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Vascular access in emergency hemodialysis patients in remote areas: A 4-year observational study

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***Abstract*---**The goal of this study was to identify vascular access in patients undergoing emergency hemodialysis in outlying areas at RSU NTB. This study, which was conducted concurrently from secondary data of patients with chronic kidney disease (CKD) who needed emergency hemodialysis through a temporary non-tunnel double-lumen vascular catheter access at the West Nusa Tenggara Regional General Hospital from May 2019 to May 2022, is a quantitative descriptive study using a cross-sectional approach. by including 331 research participants, the majority of them were between the ages of 46 and 55 (n=31.4%), with a male to female ratio of 54.4% to 45.6%. According to this study, hypertension, which affected 158 individuals (n=47.7%) of the research subjects, was the most prevalent ailment. As many as 122 patients (n=36.9%) with chronic kidney disease (CKD) who have hemodialysis grounds report shortness of breath as their primary complaint. Emergency hemodialysis, which involved 295 patients (n=89.1%) of patients with chronic kidney disease, was the most common reason for hemodialysis, followed by chronic or regular hemodialysis, which involved 30 patients (n=9.1%). In conclusion, comorbidities and clinical symptoms were taken into account when deciding the type of hemodialysis that will be administered.

***Keywords*---**Emergency Hemodialysis, Non-tunnel Double Lumen Catheter, Chronic Kidney Disease (CKD) stage V.

Introduction

Chronic Kidney Disease is a long-lasting, progressive and irreversible kidney disease, accompanied by anemia and hypertension. Chronic Kidney Disease requiring dialysis is a chronic kidney disease that has decreased kidney function with a glomerular filtration rate of less than 15 mL/minute. In this situation, kidney function has greatly decreased, resulting in the accumulation of toxins in the body called uremia. In a state of uremia, renal replacement therapy is needed to take over kidney function by eliminating body toxins, so that severe symptoms do not occur (Ali, 2018; Ammirati, 2020; Bouya et al., 2018; Braun & Khayat, 2021; Charles & Ferris, 2020; Milik & Hrynkiewicz, 2014).

Since 1960, hemodialysis has been applied as renal replacement therapy in patients with acute kidney injury and end-stage renal disease. Hemodialysis is a replacement therapy that acts as an artificial kidney (*dialyzer*). Hemodialysis as a treatment for end-stage kidney disease is used by more than 300,000 people in the United States. Standardization of this therapy was started in 1973 by several experts such as Kolff, Merrill, Sribner, and Schreiner. This therapy also considers the patient's education, occupation, and health condition. Most kidney specialists make therapeutic decisions based on the patient's health which is followed closely as an outpatient (Ammirati, 2020; Charles & Ferris, 2020; Xue et al., 2001).

Hemodialysis is one of the renal physiology therapies to remove protein metabolism substances and correct disturbances in water and electrolyte balance between the patient's blood compartment and the dialysis solution compartment through a semipermeable membrane acting as a kidney replacement. Hemodialysis is often referred to by ordinary people as dialysis therapy. Hemodialysis is beneficial in prolonging life and improving the quality of patients' life with end-stage renal disease (Ammirati, 2020; Charles & Ferris, 2020; Um-e-Kalsoom et al., 2020).

Indonesia and other developing countries experience an increasing number of chronic kidney disease patients. This is attributed to the increasing number of elderly people and the speed of urbanization accompanying economic growth. Based to The Indonesian Renal Registry, the number of incident cases of end-stage renal disease increased from 11,484 patients in 2010 to 77,892 patients by 2017. In Indonesia, the treatment of kidney disease was the second highest-cost health care after heart disease in 2015. Patients often miss scheduled hemodialysis sessions. These phenomena are associated with an increased risk of death, interdialytic weight gain, increased phosphate level, cardiovascular complications, and increased mortality. Thus, patients need emergency hemodialysis to prevent this complication (Liu et al., 2021).

Hemodialysis in Indonesia started in 1987 and has been implemented in many referral hospitals to date. Commonly, the hemodialysis procedure uses a semipermeable membrane capillary which will be connected to the blood compartment of the kidney (*hollow fiber dialyzer*). Usually, in Indonesia hemodialysis is done 2 times a week. Each time, hemodialysis takes approximately 5 hours. In several other dialysis centers, practitioners do hemodialysis 3 times a week for 4 hours. The quality of life obtained is quite good

and the highest longevity is 15 years (Hyodo et al., 2019; Um-e-Kalsoom et al., 2020; Xue et al., 2001).

According to Jaber, Kumar, and Szeto, there are two types of indications for hemodialysis therapy, namely emergency hemodialysis and chronic or regular hemodialysis (Jaber, 2007; Kumar, 1995; Szeto, 2015). The number of chronic hemodialysis patients in developed countries has increased dramatically in the1970s and the number continues to increase rapidly. Estimated 12,000 Americans develop end-stage kidney disease each year and the majority require dialysis therapy. Dialysis has become an outpatient procedure, performed in dialysis clinics and even at home. Due to the increasing number of patients and the shift from inpatient to outpatient, it seems that more patients will experience problems in the absence of a nephrologist and turn to the emergency department (Ali, 2018; Bouya et al., 2018; McAllister & Gibson, 1978).

There is a progressive increase in the number of patients on renal replacement therapy worldwide. Permanent vascular access and hemodialysis are included in the treatment options. Permanent vascular access and appropriate management are mandatory to reduce complications. Properly functioning access is necessary to provide adequate hemodialysis therapy in end-stage renal disease patients. Despite the advances in hemodialysis technology, polytetrafluoroethylene graft and silicone double lumen catheter are new procedures in the field of vascular access in recent years. However, access to vascular care for patients with arteriovenous grafts costs five times as much as for patients with functional arteriovenous fistula. The arteriovenous fistula described by Brescia and Cimino in 1966, remains the first choice of VA. Vascular access is still the "*Achilles Heel*", while hemodialysis vascular access dysfunction is one of the main causes of morbidity. Currently, the three types of permanent vascular access in use are arteriovenous fistula (AVF), arteriovenous graft (AVG), and central venous catheter. These alternatives must meet several requirements, namely providing adequate blood flow in hemodialysis procedures, having a long service life, and having low chances of complications. An arteriovenous fistula (AVF) of the forearm has the longest survival and requires the least amount of intervention. Therefore, forearm AVF is the first choice, followed by upper arm AVF, arteriovenous graft (AVG), and central venous catheter as a last resort (Bode & Tordoir, 2013; Murea et al., 2019; Pantelias & Graps, 2011).

Transplant is one of the treatment options. The shortage of donor organs results in the need for temporary dialysis therapy, whereas hemodialysis is performed in most countries. To facilitate adequate hemodialysis therapy, reliable vascular access is mandatory, i.e., through surgery to connect arteries and veins (arteriovenous fistulas), surgery to connect arteries and veins using interposition of prosthetic graft material (arteriovenous grafts), or central venous catheters. Several findings indicate that the creation and management of vascular access have progressed rapidly (Bode & Tordoir, 2013; Pantelias & Graps, 2011).

When emergency hemodialysis is required, vascular access is urgently needed. This type of access must have some special features, such as ease of insertion and availability for immediate use. Two types of access are currently available: non-tunneled hemodialysis catheters (NTHC) and tunneled cuffed catheters (TCC).

The non-tunnel double-lumen non-cuffed, non-tunnel hemodialysis catheters are the preferred methods for immediate hemodialysis when long-term access is not available. They are made of polymers that are rigid at room temperature for easy insertion but soften at body temperature to minimize vascular injury and vascular lacerations. To minimize recirculation, the distance between the proximal and distal lumens should be at least two cm (Bode & Tordoir, 2013; Murea et al., 2019).

Non-tunneled double lumen hemodialysis catheters are more common and frequently used due to their faster and easier application of vascular access. The implantation procedure of a non-tunnel double lumen catheter can lead to emergency complications or delay, which are characterized by the occurrence of pneumothorax, hemothorax, bleeding, and cardiac tamponade. In addition, the highest complications and significant secondary infection can occur with the insertion of a non-tunnel double lumen catheter. The cause of this complication is related to the incidence of nosocomial secondary infection in the ICU, so prevention is needed to prevent infection, namely by locking the antimicrobial catheter and giving antibiotics. A complication of vascular access from the installation of a non-tunnel double lumen catheter is a major cause of increased morbidity and mortality in hemodialysis patients. Other complications can occur due to the length of stay of patients who require hemodialysis. KDOQI guidelines recommend the use of a non-tunneled double lumen catheter for less than one week. This is related to the high frequency of infection which is most commonly found in the installation of a double-lumen catheter (Basri & Patrianef, 2017; Ferreira et al., 2018).

In West Nusa Tenggara General Hospital, the incidence of chronic kidney disease patients and the installation of a non-tunnel double lumen catheter was quite high. The use of a non-tunneled double lumen catheter revealed a difference. In addition, there were many limitations under previous studies, namely inadequate access to hemodialysis at a referral hospital providing hemodialysis facilities, high cost, and long hospitalization of some patients with chronic kidney disease at West Nusa Tenggara General Hospital. This made patients often miss the scheduled hemodialysis session. Therefore, researchers aimed to study chronic kidney disease patients requiring emergency hemodialysis through vascular temporary non-tunnel double lumen catheter access at West Nusa Tenggara General Hospital.

Methods

This study was conducted at West Nusa Tenggara General Hospital. The study was conducted by reviewing patient registries from May 2019 to May 2022. This study was a quantitative descriptive study, with a *cross-sectional* approach, which was conducted at the same time taken from secondary data of patients diagnosed with chronic kidney disease (CKD) and undergoing hemodialysis treatment at the West Nusa Tenggara General Hospital. In this study, the samples used were patients diagnosed with chronic kidney disease (CKD) and undergoing hemodialysis treatment in 2019, 2020, 2021, and 2022 at the West Nusa Tenggara General Hospital. The number of samples obtained and used was as many as 331 patients.

In this study, the inclusion criteria used were patients diagnosed with CKD and undergoing hemodialysis treatment at the West Nusa Tenggara General Hospital. Patients with comorbid diseases such as diabetes mellitus, hypertension, and kidney stones, and willing to be research subjects and presented during the study. While the exclusion criteria used were patients who did not suffer from CKD and did not receive hemodialysis therapy. In addition, the exclusion criteria were in terms of the patient's comorbid disease, namely other than diabetes mellitus, hypertension, pulmonary edema, and kidney stones, and were not willing to be research subjects.

The data used in this study were primary data obtained from patient registration data undergoing hemodialysis treatment at the West Nusa Tenggara General Hospital, where every patient diagnosed with CKD was the subject of the study. Then, the record of each patient was accessed from office records based on the identified list.

The data used in this study were secondary data about the clinical characteristics of the use of vascular access in patients diagnosed with CKD and undergoing hemodialysis treatment. After the data was collected, the data were grouped based on data variables and then processed using Microsoft Excel and SPSS version 18 applications on the computer. Variables of gender, age, comorbid, and clinical symptoms were displayed in percentage form. The results of the data analysis were then presented in tabular form.

Result

According to the inclusion and exclusion criteria, 331 research subjects were obtained. The following are the clinical characteristics of the research subjects. Based on (Table 1), it was found that the male quantity was 54.4% while the female-only amounted to 45.6%. Based on the results of age data, the majority of subjects were aged 46-55 years (n=31.4%) (Table 2). While the results of the most comorbid disease data on research subjects were hypertension with a total of 158 patients (n=47.7%), followed by comorbid diabetes mellitus and pulmonary edema in 16 patients (n=4.8%) and 7 patients (n=2,1%) (Table 3). In addition, the most common clinical symptoms of patients with chronic kidney disease with hemodialysis indication were breathless, which was 122 patients (n=36.9%), followed by general weakness, which was 82 patients (n=24,8%), and nausea and vomiting were 30 patients (n=9,1%) (Table 4). Based on the type of hemodialysis, the most common type of hemodialysis in patients with CKD with hemodialysis indication was emergency hemodialysis, which was 295 patients (n=89.1%), followed by Chronic or Regular hemodialysis, as many as 30 patients (n=9.1 %) (Table 5).

Table 1. Sex Distribution

Sex	N=331	Frequency %
Male	180	54,4
Female	151	45,6

Table 2. Age Distribution

Age	N=331	Frequency %
15 – 25	23	6,9
26 – 35	42	12,7
36 – 45	68	20,5
46 – 55	104	31,4
56 – 65	65	19,6
66 – 75	22	6,6
76 - 85	7	2,1
Total	331	100

Source: data analyzed

Table 3. Comorbid

Comorbid	N=331	Frequency %
Hypertension	158	47,7
Diabetes Mellitus	16	4,8
Kidney Stones	19	5,7
Hypertension and Diabetes Mellitus	41	12,4
Pulmonary Edema	7	2,1
Without Comorbid	90	27,2
Total	331	100

Source: data analyzed

Table 4. Clinical Symptoms in Patients with Chronic Kidney Disease

Symptoms	N=331	Frequency %
Fever	9	2,7
General Weakness	82	24,8
Breathless	122	36,9
Loss of Consciousness	28	8,5
Abdominal Pain	8	2,4
Nausea and Vomiting	30	9,1
Bleeding in Left Arm	4	1,2
Seizure	7	2,1
Double Lumen Stuck	8	2,4
Heartburn	11	3,3
Left Back Pain	9	2,7
Difficult to Urinate	5	1,5
Hematochezia	7	2,1
Bleeding in legs	1	0,3
Total	331	100

Source: data analyzed

Table 5. Profile of Types of Hemodialysis in Chronic Kidney Disease Patients

Types	N=331	Frequency %
Emergency	295	89,1
Preparative	6	1,8
Chronic/Regular	30	9,1
Total	331	100

Source: data analyzed

Based on the relationship between sex and the type of hemodialysis used, it was found that the male received the most emergency hemodialysis, which was 159 patients (n=48.4%), while the females receiving emergency hemodialysis were 136 patients (41,9%) (Table 6).

In this study, researchers conducted a *Chi-square* test to determine the significance of the effect or relationship between the sex variable (dependent variable) and the type of hemodialysis (independent variable) on the categorized data, with a significance level of $p < 0.05$. Based on the table below, there was no relationship between gender and the choice of hemodialysis type at $p < 0.005$. The value of 0.356 indicates the statistical test value was not significant with $p < 0.05$, then H1 was rejected (Table 6).

Based on the age variable studied for the type of hemodialysis, the average patient aged 46-55 years dominantly received emergency hemodialysis, namely as many as 90 patients (n = 27.19%). After the statistical test of the relationship between age and type of hemodialysis using *Chi-square*, with $p < 0.05$. It revealed that the p-value was 0.228, so it can be concluded that there was no relationship between age and the type of hemodialysis given (Table 7).

Comorbidity is a condition where other diseases are experienced besides the main disease. In the medical dictionary, comorbid occurs when two diseases exist together and can worsen the condition of the main disease. The results showed that chronic kidney disease patients with comorbid hypertension received on average emergency hemodialysis, which was 138 patients (n=41.69%) (Table 8).

Table 6. Relationship between Gender and Type of Hemodialysis

Sex	Emergency	Type of Hemodialysis			req.	P-value
		Preparative	Chronic/Regular	Total		
Male	159	2	19	180	54%	0,356
Female	136	4	11	151	46%	
Total	295	6	30	331	100%	

Source: data analyzed

Table 7. Relationship between Age and Type of Hemodialysis

Age in years	Types of Hemodialysis			Total	Freq.	*p-value*
	Emergency	Preparative	Chronic/Regular			
15 - 25	21	0	2	23	6,95	0,228
26 – 35	34	1	7	42	12,69	
36 - 45	63	0	5	68	20,54	
46 - 55	90	2	12	104	31,42	
56 - 65	61	1	3	65	19,64	
66 - 75	19	2	1	22	6,65	
76 - 85	7	0	0	7	2,11	
Total	295	6	30	331	100	

Source: data analyzed

Table 8. Relationship between Comorbid and Type of Hemodialysis

Comorbid	Types of Hemodialysis			Total	Freq.	*p-value*
	Emergency	Preparative	Chronic/Regular			
Hypertension	138	1	19	158	47,73	0,032
Diabetes Mellitus	16	0	0	16	4,83	
Kidney Stones	16	2	1	19	5,74	
Hypertension and Diabetes Mellitus	41	0	0	41	12,39	
Pulmonary Edema	6	0	1	7	2,11	
Without Comorbid	78	3	9	90	27,19	
Total	295	6	30	331	100	

Source: data analyzed

In this study, the researchers also performed a *Chi-square* test of the relationship between the comorbid disease variable and the choice of hemodialysis type, with a significance level of $p < 0.05$. Based on the table below, there was a relationship between comorbid disease and the choice of hemodialysis type with $p < 0.05$. The result showed a p-value of 0.032, then H1 was accepted.

The result of the observation of the relationship between the clinical symptom variable and the type of hemodialysis showed that on average patients with shortness of breath received emergency hemodialysis, namely as many as 113 patients (n = 34.14%). After statistical testing using *Chi-square*, it was obtained p-value <0.05 (p=0.000). As the consequence, it accepted H1. Therefore, it can be concluded that there was a relationship between the clinical symptoms and the type of hemodialysis given (Table 9).

Table 9. Relationship between the Clinical Symptoms and the Type of Hemodialysis

Clinical symptoms	Types of Hemodialysis			Total	Freq.	*p-value*
	Emergency	Preparative	Chronic/Regular			
Fever	9	0	0	9	2,72	0,000
General Weakness	73	0	9	82	24,77	
Breathless	113	0	9	122	38,86	
Loss of Consciousness	26	1	1	28	8,46	
Abdominal Pain	7	1	0	8	2,42	
Nausea and Vomiting	27	1	2	30	9,06	
Bleeding in Left Arm	3	0	1	4	1,21	
Seizure	6	0	1	7	2,11	
Double Lumen Stuck	3	2	3	8	2,42	
Heartburn	9	0	2	11	3,32	
Left Back Pain	7	0	2	9	2,72	
Difficult to Urinate	4	1	0	5	1,51	
Hematochezia	7	0	0	7	2,11	
Bleeding in legs	1	0	0	1	0,30	
Total	295	6	30	331	100	

Source: data analyzed

Discussion

Characteristics of Research Subjects

Based on the results of the study, the distribution of data and the number of research samples were 331 patients. From this distribution, the research samples met the inclusion and exclusion criteria. The samples in this study were patients who needed emergency hemodialysis with vascular non-tunnel double lumen catheter access at West Nusa Tenggara General Hospital from 2019 to 2022. Research data showed that the number of males suffering from chronic kidney disease was more than that of females. This study is in line with Iseki's study in 2008, stating that epidemiologically men suffering from chronic kidney were more than women. This is related to lifestyle factors that are often associated with obesity and metabolic syndrome which may also play a role in the development and progression of chronic kidney disease. The obesity-related risk for developing proteinuria was independent of hypertension and diabetes mellitus. In addition, smoking can also accelerate kidney damage in patients with metabolic syndrome. Lifestyle-related factors, smoking, and excessive alcohol intake are known as risk factors for chronic kidney disease (Braun & Khayat, 2021; Iseki, 2008).

Based on the results of the study, a sample of patients with an average age of more than 35 years totaling 266 patients (81.36%) had chronic kidney disease.

Meanwhile, there were 65 patients (19.64%) under 35 years who had chronic kidney disease. Clinically, older patients are more at risk of developing chronic kidney disease (Ravani et al., 2020). Age is an unavoidable risk factor for degenerative diseases (Ammirati, 2020; Charles & Ferris, 2020). In this study, the older a patient gets, the higher a patient's risk of experiencing chronic kidney disease.

In this study, it was found that the most comorbid diseases were hypertension with a percentage of 47.7%, then hypertension and diabetes mellitus at 12.4%. This is in line with Braun, Luyckx, and Ravani studies, stating that diabetes, hypertension, and obesity are the main contributors to degenerative diseases and are important risk factors for chronic kidney disease in addition to exposure to nephrotoxins, kidney stones, fetal and maternal factors, infections, environmental factors, and acute kidney injury (Braun & Khayat, 2021; Luyckx et al., 2017; Ravani et al., 2020).

Profile of Clinical Symptoms in Chronic Kidney Disease Patients

From the results of this study, the clinical symptoms of most patients with chronic kidney disease with an indication of hemodialysis were shortness of breath (which was 36.9%), followed by general weakness (which was 24.8%nd nausea and vomiting 9.1%. Chronic Kidney Disease has various manifestations, including gastrointestinal, cardiovascular, respiratory, neuromuscular, metabolic, dermatological symptoms, and supporting laboratory results (Chen et al., 2019).

Relationship between Gender and Types of Hemodialysis

Based on the results of the statistical test value, a p-value of 0.356 was obtained. The result indicates that there was no relationship between gender and the types of hemodialysis given, based on a p-value greater than 0.05. Gender difference is going to affect blood vessel size, blood vessel strength, and blood flow velocity (Weale et al., 2008). Relationship between Age and Types of Hemodialysis.

Relationship between Age and Types of Hemodialysis

Based on the results of the statistical test values, a p-value of 0.228 was obtained. The result indicates that there was no relationship between age and the types of hemodialysis given, based on $p < 0.05$. Based on the analysis of the relationship between age and the type of hemodialysis, it was found that the average age of 46-55 years old received a lot of emergency hemodialysis, namely as many as 177 patients. The increasing life span of the population results in a higher prevalence of diabetes, hypertension, and cardiovascular disease, thus leading to an increase in the prevalence of chronic kidney disease. The more very old patients reach end-stage kidney disease, the more need these patients to undergo dialysis procedures. The incidence and prevalence of dialysis patients are growing faster in the old age group than in the younger age group. The heavy burden of comorbidities in the elderly leaves the nephrologist facing many

challenges in deciding to initiate dialysis or offer maximum conservative management (Leimbach et al., 2015).

Relationship between Clinical Symptoms and Types of Hemodialysis

From the results of the research, it is known that there was a relationship between the clinical symptoms and the type of hemodialysis given. The result refers to the results of the bivariate analysis which was able to provide an assessment of research subjects that the correlation between the clinical symptoms and the type of hemodialysis was $p < 0.05$ ($p = 0.000$). The result of this study indicates that the p-value was smaller than $p < 0.05$, so it can be concluded that there was a significant relationship between the clinical symptoms and the type of hemodialysis given to patients with chronic kidney disease undergoing hemodialysis therapy at the West Nusa Tenggara General Hospital. Patients with Chronic Kidney Disease are at risk for medical emergencies, many of whom require hemodialysis for definitive treatment. Emergency hemodialysis in conjunction with adjunct medical care is a useful emergency treatment technique in Acute Kidney Disease emergency (Sacchetti et al., 1999).

Conclusions

Based on the data assessment of age, gender, comorbidity, main complaint, and type of hemodialysis in chronic kidney disease patients, it was found that patients requiring emergency hemodialysis with vascular access non-tunneled double lumen catheter showed significant results. The prevalence of sex requiring emergency hemodialysis revealed almost the same number between men and women. The age prevalence requiring emergency hemodialysis showed little difference. In this case, patients aged 46-55 years became a significant proportion compared to the proportion of other ages. Based on the observation of the prevalence of comorbidities requiring emergency hemodialysis, it was found that hypertension was a comorbid with a high enough risk compared to other comorbidities. Furthermore, the main complaint requiring emergency hemodialysis showed that shortness of breath was a significant complaint for emergency hemodialysis compared to other complaints. Judging from the prevalence of hemodialysis types, it was found that emergency hemodialysis was a procedure performed with a fairly high frequency compared to other types of hemodialysis. This proves that emergency hemodialysis and installation of vascular access non-tunneled double lumen catheter at West Nusa Tenggara General Hospital were significantly correlated.

Ethical Approval

The paper was approved by the Ethics Committee of West Nusa Tenggara General Hospital.

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Conflicts of Interest

There is no conflict of interest

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