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Original Article

Adequacy of haemodialysis and associated factors among patients with end-stage kidney disease in Tanzania

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الملخص

أهداف البحث: يساعد غسيل الكلى المناسب في الحفاظ على الوظيفة الطبيعية للكلى عن طريق إزالة السموم والنفايات الأخرى لدى المرضى الذين يعانون من مرض الكلى في المرحلة النهائية. تهدف هذه الدراسة إلى تحديد مدى انتشار ومؤشرات كفاية غسيل الكلى ونتائج المرضى الذين يعانون من مرض الكلى في المرحلة النهائية.

طريقة البحث: كانت هذه دراسة تحليلية طولية قائمة على المستشفى تم إجراؤها في مركزين لغسيل الكلى في مدينة دودوما، تنزانيا في الفترة من فبراير إلى يوليو 2020. وتم قياس كفاية غسيل الكلى باستخدام مجموعة واحدة من (ك ت/ف) وصيغ معدل تخفيض اليوريا. تم استخدام تحليل الانحدار اللوجستي الثنائي تحت التحليل متعدد المتغيرات لتقييم تنبئ مستقل بكفاية غسيل الكلى.

النتائج: تم تضمين ما مجموعه 100 مريض بمتوسط عمر 50.6 ± 15.0 سنة في التحليل. كان معدل انتشار كفاية غسيل الكلى لمعدل خفض اليوريا 72% ولـ (اس بي-ك ت/ف) 75%. إن وجود أقل من 12 شهرا منذ بدء غسيل الكلى، وإجراء أقل من 3 جلسات غسيل كلوي أسبوعيا، والإصابة بفقر الدم الشديد، كانت تنبئ بعدم تحقيق غسيل الكلى المناسب وفقا لمعادلة معدل خفض اليوريا. ارتبط إجراء أقل من 3 جلسات غسيل كلوي أسبوعيا بشكل كبير بعدم وجود غسيل كلوي كاف وفقا لصيغة (اس بي-ك ت/ف). كان معدل الوفيات 11.2%، وكانت أمراض القلب والأوعية الدموية ومتلازمة اليوريمي مسؤولة عن معظم الوفيات.

الاستنتاجات: أظهرت هذه الدراسة نسبة عالية من كفاية غسيل الكلى بين المرضى الذين يعانون من مرض الكلى في المرحلة النهائية. إن إجراء أقل من 3 جلسات غسيل كلوي أسبوعيا، والبدء المتأخر لغسيل الكلى بعد تشخيص مرض الكلى في المرحلة النهائية، وفقر الدم الشديد، كانت تنبئ بالفشل في تحقيق غسيل الكلى المناسب بين المرضى.

الكلمات المفتاحية: قدرة؛ فشل كلوي مزمن؛ نتائج سريرية؛ العوامل المرتبطة؛ غسيل الكلى

Abstract

Objectives: Adequate haemodialysis helps maintain normal renal function by removing toxins and other waste products in patients with end-stage kidney disease. This study was aimed at determining the prevalence and predictors of adequacy of haemodialysis and outcomes in patients with end-stage kidney disease.

Methods: This longitudinal analytical hospital-based study was conducted at two dialysis centres in Dodoma city, Tanzania, between February and July of 2020. Adequacy of haemodialysis was measured with single-pool (sp) Kt/V and urea reduction rate (URR) formulae. Binary logistic regression and multivariable analysis were used to assess the independent predictors of adequacy of haemodialysis.

Results: The analysis included 100 patients with a mean age of 50.6 ± 15.0 years. The prevalence of adequacy of haemodialysis according to URR and sp-Kt/V was 72 % and 75 %, respectively. Having <12 months since dialysis initiation (AOR = 7.3, 95 % CI = 0.11–0.90, p = 0.032), fewer than three dialysis sessions per week (AOR = 6.9, 95 % CI = 1.52–31.49, p = 0.013) and severe anaemia (AOR = 2.2, 95 % CI = 0.26–0.93, p = 0.033) were predictors of inadequate haemodialysis, according to the

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URR formula. Having fewer than three dialysis sessions per week was significantly associated with inadequate haemodialysis (AOR = 5.6, 95 % CI = 1.47−19.66, p = 0.011), according to the sp-Kt/V formula. The mortality rate was 11.2 %, and cardiovascular disease and uremic syndrome were responsible for most deaths.

Conclusion: This study indicated a high percentage of adequacy of haemodialysis among patients with end-stage kidney disease. Having fewer than three dialysis sessions per week, late initiation of dialysis after diagnosis of end-stage kidney disease and severe anaemia were predictors of inadequate haemodialysis among patients.

Keywords: Adequacy; Chronic kidney disease; Clinical outcome; Factors associated; Haemodialysis

Introduction

Chronic kidney disease (CKD) affects approximately 16 % of the population worldwide and is typically under-recognized by patients and clinicians.[1] According to the Centers for Disease Control and Prevention, more than 26 million people in the United States of America have kidney failure.[2] CKD affects more young adults 20−50 years of age in sub-Saharan Africa and is commonly caused by hypertension and glomerular diseases, which progress to end-stage kidney disease (ESKD).[3] Advanced stage ESKD is associated with gradual loss of renal function.[4] ESKD develops as a result of CKD progression, and the kidneys lose their normal function,[5] thus contributing to morbidity and mortality, and causing major economic effects on health care systems.[6] By the year 2030, more than 70 % of all people with ESKD are expected to live in resource constrained countries, particularly sub-Saharan Africa, where the availability of haemodialysis services remains a major challenge.[7]

Haemodialysis, a major treatment modality for renal failure, helps remove accumulated waste products and maintain the internal environment, as well as remove toxins causing irreversible kidney injury.[8] Patients receiving haemodialysis have high mortality and hospitalization rates, and poorer health than the general population.[9] Provision of adequate haemodialysis helps avoid uremic complications and consequent effects on various organs in the body.[10] Quantification of the haemodialysis dose is critical in the management of patients with ESKD, because the adequacy of haemodialysis (AoH) reflects patients' outcomes.[11] Correct and optimal dialysis can prevent complications, repeated hospital stays and costs, and provide better quality of life to patients.[12]

In Tanzania, little is known regarding the assessment of AoH and associated factors among patients with ESKD, thus resulting in knowledge gaps among physicians and the general population, and varying treatment practices. Consequently, the management of patients with ESKD is affected, in addition to their morbidity and mortality. Therefore, this study was aimed at determining the prevalence of AoH, and its associated factors and outcomes, among patients with ESKD.

Material and Methods

Study design and setting

This longitudinal analytical hospital-based study was conducted between February and July of 2020 at two dialysis centres; Benjamin Mkapa Hospital and the University of Dodoma Hospital. Both hospitals are located in the city of Dodoma, the capital of Tanzania. These hospitals serve as teaching hospitals for the University of Dodoma, as well as dialysis centres for the Dodoma region, which has a total population of 3,086,525, according to the Tanzania Population and Housing Census of August 2022.[13] These centres also provide dialysis services for patients from neighbouring regions in the country, including Manyara, Morogoro, Iringa and Singida.

Patient characteristics and recruitment criteria

Patients with ESKD who were ≥18 years of age and had received haemodialysis for at least 3 months were included in this study. All patients, or their relatives if proxies were necessary, provided signed informed consent before participation. The data obtained during the study were kept anonymous. All patients were sampled from the two dialysis centres, which used the same haemodialysis strategy to ensure homogeneity of the study population. Patients who did not adhere to dialysis, underwent kidney transplantation or were terminally ill with multiple comorbidities were excluded from the analysis.

Sample size calculation and sampling method

The sample size was calculated with the Kish Leslie formula for the prevalence of a single population, adapted from a prior study[7]:: $n = z^2 \times p(1\text{-}p)/e^2$, where n is the required sample size, z is the critical value of the normal distribution at 95 % confidence interval (standard value of 1.96), p is the prevalence of AoH of 40.6 % based on sp-Kt/V from a previous study,[7] and e is the marginal error of (5 %): $n = [(1.96)^2 \times 0.406\ (1-0.406)]/(0.05)^2 = 0.9264556224/0.0025$. The calculated sample size was 370 patients, a number greater than the possible population size of 130 patients estimated during a simple pilot study. Therefore, the finite population correction formula $n = Nz^2p(1\text{-}p)E^2/(N\text{-}1) + z^2p(1\text{-}p)$ was applied, as previously described.[14] Therefore,

$$n = \frac{130 \times 3.8416 \times 0.406 \times 0.594}{0.0025 \times 129 + 0.9264556224}$$

The sample size obtained was 100 patients. Given the small number of patients available, we recruited study participants through a convenience sampling method.

Measurement of variables

Adequacy of haemodialysis

AoH is defined as how well toxins and waste products are removed from the patient's blood and symptoms are alleviated.[7] AoH was assessed with the single-pooled Kt/V (Kt/Vsp) and Daugirdas formula[15]: -ln (R-0.008t) + (4−3.5R) × UF/W was applied, where ln is the natural logarithm, R is the ratio of post-dialytic to pre-dialytic blood urea nitrogen (BUN), t is the effective dialysis time in hours, Uf is the ultrafiltration volume in litres, W is the weight of the patient after dialysis in kg, and Kt/Vsp is the single pool Kt/V. We additionally assessed the AoH with the urea reduction ratio (URR), which was calculated as follows: pre-dialysis BUN − post-dialysis BUN)/(pre-dialysis BUN) × 100 %.

Pre-dialysis blood samples were collected before the initiation of each dialysis session. Five-millilitre blood samples were initially collected through an arterial catheter, and the syringes were discarded. A second blood sample of 5 ml was obtained at the end of the same session, after the ultrafiltration rate was set to zero to decrease the blood pump flow to <100 ml/min for at least 20 s, and the pump flow was stopped. The second blood sample was collected for estimation of pre-dialysis BUN to avoid dilution effects of saline and heparin. BUN analysis was performed with a biochemistry analyser (Erba chem XL 600, German). The obtained values were used to calculate the estimated AoH with Kt/Vsp and URR. The dialysate flow was stopped for 3 min while the blood flow was maximal at the end of each dialysis session. Post-dialysis blood samples were collected 3 min after dialysis from the arterial sampling to avoid recirculation effects. Both the pre and post blood samples were collected during the same sitting and session.

Haemoglobin levels

The venous blood samples were collected into ethylenediamine tetraacetic acid vacutainer tubes and used to test haemoglobin (Hb) levels with a HemoCue 201+ System (HemoCue AB, Ängelholm, Sweden), according to the manufacturer's instructions.

Patient follow-up

Patients were followed-up for 4 months after being enrolled in the study between April and July of 2020. The patients were evaluated after every 2 weeks of subsequent hospital visits for dialysis. The evaluation process involved assessment of blood pressure (BP), dialysis related complications and general patient performance. Patients who did not present for their normal scheduled dialysis sessions were contacted by telephone. Patients who did not answer the calls, those with unreachable telephone numbers and those reported to be dead were considered lost to follow-up.

Data collection

We reviewed the medical records of the patients and extracted the sociodemographic characteristics (age, sex, marital status, place of residence, occupation and level of education) clinical data (comorbidities, duration since dialysis initiation, number of dialysis sessions, pre-and post-dialysis BP, Hb level, vascular access, risks of ESKD, complications during dialysis and blood flow). A questionnaire from a previous study was adapted and modified for data collection.[16] Data collection was performed by two general medical physicians who had previously been familiarized with the data collection procedures. For privacy purposes, a screen was used to prevent interviewed patients from being seen by other patients and/or people in the dialysis room.

Statistical analysis

Data were analysed in SPSS version 25.0 (IBM Statistics, Chicago, US). Continuous variables are summarized as mean ± standard deviation, and categorical variables are summarized as frequencies and percentages. Binary logistic regression analysis was used to determine the independent predictors of AoH through both bivariate and multivariable analyses. All significant variables and those with $p < 0.2$ in bivariate analyses were fitted in the multivariable analysis. A two-tailed $p < 0.05$ was considered statistically significant.

Results

Flow chart for enrolment of study participants

For 6 months between February and July 2020, 130 patients receiving haemodialysis at the two dialysis centres were screened for study eligibility. Among all patients, 76.9 % (100/130) met the eligibility criteria and were included in the analysis (Figure 1).

Sociodemographic characteristics of the patients

A total of 100 patients with ESKD receiving haemodialysis during the study period were analysed. Their mean age was 50.6 ± 15.0 years (range: 18−73 years). Most patients (60 %) were men, and the male to female ratio was 1:0.7. More than half the patients 55 % were younger than 50 years. In addition, 19 % of patients had various comorbidities (Table 1).

Treatment characteristics of the patients

More than half the patients (58 %) received dialysis for no more than 12 months, and the mean duration was 21.4 ± 19.4 months. In addition, most patients (87 %) had three or more dialysis sessions per week. Anaemia was present in most patients (77 %), and severe anaemia was present in 12 % of all patients. Among risk factors for ESKD, hypertension was present in most patients (68 %) and was followed by T2DM (in 25 % of all patients) (Table 2).

Prevalence of adequate haemodialysis

Sp-Kt/V was expressed as a score, and 1.2 was used as a cut-off point (with <1.2 indicating inadequate haemodialysis and ≥1.2 indicating adequate haemodialysis). URR is expressed as a percentage, and ≥65 % was used as a cut-off

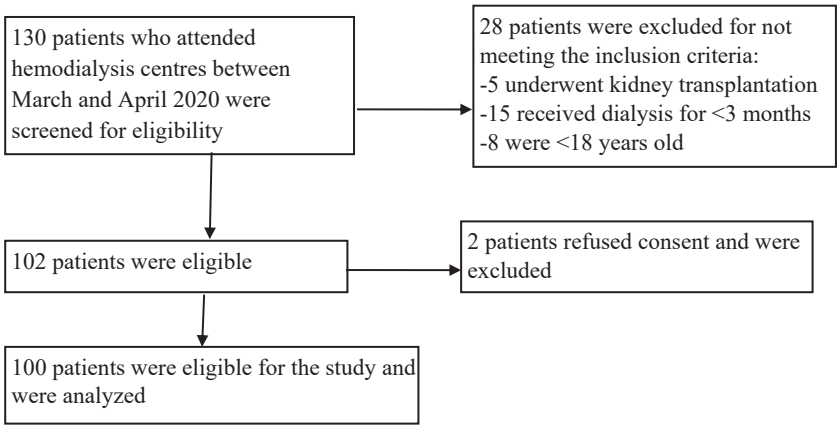

Figure 1: Flow chart indicating the recruitment process for the patients in the study.

point (with <65 % indicating inadequate haemodialysis and ≥65 % indicating adequate haemodialysis), as previously described.[17] The mean scores for URR and sp-Kt/V were 70.1 ± 21.5 % and 1.6 ± 0.6, respectively. The prevalence of AoH, on the basis of the URR and sp-Kt/V formulae, was 72 % and 75 %, respectively. The remaining 28 % and 25 % of patients had inadequate haemodialysis, according to the URR and sp-Kt/V formulae, respectively.

Binary logistic regression analysis of predictors of adequacy of haemodialysis

Table 3 presents the binary logistic regression analysis of predictors of AoH, on the basis of the URR formula. After adjustments were made for the duration since dialysis initiation, number of dialysis sessions per week, Hb level and pre-dialysis BP in multivariable analysis, having <12 months of dialysis after initiation of haemodialysis (AOR = 7.3, 95 % CI = 0.11−0.90, p = 0.032), fewer than three dialysis sessions

Table 1: Sociodemographic characteristics of the patients (N = 100).

Variables	Frequency (n)	Percentage (%)
Age group (years)		
<50	55	55.0
≥50	45	45.0
Sex		
Male	60	60.0
Female	40	40.0
Marital status		
Single	16	16.0
Married/cohabiting	64	64.0
Divorced/separated	9	9.0
Widow/widower	11	11.0
Place of residence		
Urban	86	86.0
Rural	14	14.0
Occupation		
Employed	45	45.0
Self-employed	35	35.0
Unemployed	20	20.0
Level of education		
Informal	8	8.0
Primary	19	19.0
Secondary	25	25.0
Tertiary	48	48.0
Comorbidities		
Yes	19	19.0
No	81	81.0

Table 2: Treatment characteristics of the patients (N = 100).

Variables	Frequency (n)	Percentage (%)
Duration since dialysis initiation (months)		
≤12	58	58.0
>12	42	42.0
No. dialysis sessions per week		
<3	13	13.0
≥3	87	87.0
Pre-dialysis blood pressure		
Normotensive	8	8.0
Pre-hypertensive	34	34.0
Hypertensive stage 1	30	30.0
Hypertensive stage 2	28	28.0
Post-dialysis blood pressure		
Normotensive	2	2.0
Pre-hypertensive	34	34.0
Hypertensive stage 1	44	44.0
Hypertensive stage 2	20	20.0
Haemoglobin level (g/dl)		
Normal	23	23.0
Mild	25	25.0
Moderate	40	40.0
Severe	12	12.0
Vascular access		
Arteriovenous fistula	60	60.0
Central venous catheter	37	37.0
Subclavian	3	3.0
Risk factors for ESKD		
Hypertension	68	68.0
Diabetic mellitus	25	25.0
Others	7	7.0
Complications during dialysis		
No	55	55.0
Yes	45	45.0
Blood flow (ml/min)		
<200	7	7.0
≥200	93	93.0

Table 3: Binary logistic regression analysis of predictors of adequacy of haemodialysis, according to the URR formula.

Variables	Univariate analysis		Multivariate analysis	
	UOR (95 % CI)	p	AOR (95 % CI)	p
Duration since dialysis initiation (months)				
≥12	Reference		Reference	
<12	4.4 (0.17–1.03)	0.059	7.3 (0.11–0.90)	0.032
No. of dialysis sessions per week (days)				
≥3	Reference		Reference	
<3	10.7 (2.64–43.63)	0.001	6.9 (1.52–31.49)	0.013
Haemoglobin level (g/dl)				
Normal	Reference		Reference	
Mild	0.8 (0.19–3.62)	0.817	–	–
Moderate	0.5 (0.14–1.75)	0.077	0.6 (0.14–2.28)	0.429
Severe	2.3 (0.03–0.73)	0.018	2.2 (0.26–0.93)	0.033

Table 4: Binary logistic regression analysis of predictors of adequacy of haemodialysis, according to the sp-Kt/V formula.

	Univariate analysis		Multivariate analysis	
	UOR (95 % CI)	p	AOR (95 % CI)	p
Duration since dialysis initiation (months)				
≥12	Reference		Reference	
<12	4.4 (0.15–0.95)	0.039	3.7 (0.15–1.01)	0.052
No. of dialysis sessions per week				
≥3	Reference		Reference	
<3	5.4 (1.52–18.91)	0.009	5.6 (1.47–19.66)	0.011
Pre-dialysis BP				
Normotensive	Reference		Reference	
Pre-hypertensive	1.8 (0.90–23.87)	0.113	0.3 (0.66–11.88)	0.204
Hypertensive stage 1	1.5 (0.21–12.03)	0.532	–	–
Hypertensive stage 2	2.9 (0.36–0.73)	0.026	3.3 (0.90–4.80)	0.481

per week (AOR = 6.9, 95 % CI = 1.52–31.49, p = 0.013) or severe anaemia (AOR = 3.2, 95 % CI = 0.26–0.93, p = 0.033) were found to be independent predictors of inadequate haemodialysis, according to the URR formula.

For the sp-Kt/V formula, having fewer than three dialysis sessions per week remained an independent predictor of inadequate haemodialysis (AOR = 5.6, 95 % CI = 1.47–19.66, p = 0.011) (Table 4).

Patient outcomes

After a follow-up period of 4 months (April through July of 2020), 2 % of the 100 patients were lost to follow-up (did not present for dialysis in subsequent weeks); thus, a total of 98 % of patients were available until the end of the study period. A total of 82.3 % of patients had good outcomes; the remaining 17.3 % had poor outcomes, among whom 11.2 % died, and 6.1 % had recurrent hospitalization for uremic syndrome or severe anaemia. The most common causes of death were cardiovascular complications, which accounted for more than half of the deaths (54.5 %, 6/11). Other causes included uremic syndrome (27.3 %, 3/11) and severe anaemia (18.2 %, 2/11).

Discussion

This study was aimed at assessing the prevalence and factors associated with AoH among patients with ESKD. Additionally, the patients' clinical outcomes were determined. Assessment of AoH in patients with ESKD is critical to ascertain clinical outcomes. Several factors aid in determining the chances of adequate or inadequate haemodialysis, and the success of dialysis, among patients with ESKD.

In this study, most patients achieved adequate haemodialysis (more than 70 %), on the basis of either the URR or sp-Kt/V formula. These findings are similar to those from an Iranian study in which the prevalence of AoH among patients with ESKD was 83.3 % and 78.9 % according to sp-Kt/V and URR, respectively.[18] In addition, similar findings have been reported in a study in the United Kingdom, in which the prevalence of AoH among patients with ESKD, according to sp-Kt/V, was 73.8 %.[19] Furthermore, other studies in Rwanda[20] and Kenya[21] have reported high prevalence of AoH (62 % and 83 %, respectively). However, additional studies in Tanzania,[7] Egypt[22] and Nigeria[23] have reported substantially lower prevalence of AoH (40.6 %, 34.3 % and 45.3 %, respectively, on the basis of the sp-Kt/V and URR formulae).

The discrepancy in the prevalence of AoH across studies in different countries might be due to various reasons. For example, differences in the clinical characteristics of patients with ESKD at study enrolment might have contributed to the difference in the prevalence of AoH. Among patients with ESKD, those with comorbidities have been found to be more likely than those without comorbidities to have challenges in achieving adequate haemodialysis.[24,25] In addition, differences in the number of dialysis sessions per week might

have contributed to the differences in achieving adequate haemodialysis among patients.[23] For example, patients with ESKD who start haemodialysis earlier are more likely to achieve adequate haemodialysis. These factors together have been found to contribute to the low prevalence of AoH among patients with ESKD.[26,27]

Factors determining the ability of patients with ESKD to achieve adequate haemodialysis vary considerably. Despite evidence that early initiation of dialysis among patients with advanced CKD helps improve patient outcomes, no consensus exists regarding the optimal time for the initiation of renal replacement therapy, particularly haemodialysis.[28] Contradictory findings have been reported. In this study, early initiation of haemodialysis was statistically significantly associated with AoH. Patients undergoing dialysis for $\geq$12 months were more likely to achieve adequate haemodialysis than those undergoing dialysis for $<$12 months. A review article by Maffei et al. has also indicated that early initiation of dialysis among patients with ESKD helps prevent disease progression to renal failure and mortality.[29] In another large observational study in 10,290 patients with advanced CKD, modestly lower mortality rates and higher chances of achieving adequate haemodialysis was observed with early rather than late dialysis initiation; however, the difference did not reach statistical difference.[30]

Some studies have reported no association between early and late initiation of dialysis in achieving adequate haemodialysis. For example, in a large randomized controlled clinical trial in 828 patients, conducted between 2000 and 2008, no significant difference in prognosis (early and late initiation of dialysis) has been observed between arms.[31] In addition, a study in Tanzania has indicated low prevalence of AoH among patients with longer rather than shorter times since the initiation of dialysis (30.5 % vs 36.9 %), although the difference was insignificant ($p = 0.428$).[7]

Some studies have reported a lack of association between early initiation of dialysis and adequate dialysis; nonetheless, clear benefits have been associated with early initiation of dialysis among patients with ESKD.[31,32] Furthermore, early dialysis initiation is associated with low levels of dialytic and endogenous renal clearance, as well as improvements in morbidity, mortality and nutrition, among patients with ESKD.[32] The reason for these contradictory findings might be explained by the lack of consensus regarding the optimal time of dialysis initiation and the lack of universal criteria for selecting patients to start dialysis.

Another predictor of AoH in this study was the number of dialysis sessions per week, in agreement with findings from a study in Egypt indicating a strong association between higher clearance rates and increased dialysis duration in each session, with a frequency of 3 times dialysis per week.[33] In another study in Iran, Aghighi et al. have reported that, patients receiving three or more sessions of dialysis weekly are more likely to achieve adequate haemodialysis than patients receiving fewer than three dialysis sessions per week.[34] Furthermore, a study in Palestine has reported that having fewer than three dialysis sessions per week, with a duration of less than 8 h per week, is associated with an elevated risk of mortality.[35] Although three sessions per week for haemodialysis are recommended by the kidney disease outcomes quality initiative (KDOQI) guidelines[36] as the standard of care for achieving AoH in patients with ESKD, dialysis sessions twice per week are widely used as an initial treatment in some countries, such as China, India and many other resource constrained countries, for a range of clinical and financial reasons.[37]

Clinical practice guidelines usually recommend not having fewer or more than three dialysis sessions per week.[38] This approach of three dialysis sessions per week has been used since haemodialysis was introduced as a kidney replacement therapy modality. However, over time, the use of two sessions or more than three sessions per week has been assessed. Short durations of fewer than three times per week (i.e., two sessions weekly), compared with three times per week, have been associated with longer treatment times and lower likelihood of achieving adequate dialysis among patients with advanced CKD, although the survival difference was not significant.[39] Therefore, patients undergoing haemodialysis must have a minimum of three sessions of dialysis per week for potential timely achievement of adequate dialysis.

The effect of anaemia on AoH was also assessed in the present study. Patients with severe anaemia were notably less likely to achieve adequate haemodialysis than patients with normal Hb levels, but the difference did not reach statistical significance. Similarly, Somji et al. have reported that patients with Hb levels $<$10 g/dl are significantly more likely to have inadequate haemodialysis than patients with Hb levels $\geq$10 g/dl (7). Vinhas et al. have reported an association with elevated mortality among patients with advanced CKD receiving haemodialysis with Hb $<$ 103 g/L.[40] However, other studies in Iran[41] and India[42] have reported that low Hb levels do not predict inadequate haemodialysis. In another randomized controlled clinical trial, treatment of patients with advanced CKD with erythropoietin-inducing agents has not been associated with improvement in survival.[43]

The association between low Hb levels and failure to achieve adequate haemodialysis among patients with ESKD, as observed in most observational studies including the present study, might potentially be due to chance rather than being a true association, because observational studies cannot establish causality. In addition, although the primary cause of anaemia in patients with advanced CKD is impaired erythropoiesis due to diminished kidney function, patients may have other underlying causes of anaemia that contribute to the heterogeneous effects among patients. This heterogeneity might have led to the discrepancies among the results observed.

Most patients in this study had good outcomes, whereas only 17.3 % patients had adverse outcomes. Among the latter, 11.2 % died, primarily because of cardiovascular disease or uremic syndrome. This mortality rate was close to the 17.9 % reported in a study by Meremo et al. in Tanzania among patients with ESKD, in which cardiovascular disease was also the main cause of death.[44] Other studies have shown markedly higher mortality rates than observed in the present study. For example, in studies in Cameroon,[45] Canada[46] and Nigeria,[47] mortality rates of 44.9 %, 28 % and 66.7 %, respectively, have been reported.

Although patients in this study had better outcomes than reported in other studies, most patients with ESKD undergoing haemodialysis, particularly those in most developing countries, have poor outcomes because of the high cost of haemodialysis, challenges associated with availability of such services and late presentation for treatment.[48] Other factors contributing to poor outcomes include uremic bleeding; septicaemia; repeated blood transfusions; and fewer dialysis sessions per week, possibly because of financial constraints.[44] Furthermore, a lack of reliable health insurance to cover haemodialysis costs for most patients widely contributes to poor outcomes among patients with ESKD, because of discontinuation of dialysis.

Limitations of the study

This study had financial constraints that prevented the investigation of other parameters such as albumin, inflammatory biomarkers and residual renal function. In addition, the relatively short follow-up duration might have influenced the low mortality rate. Future prospective studies with larger sample sizes and longer follow-up durations would provide more comprehensive information regarding the prevalence and predictors of AoH among patients with ESKD.

Conclusion

This study suggested that early initiation of dialysis and having at least three dialysis sessions per week may help patients with ESKD achieve adequate haemolysis and hence improve their clinical outcomes. In addition, prevention of anaemia among patients with ESKD may improve patient prognosis through achieving adequate haemodialysis.

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Conflict of interest

All authors declare that they have no conflicts of interest to be disclosed.

Ethical approval and consent to participate

We obtained ethical approval from the ethical research committee of the University of Dodoma (reference UDOM/RP/68/vol. IV/8, issued on 23 March 2020).

Recommendations

The importance of early haemodialysis initiation among patients with ESKD should be emphasized to increase the chances of achieving adequate dialysis and improve patient outcomes. Additionally, controlling anaemia, particularly severe anaemia, is also important to help patients achieve adequate haemodialysis.

Authors contributions

AIB, JJY and ZSA: conception, design, data curation, statistical analysis and writing the first manuscript draft. **BMM** and **BM**: organizing, supervision and methods. All authors reviewed the final version of the manuscript. All authors have critically reviewed and approved the final draft, and are responsible for the content and similarity index of the manuscript.

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