	*Reuse*
1	Doctor's Fees	Rp.87,500.00	Rp.87,500.00
2	Laboratory Fees	Rp. 261,595.74	Rp.252,115.38
3	Drug Costs	Rp. 806,714.20	Rp.573,207.53
4	Hemodialysis Set Cost	Rp.379,770.60	Rp.282,500.00
	Total Average	**Rp. 1,535,580.54**	**Rp. 1,195,322.91**

To find out the most effective and efficient therapy between the use of single use and reuse dialyzers, researchers used unit cost calculations. Based on the increase in creatinine, urea and hemoglobin values between patients using single use dialyzers, it was higher, namely Rp.1,535,580.54. Compared to Reuse Dialyser Rp.1.195,322.91.

Patients who had a decrease in creatinine and effective rheum levels were more likely to use reuse dialyzers than reuse.

Table 6. Calculation of Cost Effectiveness Analysis Comparison for Patients Using Single-use and Reuse Dialyzers

No	Description	*Single Use Dialyser*	*Dialyser Reuse*
1	**Total Cost**	Rp.1,535,580.54	Rp.1.195,322.91
2	**Outcome changes**		
	-Creatinine	5.1mg/dl	4.3mg/dl
	-Urea	145.7mg/dl	141.3mg/dl
	-Hemoglobin	7.8g/dl	8.0g/dl
3	**Outcome Effectiveness**		
	Creatinine	92%	89.3%
	Urea	90%	88.7%
	Hemoglobin	86.7%	84.3%

According to the researcher's assumption, the use of reuse dialysis has the potential for significant cost savings. However, it is important to consider aspects of effectiveness, risk, and overall quality of patient care. The decision to use reuse or single-use dialysis should be made carefully after considering

various factors, including patient conditions, resource availability, and applicable medical guidelines.

IV. CONCLUSIONS

From the cost efficiency, Reuse dialyzers are proven to be lower than Single Use dialyzers. Whilein producing changes in the outcomes of creatinine, urea, and hemoglobin, single-use dialyzers are more effective than reuse dialyzers. In the context of caring for chronic kidney failure patients undergoing hemodialysis, further steps for more in-depth pharmacoeconomic research are needed due to the potential for significant cost savings. However, it is important to consider aspects of effectiveness, risk, and overall quality of patient care. One of them is a cost utility analysis conducted prospectively to compare the use of single-use and reuse dialyzers. In addition, a cost-effectiveness analysis is also needed by taking samples from different dialyzer brands to provide a more comprehensive understanding of the benefits and efficiency of each brand.

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