# EXPERIENCE WITH ARTERIOVENOUS FISTULAE IN LONG TERM HAEMODIALYSIS PATIENTS AT THE KENYATTA NATIONAL HOSPITAL

**PRINCIPAL INVESTIGATOR**

**DR. JULIET AKOTH OOKO**

**H114/34942/2019**

**A DISERTATION SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF FELLOWSHIP IN CLINICAL NEPHROLOGY**

**NOVEMBER, 2021**

## DECLARATION

I hereby declare that this dissertation is my original work and has not been presented for any award in any other university elsewhere

Signed ………………………………………………… Date ……19-11-2022

Dr. Juliet Akoth, M.B.Ch.B, MMED (Internal Medicine)

Nephrology fellow, EAKI

## SUPERVISORS

The dissertation has been presented with my full approval as supervisor

Signed .............................................. Date 18/11/22

Prof. Seth O. McLigeyo, M.B.Ch.B., M.MED (Internal Medicine)
Professor of Medicine,
Department of Clinical Medicicne and Therapeutics, University of Nairobi
Consultant Physician & Nephrologist

The dissertation has been presented with my full approval as supervisor

Signed .............................................. Date ..................

Prof. Joshua Kayima, M.B.Ch.B., M.MED (Internal Medicine)

Associate Professor of medicine

Department of Clinical Medicine & Therapeutics, University of Nairobi,

Consultant Physician & Nephrologist

The dissertation has been presented with my full approval as supervisor.

Signed .............................................. Date 25/11/2022

Dr. Benjamin Wambugu, M.B.Ch.B., M.MED (Internal Medicine)
Fellow of International Society of Nephrology
Department of Medicine, Kenyatta National Hospital
Consultant Physician & Nephrologist

The dissertation has been presented with my full approval as supervisor

Dr. Samuel K. Kabinga M.B.Ch.B., M.MED (Internal Medicine)

Fellowship in Clinical Nephrology

Consultant Physician & Nephrologist

Signed .............................................. Date ..................

## TABLE OF CONTENTS

**LIST OF ABBREVIATIONS**

| | | |
|---|---|---|
| AVF | - | Arteriovenous fistulae |
| AVG | - | Arteriovenous graft |
| BMI | - | Body mass index |
| BC | - | Brachio-cephalic |
| CGN | - | Chronic glomerulonephritis |
| CKD | - | Chronic kidney disease |
| DOPPS | - | Dialysis Practice and Outcome Patterns |
| EAKI | - | East Africa Kidney Institute |
| ESKD | - | End stage kidney disease |
| FFCL | - | Fistula first catheter last |
| HD | - | Haemodialysis |
| KDOQI | - | Kidney Disease Quality Initiative |
| KNH | - | Kenyatta National Hospital |
| KRT | - | Kidney replacement therapy |
| NKF | - | National Kidney Foundation |
| PD | - | Peritoneal dialysis |
| RC | - | Radio-cephalic |
| UON | - | University of Nairobi |

## LIST OF FIGURES

## LIST OF TABLES

## OPERATIONAL DEFFINITIONS

**Time from AVF creation to first cannulation**: This is the interval from the time of access placement to its first successful use for hemodialysis. This will be categorized into groups as < 4 weeks, 4-6 weeks, 6-8 weeks, 8-10weeks, 10 – 12 weeks >12 weeks.

**AVF Cannulation:** The insertion of cannulate (a needle with a lumen) or angiocaths into a vascular vessel

**Primary AVF failure**: An AVF that never developed to the point that it could be used for HD or one that failed within the first three months of its use

**Functional primary patency -** This is the interval from the time of first successful cannulation for hemodialysis to the date of one of the following events [whichever comes first]: thrombosis, any intervention to facilitate, maintain, or re-establish patency or the time of measurement of patency

## ACKNOWLEDGEMENT

*I wish to express my sincere gratitude to the following for their contribution towards the success of this dissertation: My supervisors Professor. Seth Mc Ligeyo, Professor Joshua Kayima, Dr.Samuel Kabinga and Dr. Benjamin Wambugu have worked tirelessly and very patiently to ensure completion of this dissertation.*

*I'm thankful to my Family and classmates for their unwavering support and patience.*

*And finally, to Almighty God for his grace and mercies*

## ABSTRACT

**Background:** Arteriovenous fistulae (AVF) are associated with fewer long-term events such as thrombosis, loss of primary patency and interventions, and should therefore be considered the vascular access of choice for HD whenever feasible. However, like any other vascular access, AVF are prone to a myriad of complications and varying rates of dysfunction. The number of patients on long term HD in Kenya has exponentially increased from 120 in 1995 to 2300 in 2017 and 4800 in 2020. In an attempt to increase AVF access among HD patients and reduce the number of patients on maintenance HD using central venous catheters (CVC), AVF surgery activities in KNH were up scaled through fistula camps in 2018 and 2019 and regular AVF surgeries and clinics in 2021. There are large international variations on experiences and outcomes of AVFs for hemodialysis with limited data from Africa. At the KNH, there is no structured system of following up patients after arteriovenous fistula creation, therefore the anatomical sites of AVF placement and their outcomes remain largely unknown.

**Objectives:** The objectives of this study were to describe sociodemographic and clinical characteristics of patients who underwent AVF creation surgery during the 2018 and 2019 AVF camps at the KNH, document the anatomical sites and describe the outcomes of AVFs created during this period at the KNH.

**Methodology:** This was an ambispective observational study of the outcomes of AVFs placed during the 2018 and 2019 AVF surgery camps at the KNH. Data on the patients' sociodemographic and clinical characteristics, vascular access history, anatomical location of the AVF under study, date of first successful AVF cannulation and functional status of the AVF at the time of the study was collected and analyzed.

**Data management and analysis:** Data was entered into a pre-programmed Statistical Package for Social Sciences (SPSS®) version 21.0 with which statistical analyses were performed. Continuous variables were summarized into means, modes and median. Categorical variables were summarized into frequencies. Fishers exact and Chi-square test of association were used to test for significant clinical associations. All statistical tests were done at 95% level of confidence where p-value <0.05 was considered significant.

**Results:** Data from 95 participants who underwent AVF creation surgery at the Kenyatta National Hospital was analyzed. Majority were male 56 (58.9%). Their median age was 43.0 years (range from 18 – 82 years). Hypertension was the most frequent cause of ESKD 71(74.7%), followed by diabetes 28(29.5) and chronic glomerulonephritis 22 (23.2). Their median hemodialysis vintage was 8 months. The incident hemodialysis vascular access was acute internal jugular catheter in 31(32.6), subclavian vein catheter in 29(30.5%) and cuffed tunneled catheter in 24 (25.3%). Only 2(2.1) participants were initiated on hemodialysis using AVF. Brachiocephalic AVF was created in 53(55.8%) and radio cephalic AVF in 40(42.1%) of the participants. Successful primary AVF maturation was reported in 54(56.8%) and primary AVF failure in 41(43.2%). The median time from creation to cannulation was 8 weeks. Arteriovenous fistula patency was 47(87.0) at 6 months and 45(83.3%) at one year. Only the incident vascular access was significantly associated with primary AVF maturation or failure.

**Conclusion:** This study revealed a low uptake of AVF for incident hemodialysis, central venous catheters were preferred for initiation and maintenance of hemodialysis. Brachiocephalic anastomosis was preferred in majority of the participants. This raises a concern over future vascular access options for this young population of patients. The AVF primary failure rate was comparable to the rest of the world and AVF survival at 6 months and 1 year was good. However electronic medical records and AVF surveillance protocols would enable early identification of fistulas at risk of non-maturation for for timely referral and intervention.

# CHAPTER ONE

# INTRODUCTION

## 1.1. Background

The prevalence of chronic kidney disease (CKD) has increased drastically in the last decade. The estimated global prevalence of CKD at various stages is 9.1%, with stage 5 accounting for 0.07% and dialysis 0.041% of the cases(1). The average prevalence of CKD in the African continent is 10.1%, with North Africa having the lowest while West and Central Africa has the highest prevalence of 4% and 16% respectively (1,2). It is projected that the number of end- stage kidney disease (ESKD) cases requiring kidney replacement therapy (KRT) worldwide will double from the current 2.3 million to 5.4 million by 2030 (1).

The availability of KRT modalities which include hemodialysis (HD), peritoneal dialysis (PD), and kidney transplantation, are limited in most of the low- and middle-income countries. Kidney transplantation, which is the treatment of choice for ESKD is extremely expensive and places a significant economic constraint on the health care systems system in both developed and third world countries(3). Besides, there are few or no nephrologists and nephrology nurses in a majority of the African countries (4,5). In Kenya and the majority of African countries, in-center HD units are the most common, the prevalence of CVC use for incident and prevalent HD high (5,6). As a result of Intense lobbying by the Kenya renal association and patient groups, the government of Kenya established at least one hemodialysis unit in each of the 47 counties between the year 2015 and 2017. Consequently, the number of ESKD patients on long term HD increased from 120 in the year 1995 to 2300 in 2017 and 4800 in 2020 (7)

The choice of dialysis access for patients undergoing HD varies widely depending on the availability of resources, reasons for starting HD, timing of HD initiation, patient education and preparedness (8). Arteriovenous fistulae (AVF) are the vascular access of choice for patients on maintenance HD (8).

They have greater functional longevity, less prone to infection, and are associated with lower mortality and cost. AVF delivers better blood flow which translates in part to the adequacy of hemodialysis and ultimately better treatment outcomes. However, like other vascular accesses, they are prone to a myriad of complications and varying rates of dysfunction including primary failure, bleeding, thrombosis, stenosis, aneurysms, infections, arterial steal and nerve injury.

Implementation of the 'fistula first catheter last' (FFCL) initiative has led to a steady rise in the percentage of prevalent HD patients on AVF in the USA and other developed counties (9,10). Barriers to increasing the prevalence rate of AVF use in dialysis units include late referral to nephrologists, lack of awareness among incident HD patients, high cost of AVF creation, few vascular surgeons, poor communication among nephrologists, surgeons interventional radiologists, and dialysis staff prolonged duration of maturation, primary fistulae failure and fistulae malfunction (8,10,11). In an attempt to increase AVF access among HD patients and reduce the number of patients on maintenance HD using CVCs, AVF surgery activities in KNH were upscaled through fistula camps from the year 2018, and regular AVF surgeries and clinics in 2021.

### 1.2. Problem statement

Arteriovenous fistulae are the vascular access of choice for patients on maintenance hemodialysis. They have a greater functional longevity, less prone to infection and are associated with lower mortality and cost. However, AVF are prone to a myriad of complications and varying rates of dysfunction. In Kenya, there have been deliberate efforts to increase AVF access and uptake among HD patients at the Kenyatta National Hospital (KNH) through AVF camps in collaboration with local and foreign vascular surgeons. There is no structured system of following up patients after arteriovenous fistula creation, therefore their outcomes remain unknown

### 1.3. Research questions

i. What were the anatomical sites used for AVF creation in HD patients during the 2018 and 2019 AVF camps at the KNH?

### 1.4. Objectives

#### 1.4.1 Broad objective

To document the anatomical sites of AVF placement and describe the outcomes of arteriovenous fistulae created during the 2018 and 2019 AVF camps

#### 1.4.2 Specific objectives

i. To describe the socio-demographic and clinical characteristics (age, gender, documented etiology of kidney disease, hemodialysis vintage, and vascular access history) of HD patients who underwent AVF creation surgery during the 2018 and 2019 AVF camps at the KNH.
ii. To document the anatomical sites used for AVF creation in HD patients during the 2018 and 2019 AVF camps at the KNH?
iii. To describe the outcomes of AVFs created during the 2018 and 2019 AVF camps at the KNH including;
    - Time from AVF creation to first successful cannulation in days
    - The prevalence rate of primary AVF failure.
    - Functional primary patency rate at 6 and 12 months

#### 1.4.3 Secondary objective

i. To correlate AVF outcomes with selected patient factors including age, sex, anatomical site of AVF creation, previous central venous catheter use, dialysis vintage, co-morbidities like diabetes, hypertension and congestive heart failure

### 1.5 Study justification

Vascular access plays a central role in the management of CKD patients on maintenance HD. Arteriovenous fistulae are recommended worldwide as the vascular access of choice for patients on maintenance hemodialysis(8). Arteriovenous fistulas have longer patency rates and fewer complications when compared to central vein catheters and arteriovenous grafts. Survival and uptake of AVF has been shown to differ across continents with Japan reporting the longest survival compared with Europe, Australia, and North America (9,10).

The number of patients on long-term HD in Kenya has exponentially increased from 120 in 1995 to 2300 in 2017 and 4800 in 2020 (7). A study published by Samuel K. et al in 2019 documented a prevalence AVF use of 2% among incident HD at the KNH dialysis unit, this improved to 14% at three months of HD (6). With the rising number of ESKD patients on maintenance hemodialysis, it is expected that the prevalence of AVF will equally increase. In order to meet the demands of the growing HD population, reduce the number of patients on maintenance HD using catheters, AVF surgery activities at the KNH have been upscaled through AVF surgical camps from 2018 and regular AVF clinics from the year 2021.

There are large international variations and paucity of data from Africa on AVF experiences and outcomes, besides, no study of this nature has been carried out in Kenya. AVF outcomes and their associated factors in our set up, therefore, remain largely unknown. This study will give a snapshot of AVF outcomes in our setup, provide baseline data and inform a structured AVF surveillance system.

# CHAPTER 2

# 2 LITERATURE REVIEW

### 2.1. Prevalence rate of arteriovenous fistula use for hemodialysis

An arteriovenous fistula for dialysis is a surgically created connection between an artery and vein for the purpose of vascular access for hemodialysis. Arteriovenous fistulae were first described and used by Brescia et al in 1966 (12). The first successful surgically created AV fistulae was placed in 1965 followed by a further 14 in 1966 by Dr. Apell in New York by performing a side to side anastomosis between the radial artery and cephalic vein. Lars Rohl et al in 1968 published the results of 30 radial artery side to vein end anastomosis (13), many years later, this technique has become a standard procedure for AVF creation. Further developments and innovations in vascular access saw a dramatic increase in the use of arteriovenous grafts (AVG) and central venous catheters (CVC) and a decline in the use of arteriovenous fistulas in the 1990s (9).

In 2003, the FFCL was initiated in the USA. Its main purpose was to increase the appropriate use of AVF for hemodialysis access and to reach or exceed the Kidney Disease Outcome Quality Initiative (KDOQI) recommendations of 50% in incident and 40% in prevalent HD patients (9). The current goal for fistula uses among prevalent hemodialysis patients is 68%. In the USA, only about 16.9% of patients initiate hemodialysis with an AVF, however at 1 year, 65% of the patients dialyze exclusively using an AVF (14). Results from the dialysis outcome and practice patterns studies (DOPPS) demonstrated a high level of AVF use in European countries, USA, china, Japan and the gulf cooperation countries ranging between 58% and 88.2% among prevalent HD patients (15–19)

Data on vascular access use in Africa is limited. However, in a majority of African countries, the prevalence rates of hemodialysis catheters for maintenance of hemodialysis is way above the recommendation of less than 10% in prevalent hemodialysis patients. In a cross-sectional descriptive survey carried out in a public hospital in Kenya, 80% of patients were initiated on hemodialysis using acute catheters while less than 2% had AVF at initiation of hemodialysis. The rate of AVF use increased to 14.5% at three months post initiation (6,20). In yet another survey in a private dialysis facility, the arteriovenous fistula prevalent rates of 81.4% was reported, with the remaining 18.6% using tunneled catheters for maintenance of hemodialysis (21). In a study carried out in a South African tertiary hospital, 5% of patients were initiated on dialysis using AVF while 38% of prevalent hemodialysis patients used AVF (22)

**2.2. Timing, selection of patients and anatomical sites for arteriovenous fistula placement**

Timing of AVF placement and avoidance of catheter access is critical to the successful transition from chronic kidney disease to end stage kidney disease with hemodialysis. While the CKD staging systems identify specific actions to enhance the health and outcomes patient with CKD, it does not predict the optimal time to start of HD and for AVF access creation(23). Delay in AVF placement leads to increased reliability on catheter access contributes significantly to morbidity, mortality and high cost of hemodialysis(24). On the other hand, early AVF creation could lead to high rates of AVF failure and death before dialysis commencement (25,26)

The mean maturation time for a new AVF is about two months (27). Patients whose fistula fail to mature adequately for use in hemodialysis require subsequent interventions to promote maturation or creation of alternative vascular access (28). The KDOQI 2006 guidelines recommended vascular access creation six months prior to initiation of hemodialysis. The 2019 National Kidney foundation (NKF) guidelines recommends a patient centered, multidisciplinary approach to the development of an ESKD life plan for patients with an eGFR of 15-20ml/min/1.73 $m^3$ or already on dialysis. This includes individualized selection and quarterly review of each patients' kidney replacement modality and vascular access choice, functionality, complications, risks and potential future dialysis access options (29). Some guidelines recommend vascular access creation at CKD stage 5 and consideration at a higher eGFR in patients with diabetic nephropathy while others suggest evaluating patients for vascular access placement at eGFR of 15-20ml/min/1.73m$^3$ if they demonstrate a progressive decline in kidney function (30,31).

Adequate patient evaluation and selection increases the likelihood of a successful AVF creation and function. Patient evaluation includes medical history, access focused history, physical examination, and when necessary, a doppler examination of the vessels (30,32,33). This determines a patient's eligibility for AVF and provides insight into the risk of developing complications such as primary failure, steal syndrome and thrombosis(30,33). Young patients with few co morbidities, appropriately sized vessels, long life expectancy and sufficient time for AVF maturation should be offered AVF as the first hemodialysis access. Patients with a short life expectancy, multiple co morbidities like significant peripheral vascular disease and heart failure should be considered for catheter or arteriovenous grafts (33). Vascular mapping using a doppler ultrasound is associated with increased rates of AVF creation, reduced primary failure and increased AVF patency rates (34). When a vessel is examined using doppler ultrasound, the vessel caliber, depth presence of calcifications should be noted. Other anomalies including thrombophlebitis, atherosclerosis and tortuosity are also taken into account (33,35). If an intrinsically diseased, calcified artery or sclerotic vein without adequate flow is selected, the chances of primary failure are high (10,34)

Arteriovenous fistulas are named according to the specific vein and artery involved. Most arteriovenous fistulas fall within these basic categories (33,36)

i. Radial- cephalic - anastomosis between the radial artery and cephalic vein at the wrist
ii. Fore arm basilic – anastomosis between the radial or ulna artery and basilic vein at the wrist
iii. Brachial cephalic – anastomosis between the brachial artery and cephalic vein in the proximal fore arm
iv. Brachial basilic – anastomosis between the brachial artery and basilic vein
v. Lower extremity arteriovenous fistulae – anastomosis between the superficial femoral artery and the saphenous or femoral/popliteal vein in the thigh

Vascular access guidelines in the united states, Europe and Japan strongly recommend distal upper extremity sites as the first choice for AVF creation when feasible (29,30,32,37). This is commonly called the Cimino fistula based upon the first fistula placed by Dr. Cimino in 1966(12). Distal fore arm radio cephalic AVF preserves more veins for AVF construction in the future, has fewer complications (steal syndrome, infection), have high patency rates and allows long term use of veins for cannulation. The main disadvantage of fore arm radio cephalic AVF is non maturation characterized by inadequate dimensions of the venous out flow tract or insufficient inflow. I year patency rates of distal foe arm fistulas range between 50% and 80% (38). High flows associated with upper arm brachiocephalic fistula are associated with increased cardiac output and impaired systemic blood flow in patients with impaired cardiac function, a phenomenon known as AVF cardiotoxicity. However, a study by Khadatkar A et al found that Brachiocephalic AVF had significantly less maturation time, less overall complications, more flow rates and can be cannulated earlier than radio cephalic AVF at the wrist (35). During DOPPS 1-5 study, nearly all AVFs were located in the upper extremity. Distal fore arm radio-cephalic AVF was consistently more than 95% in Japan and 65-77% in Europe. In The USA, this value declined from 70% in 2002 to 32% in 2015. Successful AVF use was greater for upper versus lower arm AVFs in the USA, little difference in Europe while the opposite pattern was true in Japan(39).

### 2.3. Clinical evaluation of arteriovenous fistula for maturation and timing of first cannulation

Immediately after arteriovenous anastomosis, the flow rates in the vessels increases as a result of both vasodilatation and vascular remodeling of the vein and artery(40). Blood flow must increase to levels that allow adequate delivery to the machine with minimal recirculation and the vessel must increase adequately in diameter to accommodate cannulation. It is the vascular  remodeling and changes in hemodynamics is that constitutes AVF maturation (10,40,41).

Physical examination of a newly created fistula by an experienced practitioner has an accuracy of more than 80% in predicting AVF maturation (41–43). A newly created AVF should be examined by the surgeon at least two weeks following the surgery to assess for early surgical complications. Maturity and usability should be assessed after four to six weeks by all hemodialysis care givers. The cornerstones of Physical examination of AVF are inspection, palpation and auscultation(44,45).

The optimal time for waiting before the first use of a newly created AVF is not known. There are significant differences globally regarding the practice of initial cannulation of AVFs. Analysis of 849 patients initiating HD with AVFs fistulas found a wide variation in the median time to AVF cannulation among  countries with an average of 25 days for Japan, 27 days for Italy, 42 days for Germany, 86 days for France, 80 days for Spain, 96 days for UK and 98 days for Us (46). Cannulation within 14 days was associated with a 2-fold increased risk of subsequent fistula failure. In another analysis of 2154 fistula, early cannulation of AVF was not associated with increased risk of vascular access failure (27).

The KDOQI guidelines considers an ideal fistula as the one that meets the 6 “s”: six weeks after creation, a mature AVF should have a blood flow of 600 ml/min, depth of less than 0.6 cm below the skin and have a straight length of at least 6 cm for cannulation (47). Other  International guidelines recommend cannulation of AVFs four to six weeks after creation if they are considered suitable for cannulation on clinical examination (37,48). Suitability for cannulation or AVF maturity on clinical examination is determined by the presence of a soft easily compressible vein with a good thrill, adequate length and superficial enough to be easily punctured by two needles. If clinical examination is inconclusive, bedside ultrasound with flow measurement should be used to decide whether to cannulate or not. Early cannulation of AVFs may lead to perforation, hematoma or destruction of the access site and inadequate quality of hemodialysis. However, delayed cannulation causes prolonged use of dialysis catheters and a delay in diagnosing AVF non maturation and interventions(37,47).

An arteriovenous fistula is considered functional and successfully used for hemodialysis when it is cannulated with two needles over a period of at least six HD sessions during a 30-day period and delivering the prescribed blood flow throughout the HD procedure (at least 350 l/min) (37,43,49,50)

In the hemodialysis fistula maturation study, 6 weeks ultrasound of the AVF blood flow, diameter and depth were moderately predictive of unassisted and overall clinical maturation (42). Inflow artery diameter, heart rate and blood pressure determine the potential AVF flow volume. Arteries with a diameter of <2mm may limit blood flow to 400ml/min depending on the blood pressure (40,51). After AVF creation, doppler examination of brachial artery-based fistulas should be done at least 5cm proximal to the site of anastomosis. An AVF flow rate of 400 – 500 ml/minute have sensitivity of 67% - 96% and specificity of 65% to 95% for predicting AVF maturation while a volume flow rate of less than 400 – 500ml/minute is associated with AVF thrombosis (41,52).

The optimal diameter for predicting usability of an AVF for hemodialysis is not clearly defined, however, however, the likelihood of vein usability increases proportionately with an increase in diameter (41,42). In a study carried out in china in 2016, cephalic vein diameter of > 5.2mm and flow rate 529 ml/min was predictive of AVF maturity (52)

### 2.4. Complications of arteriovenous fistulae

Complications of arteriovenous fistulae can be divided into acute or chronic. There are important surgical and patient related factors that determine the likelihood of AVF maturity and complications. Previous sites of vein injury e.g. venous punctures, catheter wall contact, may impede outward remodeling and present sites of stenosis. Patient factors including post-surgical inflammation and hypercoagulability may compound and cause early access failure. Acute complications occur in the first few hours or days after the construction of an AVF and always require evaluation by a vascular surgeon. They include bleeding, hematoma formation and thrombosis. Chronic complications occur days or months after creation of an arteriovenous fistula. They include lymphedema, infection, thrombosis, stenosis, aneurysm, steal syndrome, ischemic neuropathy, and congestive heart failure(53).

The consequences of AVF failure is far reaching. It denies patients a functional access, reduces the number of sites where other subsequent accesses can be placed, exposes the patient to expensive interventional procedures in the attempts to salvage the fistula. Studies have reported up to 50% primary failure rates and up to 25% secondary AVF failure rates. Early diagnosis and treatment of treatable causes of AVF failure and malfunction could increase the percentage of AVF fistulas that are successfully used for dialysis.

Aneurysms are pathological enlargement of the blood vessel wall (53). They result from repeated puncture in a clustered area or can occur naturally over time due to high blood flow and rising pressures within the fistula(54). False aneurysms are hematomas located outside the vessel wall formed due to a leaking hole in the artery, most often due to repeated puncture. Aneurysms require surgical repair in cases of skin ulceration or loss of integrity. If left untreated, they limit sites available for cannulation, are at risk of infection, tear and hemorrhage (53,54).

Infections account for 20% of arteriovenous fistula complications (55). Risk factors for arteriovenous fistula infection include pseudoaneurysm, hematomas, severe pruritus and scratching over the needle sites the use of hemodialysis fistulas as a route for injecting drugs of abuse, button hole vs rope ladder cannulation (54). The severity of fistula infections varies from localized cellulitis to abscess formation and bacteremia. Most AVF infections involve perivascular cellulitis which manifests with visible signs of inflammation at the vascular access puncture site with or without systemic symptoms (53). The incidence of peri operative infection after the creation of AVF is about 5%. Arteriovenous fistulas generally have a lower rate of infection compared to grafts and catheters.

Stenosis refers to a reduction in the vessel lumen diameter by more than 50%. It is the most common cause of arteriovenous fistula thrombosis and primary failure. Radiocephalic fistulas usually develop juxtaanastomotic stenosis while brachiocephalic fistulas at the cephalic arch. Juxta anastomotic stenosis is defined as >50% reduction in luminal diameter of the outflow vein within 2 to 5 cm from the arteriovenous anastomosis (40,56). Hemodynamically significant cephalic arch stenosis is seen in 30 – 77% of dysfunctional brachiocephalic fistulas (57). In flow AVF stenosis often presents as flaccid fistula with a weak bruit or thrill, difficulties in AVF cannulation, high negative arterial pump pressures and poor access flows. In out flow stenosis the fistula is tense, pulsatile, difficult to cannulate, has high venous pressure and prolonged bleeding time after cannulation or after removal of the dialysis needle (53,57)

Ischemic complications of complications of AV access occur almost always due to reduced blood flow to the extremities due to increased blood flow through the access (36). This can lead to hypoxia, ischemia and necrosis of the distal extremity. Dialysis access steal syndrome is a common complication of AVF with a prevalence of about 8% in the dialyzing population. Patients with diabetes, peripheral vascular disease and the elderly are at a higher risk and 75-90% may experience the complication after fashioning of AVF. Literature suggests that ischemia develops more commonly in brachiocephalic and brachio-basilic access as compares to radio cephalic access (53,57). There is a 5-20-fold increased rate of steal syndrome in patients with brachiocephalic fistula than in those with radio cephalic fistulas. It presents with discoloration of the extremities to purple or pale yellow, cold hand and severe pain at rest and during exercise (36,58). Prolonged hypoperfusion may lead to tissue necrosis, culminating in amputation of fingers in 1% of the patients. Ischemic neuropathy is a rare complication of AVF. It is most common in diabetic patients with peripheral artery disease especially when the brachial artery is used for vascular access (53). It presents as weak arms in the immediate post-operative period, severe pain and paresthesia in the area innervated by the median nerve.

Patients with preexisting cardiovascular disease or cardiovascular risk factors are at an increased risk of developing acute decompensated heart failure after AVF creation (59), however, there is inconclusive literature as regards worsening of heart failure after AVF creation.  The construction of an arteriovenous fistula leads to shunting of blood from the high resistance arterial system into the low resistance venous system, this leads to an increase in venous return and cardiac output (60). It is thought that the creation of an AVF increases cardiac output by 15- 20% and left ventricular end diastolic pressure by 5- 10% (53,60,61). The more proximal the fistula the higher the risk of high output cardiac failure. The greater the flow of the fistula the greater the stress on cardiac function. Literature shows a trend towards LVH in patients with AVF flows of >2000ml (58). In a retrospective study of 137 chronic kidney disease patients who had undergone echocardiography before and 2.6 years after AVF surgery, 43% developed heart failure (59). In another retrospective analysis of 113 kidney transplant recipients who were previously dialyzing via an AVF, about 25.7% required AVF closure due to symptoms of heart failure. The mean flow among patients who underwent shunt closure was 2197ml/min compared to 851 ml/min among those who did not undergo shunt closure (62).

## 2.5. Primary arteriovenous maturation failure

### 2.5.1. Definition and prevalence

The definition of primary AFV failure varies greatly in literature and in different clinical studies. It generally refers to changes in the vessel diameter, flow and ease of cannulation to successfully perform haemodialysis. Most literature incorporate early thrombosis, inadequate maturation or inability to be cannulated or used successfully over a sustained period of time, usually 3 to 4 weeks (36,63–65). In the hemodialysis fistula maturation study, the primary outcome of unassisted maturation was defined as fistula use with two needles for >75% of the dialysis sessions over a continuous four-week period and either four consecutive sessions during the 4-week period in which two needles are used and the mean dialysis machine blood pump speed is ≥300ml/min or, a single pool kt/V ≥1.4 or urea reduction ratio > 70% during any session in which two needles are used within the 4 week period (66). Several decades ago, AVF had acceptable primary failure rates of approximately 10% and a 1-year patency rates of 70% - 80%, with an increase in the AVF prevalence to >65%, the primary failure rates range between 30 and 70% and primary patency rates of 40 and 70% (64,67,68). Al Hassan et al in Nigeria reported a primary AVF failure rate of 47% and one year patency rate of 63% in a prospective evaluation of 174 patients who had permanent vascular access creation between 2008 and 2010 (69). However, lower primary AVF failure rates of 7.5% were reported in a 10-year retrospective review of outcomes of AVF in a teaching university in Nigeria (70)

### 2.5.2. Causes of primary arteriovenous fistula failure

**Hemodynamic factors**

A newly created AVF may fail to undergo maturation due to inadequate arterial and venous dilatation and accelerated venous neointimal hyperplasia. Following the creation of an AVF, blood flow increases 10-20-fold. In patients with preexisting peripheral artery disease, vascular microcalcification and medial fibrosis may limit arterial dilatation resulting in AVF non-maturation. Different configurations at the site of arteriovenous anastomosis results in varying degrees of shear stress at the anastomotic site due to the difference in compliance between the artery and vein. Accelerated eccentric venous neointimal hyperplasia may occur in regions of low shear stress resulting in juxta anastomotic stenosis and failed fistula maturation (57,63,71). Sections of the vein that suffer injury due to mobilization and manipulation during the procedure may undergo stenosis resulting in early AVF failure. Sites of previous vein injury e.g. venipuncture and dialysis catheter wall contact can impede outward remodeling and cause sites of stenosis. In addition, the endothelium of calcified vessels in chronic kidney disease, diabetes and the elderly may not have the ability to secret the mediators necessary for flow mediated vasodilatation (57,63,65,72)

**Patient related clinical and demographic factors**

Clinical co morbidities and demographic characteristics that affect arteriovenous fistula outcomes in ESRD patients include diabetes melitus, obesity, cardiac disease, pulmonary disease, peripheral arterial disease gender and age (68,73,74). However, risk prediction tools based on these clinical and demographic parameters do not reliably identify patients in whom AVF are likely to undergo non-maturation. In a study involving 1383 patients in Netherlands which attempted to create a prediction model for non-maturation of radio- cephalic arteriovenous fistulae (RCAVF), the overall non-maturation rate was 24%, predictors of non-maturation were female gender, peripheral vascular disease, cerebral vascular disease wand cephalic vein diameter of < 2.5mm but the prediction model lacked sensitivity and specificity for predicting individual RCAVF non maturation (68)

There is generally lack of concordance in literature on the impact of age on AVF maturation and patency. Some studies have shown that advancing age has an overall negative effect (74) while others have demonstrated that there are no significant age-related differences in AVF success rates (64). The discordance in the findings is largely driven by the different definitions of age in different studies, patient selection procedure and individual surgeon experiences. Advancing age is associated with increased burden of co morbidities like cardiovascular disease and diabetes. These may affect patient selection for AVF placement but once an AVF is established, the patency seems to be comparable to the younger population (36). In a study comparing AVF outcomes among patients >65 years old and <65 years old, the relative risk of fistula failure was 1.7 in the patients aged >65 years. The cumulative survival of fistulas at one and five years was 75.1 and 64.7 % respectively in the elderly while in the younger age group it was 79.7% and 71.4% at one and five years respectively (75). In one study evaluating AVF access in four hundred and sixty-one patients aged >65 years, all patients had ultrasound vascular mapping and were stratified according to age groups i.e. 65-74years, 74-84years and 85 – 94years. The primary, primary assisted and cumulative patency were 59.9%, 93.7% and 96.6 % respectively at 12 months. Subgroup age stratification found no statistically significant difference in functional access outcomes (76).

Females are at an increased risk of primary AVF failure as compared to males in spite of pre-operative vascular mapping (26,68,73,74). It has been proposed that females have smaller vessels with decreased luminal diameters in comparison to males (77)

Diabetes melitus is associated with increased incidence of intimal hyperplasia and peripheral arterial disease (72). Some studies have reported satisfactory AVF outcomes in patients with of diabetes melitus while others report a significant negative effect (64,73)

Obesity is a risk factor for type two diabetes. The veins in patients with obesity tend to be deep due to increased adipose tissue. This presents technical difficulties in AVF creation and cannulation for hemodialysis.

The adverse impact of cardiac disease on AVF maturation is due to reduced cardiac output which adversely affect blood flow to the developing fistula. In addition, the increase in demand for cardiac output by the newly created AVF can cause heart failure (78). Peripheral arterial disease changes characterized by calcification and intimal hyperplasia cause increased arterial stiffness and decreased elasticity. This interferes with the remodeling process which is required to achieve a functioning arteriovenous fistula (65,72)

# CHAPTER 3

# 3 METHODOLOGY

## 3.1 Study design

This was an ambispective observational study of AVFs placed during the AVF surgery camps in 2018 and 2019 at the KNH. the retrospective arm involved documentation of the patients medical, hemodialysis and vascular access history, date of first successful AVF cannulation. The prospective arm involved assessment of the functionality of the AVF at the time of the study, patency at 6 months and at 1 year.

## 3.2. Study population

ESKD patients on maintenance hemodialysis who had AVF creation surgery at the KNH in 2018 and 2019. This included patients who were referred from peripheral facilities for AVF surgery but did not routinely dialyze at the KNH and patients on routine HD at KNH who benefited from AVF surgery during these surgical camps.

## 3.3. Study site

This study was carried out at the Kenyatta National Hospital dialysis unit and medical records department. KNH is a metropolitan, tertiary, teaching and referral hospital situated at Upper Hill area along Hospital Road about 5km from Nairobi city Centre. It has a 2000 bed capacity and is one of the two main referral hospitals in Kenya, also serving the greater East and Central African region. The KNH dialysis unit serves about 100 – 120 end stage kidney disease patients on twice weekly hemodialysis.

### 3.4. Sample size

This was a census on all eligible patients from this population. All patients from this study population who meet the inclusion criteria were recruited into the study.

#### 3.5. Inclusion and exclusion criteria

**Inclusion criteria**

All patients with ESKD aged >18years who had AVF creation in 2018/2019 arteriovenous fistula camps at the Kenyatta national hospital.

**Exclusion criteria**

Patients who decline to give consent

Patients who were booked for surgery but had their procedure cancelld

#### 3.6. Definition of study variables

**Independent variables**

- Age – in years
- Sex – was categorized as male or female
- Cause of ESKD – This was considered as cause of end stage kidney disease as documented in the file.
- Anatomical location of AVF placement – referred to the arm in which the AVF was place.
- Vascular anastomosis – This was named according to the vessels anastomosed, i.e. radio-cephalic (RC) AVF, brachial-cephalic (BC) AVF and brachial- basilic (BB) AVF

- Previous vascular access – this included any vascular access including CVC, AVF, and AVG used for the purpose of hemodialysis prior to the date of placement of the AVF in study.
- Dialysis Vintage – This was the duration from initiation of hemodialysis to the date of placement of the AVF in study.

**Dependent variables**

- Time from AVF creation to first cannulation
- Primary AVF failure
- Functional primary patency

### 3.7. Data management

#### 3.7.1. Data collection procedure

Data was extracted using a study proforma (Appendix 1). Telephone numbers and file numbers of all end stage kidney disease patients who AVF surgery at the Kenyatta national hospital during the study period were identified from the fistula camp records. All eligible patients were identified. A telephonic consent was obtained, thereafter, the questionnaire was administered on phone. Patient medical records were retrieved to corroborate the information obtained from the interview and get any missing information. Each study proforma was assigned a unique study serial number to avoid duplication of data.

#### 3.7.2. Quality assurance

Data collection was done with the assistance of a trained research assistant. This ensured that the correct information is captured and entered in al illegible manner. Each data collection proforma was issued with a unique identifier code (serial number) linking it to the patient file. All the study proformas were reviewed to ensure completeness of data before transferring to the SPSS data base. Data rechecking, cleaning and verification was done by the statistician before analysis. The data has been backed up in an external hard drive whose access is limited to the investigators only. The hard copies of the filled proforma/questionnaires are safely kept in a lockable cabinet and will be destroyed six months after completion of the study.

**3.7.3. Data management and analysis**

Data from the study proforma was entered into a pre-programmed Statistical Package for Social Sciences (SPSS®) version 21.0 with which statistical analyses will be performed. Continuous variables like age were summarized into means, modes and median calculated while categorical variables like sex will were summarized into frequencies. Fisher's exact and Pearson's Chi-Square tests of significance were used to check for any significant association between selected patient characteristics and AVF outcomes.

**3.7.4. Ethical considerations**

The study was carried out after approval by the East Africa Kidney Institute (EAKI)-University of Nairobi (UON) and KNH / UON Research and Ethics and Research Committee. Confidentiality has been strictly maintained and all data gathered securely stored.

**3.7.8. Dissemination of study results**

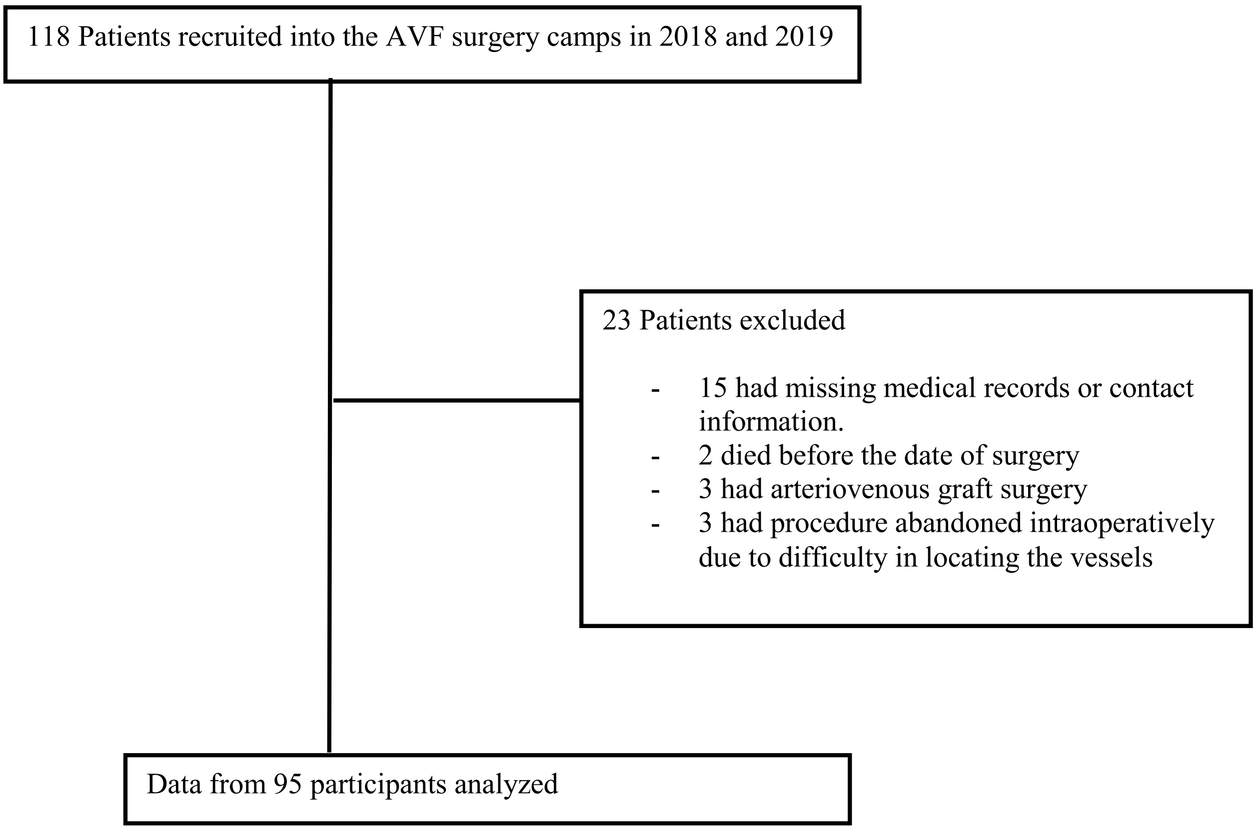
The results of this study will be disseminated to patient care givers at the KNH renal department and UON through a presentations and posters at the renal unit. Publications will be made through relevant scientific journals and presentations made as posters/abstract in scientific conferences locally and internationally.

# CHAPTER FOUR

## RESULTS

A total of 118 patient were recruited in the arteriovenous fistulae surgery camps at the Kenyatta National hospital in 2018 and 2019. Twenty-three participants were excluded from the study. Out of the 23, fifteen had missing medical records and or contact information, two died before the date of surgery and three had their procedures abandoned intraoperatively due to difficulties in locating the vessels and three underwent arteriovenous graft surgery. Data from ninety-five participants was analyzed.

**Figure 1. Study flow chart**




### 4.1. Sociodemographic and clinical characteristics

Majority of the study participants were male 56 (58.9%), with a median age 43.0 year (IQR 34 -56, p-value <0.01 95% CI 42.9-48.6). The youngest patient was 18years and the oldest 83 years. Majority were in the age group 29 – 69 years as shown in table 1 and figure 1 below. Hypertension was the most frequent cause of ESKD 71(74.7%), followed by diabetes 28(29.5) and chronic glomerulonephritis 22 (23.2). The incident hemodialysis vascular access was acute internal jugular catheter in 31(32.6), subclavian vein catheter in 29(30.5%) and cuffed tunneled catheter in 24 (25.3%). Only 2(2.1) participants were initiated on hemodialysis using AVF. Brachiocephalic AVF was created in 53(55.8%) and radio cephalic AVF in 40 (42.1%) of the participants. Successful primary AVF maturation was reported in 54(56.8%) and primary AVF failure in 41(43.2%).

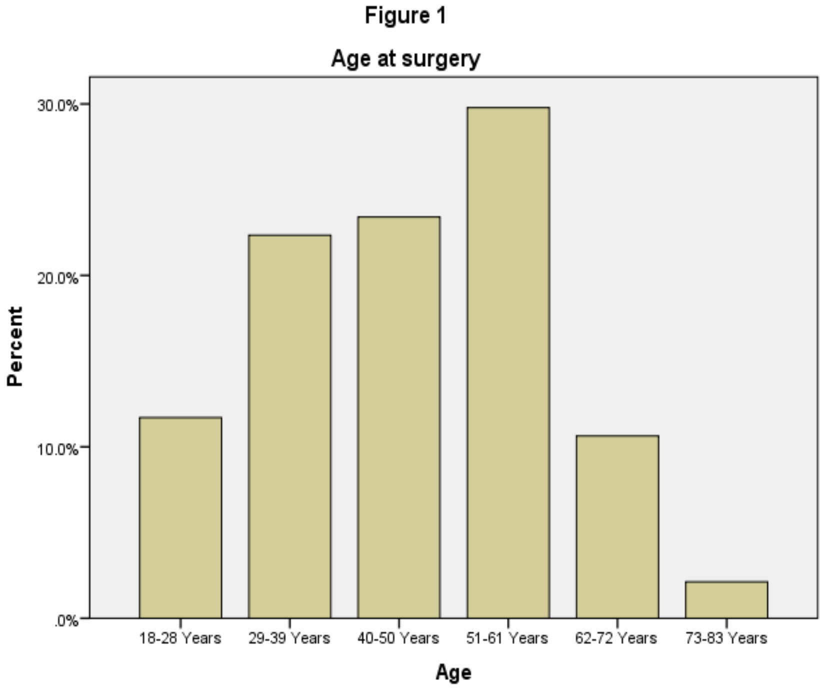
**Table 1. Sociodemographic and clinical characteristics**

| | **All n=95** | |
|---|---|---|
| **Characteristic** | **Description** | **Frequency (%)** |
| **Sex** | Male | 56 (58.9) |
| **Marital status** | Single | 22 (23.2) |
| | Married | 73 (76.8) |
| **Documented cause of ESKD** | Hypertension | 71 (74.7) |
| | Diabetes | 28 (29.5) |
| | Chronic glomerulonephritis | 22 (23.2) |
| | Obstructive uropathy | 3(3.2) |
| | Autoimmune disease | 2(2.1) |
| | Infections | 2(2.1) |
| | Malignancy | 1(1.1) |
| | PKD | 1(1.1) |
| | Others | 3(3.2) |
| **Incident HD vascular access** | Acute internal jugular catheter | 31(32.6) |
| | Subclavian vein catheter | 29(30.5) |
| | Cuffed tunneled catheter | 24(25.3) |
| | Acute femoral vein catheter | 9(9.5) |
| | Arteriovenous fistula | 2(2.1) |
| **VA for maintenance HD** | Cuffed tunneled catheter | 59(62.1) |
| | Acute internal jugular catheter | 28(29.5) |
| | Acute femoral vein catheter | 23(24.2) |
| | Acute subclavian | 13(13.7) |
| | AVF | 13(13.7)) |
| | AVG | 1(1.1) |
| **Anatomical site of AVF** | Right upper arm | 23(24.2) |
| | Left upper arm | 72 (75.8) |
| **Vascular anastomosis** | Radio-cephalic | 40 (42.1) |
| | Brachiocephalic | 53 (55.8) |
| | Brachiobasilic | 2 (2.1) |
| **Arteriovenous fistula outcome** | Successful Primary maturation | 54 (56.8%) |
| | Primary AVF failure | 41 (43.2%) |

| | | |
|---|---|---|
| **AVF patency (N=54)** | Patency at 6 months | 47 (87.0) |
| | Patency at 1 year | 45 (83.3) |

**†Chi-Square, ESKD End Stage Kidney Disease, PKD polycystic Kidney Disease, HD haemodialysis, VA Vascular access, AVF arteriovenous fistula, AVG arteriovenous graft**

**Figure 2. Age at surgery**




**Haemodialysis vintage**

Majority of the patients had been on hemodialysis for six months or less before the AVF surgery. The median hemodialysis Vintage was 8 months (IQR 4- 21, P value <0.01 95% CI 12.1-25.0).

**Table 2: Hemodialysis vintage**

| Duration on Haemodialysis | Frequency (%) |
|---|---|
| ≤ 6 months | 35 (36.8) |
| 7-12 months | 24 (25.3) |
| 13-18 months | 9 (9.5) |
| 18-24 months | 10 (10.5) |
| >24 months | 17 (17.9) |

### 4.2. Time from AVF creation to first successful cannulation

Majority of the patients had their AVF successfully cannulated for haemodialysis between 7 – 13 weeks. The median duration from AVF creation to cannulation was 8 weeks (IQR 8-13 P value 95% CI <0.01, 95% CI 10.4 – 17.6).

**Table 3. Time from AVF creation to first successful cannulation**

| Time duration | Frequency (%) |
|---|---|
| ≤ 6 Weeks | 11 (20.4) |
| 7-12 Weeks | 29 (53.7) |
| 13 - 18 Weeks | 4 (7.4) |
| >18 Weeks | 10 (18.5) |

### 4.3. Association between selected patient characteristics and primary AVF failure or successful primary maturation

Pearson chi-square/Fisher's exact tests of association were used to check for association between selected patient characteristics and primary AVF failure or successful primary maturation. Only the incident hemodialysis vascular access was significantly associated with primary AVF failure or successful primary maturation.

**Table 4. Association between selected patient characteristics and primary AVF failure or successful primary maturation**

| Variable | Category | Primary AVF failure | | Pearson Chi-Sq. | P value |
|---|---|---|---|---|---|
| | | Yes (N=41) | No (N=54) | | |
| **Age at surgery** | | | | 51.148 | 0.11 |
| **Sex** | Male | 20 | 36 | 3.081 | 0.79 |
| | Female | 21 | 18 | | |
| **Marital status** | Single | 9 | 13 | 0.059 | 0.80 |
| | Married | 32 | 41 | | |
| | | | | | |
| **Documented cause of ESKD** | | | | | |
| Hypertension | Yes | 31 | 40 | 0.029 | 0.86 |
| | No | 10 | 14 | | |
| Diabetes | Yes | 13 | 15 | 0.17 | 0.67 |
| | No | 28 | 39 | | |

| | | | | | |
|---|---|---|---|---|---|
| Chronic glomerulonephritis | Yes | 9 | 13 | 0.059 | 0.80* |
| | No | 32 | 41 | | |
| Obstructive uropathy | Yes | 0 | 3 | 2.35 | 0.25* |
| | No | 41 | 51 | | |
| Autoimmune disease | Yes | 1 | 1 | 0.039 | 1* |
| | No | 40 | 53 | | |
| Infections | Yes | 0 | 2 | 0.55 | 0.50* |
| | No | 41 | 52 | | |
| Malignancy | Yes | 1 | 0 | 1.33 | 0.43* |
| | No | 40 | 54 | | |
| PKD | Yes | 1 | 0 | 1.33 | 0.43* |
| | No | 40 | 54 | | |
| Others | Yes | 1 | 2 | 0.12 | 1* |
| | No | 40 | 52 | | |
| **Hemodialysis vintage** | | | | | |
| ≤ 6 months | | 18 | 17 | 2.70 | 0.60* |
| 7 – 12 months | | 9 | 15 | | |
| 13- 18 months | | 5 | 5 | | |
| 18 – 24 months | | 5 | 5 | | |
| >24 months | | 5 | 12 | | |
| **Anatomical site of AVF** | | | | | |
| Left upper limb | | 30 | 42 | 0.27 | 0.60 |
| Right upper limb | | 11 | 12 | | |
| **Vascular anastomosis** | | | | | |
| Brachiocephalic AVF | | 23 | 30 | 2.70 | 0.26 |
| Radio-cephalic | | 16 | 24 | | |
| **Incident HD vascular access** | | | | | |
| Acute internal jugular catheter | | 13 | 18 | 10.19 | **0.029*** |
| Subclavian vein catheter | | 12 | 17 | | |
| Cuffed tunneled catheter | | 8 | 1 | | |
| Acute femoral vein catheter | | 8 | 6 | | |
| Arteriovenous fistula | | 0 | 2 | | |

***Fisher's exact test ESKD End Stage Kidney Disease,** CGN **chronic glomerulonephritis**

# CHAPTER FIVE

## 5.1. DISCUSSION

Chronic kidney disease is a major global health concern. It is projected that the number of ESKD cases requiring kidney replacement therapy worldwide will double from 2.3 million to 5.4 million in 2030(1). The number of ESKD patients on long term hemodialysis in Kenya has increased from 120 in 1995 to 4800 in 2020(7). There has also been an exponential increase in hemodialysis units spread across government hospitals, faith based and private institutions from 4 in 1995 to 213 in 2021. The increase in the burden of ESKD on maintenance hemodialysis and improved accessibility of hemodialysis services highlights the need for a reliable and secure hemodialysis vascular access that will, in the long term, reduce the cost of hemodialysis.

In our study, 95 patients successfully underwent AVF creation surgery, 58.9% were males, the median age was 43.0 year, with an age range of 18- 80 years. While in western countries ESKD mainly affects the middle aged and the elderly population, studies done in SSA depicts a similar age group of young adults in their economically productive years as seen in this study(79–82). This may be attributed to poor access to health care, late referrals to nephrologists, lack of awareness of risk factors for kidney disease and probably the difference in etiology of ESKD (5,20,80). Hypertension was the most commonly reported cause of ESKD followed by Diabetes and chronic glomerulonephritis. Other studies done in SSA identified CGN and hypertension as the as the commonest causes of CKD although the prevalence of diabetic nephropathy is also rising (5,79,80,82–84). Only a few patients with kidney disease undergo kidney biopsy in out set up, it is therefore likely that among the patients with hypertension as the documented cause of ESKD, a good number had undiagnosed CGN.

Arteriovenous fistulae are the vascular access of choice for incident and maintenance hemodialysis. Just like in many African countries, this study demonstrated high prevalence of CVC use for incidence and prevalent hemodialysis. The preferred vascular access for initiation of haemodialysis was acute internal jugular catheters (32.6%) followed by acute subclavian vein catheters (30.5%). The prevalence of AVF for incident hemodialysis was 2.1%. Subsequently, 13.7% dialyzed using arteriovenous fistula and 62.5 % cuffed tunneled catheters. This is mirrors the findings by Kabinga et al in a similar study population, in 2019 (6,20) and the situation in other countries in sub Saharan Africa (5,22,82). While SSA still lags behind when in AVF uptake, studies in the USA indicate that about 16.9% of patients initiate hemodialysis with an AVF, and at 1 year, 65% of the patients dialyze exclusively using an AVF (14). Results from the dialysis outcome and practice Patterns (DOPPS) demonstrated a high level of AVF use in European countries, USA, china, Japan and the gulf cooperation countries ranging between 58 % and 88.2% among prevalent HD patients (15–19).

Late referral to nephrologists, vascular surgeons, poor communication between nephrologists and other CKD patient care givers, and lack of patient health education have been cited as some of the barriers to increasing the prevalence of AVF use in hemodialysis units (20,80). Our study points towards this fact as this data was from a study population referred for arteriovenous fistulae surgery from rural facilities. Besides, Kenya has only 41 nephrologists, most practice in Nairobi and a few other urban centers, therefore it is possible that most of these patients had not been seen by a nephrologist prior to initiation of hemodialysis.

International guidelines on hemodialysis vascular access advocate for a stepwise approach to AVF creation, preferring the non-dominant extremity when the choices are equivalent and distal upper extremity whenever feasible (29–32). In our case, majority (73.1%) of the AVF were placed in the non-dominant arm. Brachial artery to cephalic vein anastomosis was preferred over radial artery to cephalic vein anastomosis (55.9% Vs 42.1%). The reasons for this practice preference could not be directly discerned from this study. However, considering the hemodialysis vintage of more than 1 year on 39% of the study population and multiple CVC use It would be reasonable to speculate that poor quality of vessels in these patients necessitated the choice of brachial cephalic over radio cephalic anastomosis. This practice raises a great concern over the long-term implications for vascular access options for this relatively young hemodialysis patients in whom AVF are created in the upper rather than the lower arm. Exhaustion of sites available for vascular access exposes them to over reliance on CVC for hemodialysis in the future and the accompanying complications including catheter related infections, central vein stenosis, increased mortality and increased cost of hemodialysis(69). Additionally, high blood flows associated with brachiocephalic AVF are associated with a higher tendency for AVF cardiotoxicity and AVF steal syndrome (38,53).

While some studies have reported greater successful primary patency, significantly less maturation time and earlier cannulation of BC-AVF as compared to RC- AVF (68). This was not the case in our study. The type of vascular anastomosis was not significantly associated with AVF primary failure or successful maturation. Furthermore, the difference in median time from AVF creation to cannulation between the Brachiocephalic and radio cephalic AVF was not significant. Possible explanations include patient selection, ultrasound evaluation. Data from the DOPPS which evaluated international use and differences in the location of AVF created for hemodialysis established a shifting in trend toward a preference for BC AVF with a greater successful AVF use for upper Vs lower arm AVF in the USA, however in Japan and Europe, there was no indication that successful AVF use was inferior for lower Vs upper arm AVF (39).

The definition of primary AVF failure varies greatly in literature and in different studies. In this study, primary AFV failure was defined as an AVF that never developed to the point that it could be used for hemodialysis or one that failed within the first three months of its use. Of the 95 patients who underwent AVF surgery, 43.2% had primary AVF failure while 56.8% achieved successful primary maturation. These findings are in keeping with a primary AVF rate of 30-50% reported in many studies (69,85,86). Several patient characteristics have been associated with AVF maturation historically(86,87). In this study Age, sex, marital status, co morbidities, hemodialysis vintage, vascular access history and type of vascular anastomosis were not significantly associated with successful primary AVF maturation or failure. However, the sample size was small therefore meaningful correlation was not possible. AVF patency at 6 months and one year was high compared to other studies. This was purely based on recall by patients and the care givers and could have been biased.

The optimal time for waiting before the first use of a newly created AVF is not known. While KDIGO guidelines define an ideal fistula as the one that meets the rule of 6 “s”. There are significant differences globally regarding the practice of initial cannulation of AVF(8).In this study, we found a median time from AVF creation to cannulation of 8 weeks, 53.7% of the mature AVF were cannulated within7-12 weeks, 20.4% at or before 6weeks and 18.5% after 18weeks. A prospective analysis of 849 patients initiating hemodialysis with AVF found a wide variation in the median time to AVF cannulation among countries ranging from 25 days in Japan and 96 and 98 days for the UK and USA (27). The mode of assessment of AVF maturity and readiness for cannulation in our study population was not documented. However, there is no structured AVF surveillance system in the facility. It is common practice that fistulas are clinically assessed by the dialysis nurse who determines whether the fistula is sufficiently developed and palpable to allow cannulation. These factors likely contributed to prolongation of the time to first cannulation beyond the recommended 6-8 weeks in more than 50% of the study population

**Conclusion**

This study revealed a low uptake of AVF for incident hemodialysis, central venous catheters were preferred for initiation and maintenance of hemodialysis. Brachiocephalic anastomosis was preferred in majority of the participants. This raises a concern over future vascular access options for this young population of patients. The AVF primary failure rate was comparable to the rest of the world and AVF survival at 6 months and 1 year was good.

## 5.2. STUDY LIMITATIONS

1. Recall bias
2. Poor documentation of medical records and absence of electronic medical records
3. The sample size was small and from a single Centre therefore the findings cannot be generalized to the population

## 5.3. RECOMMENDATIONS

1. Development of an arteriovenous fistula surveillance protocol to be used in the hospital and country wide. This will ensure a standardized record keeping and enable early identification of fistulas at risk of non- maturation and hence referral for intervention to promote maturation.
2. Incorporation of bed side ultrasound for pre-operative vascular and post-operative AVF assessment as a potential mechanism to improve AVF maturation and early identification of complications.
3. large prospective multi-center studies with well-defined outcomes are needed.

## REFFERENCES


1. Bikbov B, Purcell CA, Levey AS, Smith M, Abdoli A, Abebe M, et al. Global, regional, and national burden of chronic kidney disease, 1990–2017: a systematic analysis for the Global Burden of Disease Study 2017. The Lancet. 2020 Feb;395(10225):709–33.

2. Kaze AD, Ilori T, Jaar BG, Echouffo-Tcheugui JB. Burden of chronic kidney disease on the African continent: a systematic review and meta-analysis. BMC Nephrol. 2018 Jun 1;19(1):125.

3. Bello AK, Levin A, Lunney M, Osman MA, Ye F, Ashuntantang GE, et al. Status of care for end stage kidney disease in countries and regions worldwide: international cross sectional survey. BMJ. 2019 Oct 31;l5873.

4. Matsha TE, Erasmus RT. Chronic kidney disease in sub-Saharan Africa. Lancet Glob Health. 2019 Dec 1;7(12):e1587–8.

5. Naicker S. End-stage renal disease in Sub-Saharan Africa. Kidney Int Suppl. 2013 May;3(2):161–3.

6. Hemodialysis vascular accesses in patients on chronic hemodialysis at the Kenyatta National Hospital in Kenya - Samuel K Kabinga, Joshua K Kayima, Seth O McLigeyo, John N Ndungu, 2019 [Internet]. [cited 2020 Dec 9]. Available from: https://journals.sagepub.com/doi/abs/10.1177/1129729819845571

7. Yang C-W, Harris DCH, Luyckx VA, Nangaku M, Hou FF, Garcia Garcia G, et al. Global case studies for chronic kidney disease/end-stage kidney disease care. Kidney Int Suppl. 2020 Mar;10(1):e24–48.

8. Chan CT, Blankestijn PJ, Dember LM, Gallieni M, Harris DCH, Lok CE, et al. Dialysis initiation, modality choice, access, and prescription: conclusions from a Kidney Disease: Improving Global Outcomes (KDIGO) Controversies Conference. Kidney Int. 2019;96(1):37–47.

9. Lok CE. Fistula First Initiative: Advantages and Pitfalls. Clin J Am Soc Nephrol. 2007 Sep;2(5):1043–53.

10. Allon M. Fistula First: Recent Progress and Ongoing Challenges. Am J Kidney Dis Off J Natl Kidney Found. 2011 Jan;57(1):3–6.

11. Saran R, Robinson B, Abbott KC, Agodoa LYC, Albertus P, Ayanian J, et al. US Renal Data System 2016 Annual Data Report: Epidemiology of Kidney Disease in the United States. Am J Kidney Dis Off J Natl Kidney Found. 2017 Mar;69(3 Suppl 1):A7–8.

12. Brescia MJ, Cimino JE, Appel K, Hurwich BJ. Chronic Hemodialysis Using Venipuncture and a Surgically Created Arteriovenous Fistula. N Engl J Med. 1966 Nov 17;275(20):1089–92.

13. Röhl L, Franz HE, Möhring K, Ritz E, Schüler HW, Uhse HG, et al. Direct Arteriovenous Fistula for Hemodialysis. Scand J Urol Nephrol. 1968 Jan 1;2(3):191–5.

14. Annual Data Report [Internet]. USRDS. [cited 2021 Jan 16]. Available from: https://www.usrds.org/annual-data-report/

15. Pisoni RL, Young EW, Dykstra DM, Greenwood RN, Hecking E, Gillespie B, et al. Vascular access use in Europe and the United States: Results from the DOPPS. Kidney Int. 2002 Jan;61(1):305–16.

16. Pisoni RL, Zepel L, Port FK, Robinson BM. Trends in US Vascular Access Use, Patient Preferences, and Related Practices: An Update From the US DOPPS Practice Monitor With International Comparisons. Am J Kidney Dis Off J Natl Kidney Found. 2015 Jun;65(6):905–15.

17. Zhao X, Niu Q, Gan L, Hou FF, Liang X, Ni Z, et al. Baseline data report of the China Dialysis Outcomes and Practice Patterns Study (DOPPS). Sci Rep. 2021 Jan 13;11(1):873.

18. Ecder T, Utas C, Ates K, Bieber B, Robinson BM, Pisoni RL, et al. The Dialysis Outcomes and Practice Patterns Study (DOPPS) in Turkey. Hemodial Int Int Symp Home Hemodial. 2017 Jul;21(3):430–9.

19. Pisoni RL, Bieber BA, Al Wakeel J, Al Arrayed S, Alkandari N, Hassan M, et al. The dialysis outcomes and practice patterns study phase 5 in the Gulf Cooperation Council countries: Design and study methods. Saudi J Kidney Dis Transplant Off Publ Saudi Cent Organ Transplant Saudi Arab. 2016 Nov;27(6 Suppl 1):S1-11.

20. Kabinga SK, Ngigi JN, Kayima JK, McLigeyo SO. Predialysis Care Experience Among Patients With CKD at a Teaching Hospital in Kenya. Kidney Int Rep. 2019 Aug 27;4(11):1638–41.

21. Odhiambo JO, Otieno FA, Twahir A. Dialysis outcomes and practice patterns among chronic kidney disease patients receiving hemodialysis at a private dialysis centre in Nairobi, Kenya between May 2016 and July 2016. East Afr Med J. 2018;95(5):1570–8.

22. Grant IR, Freercks RJ, Honiball EJ, Dube B. Analysis of the vascular access service for patients on haemodialysis in Livingstone Hospital. :4.

23. Hammes M. When Is the Right Time for Arteriovenous Fistula Placement in Patients with End-Stage Renal Disease? Am J Nephrol. 2017;45(4):353–5.

24. Oliver MJ, Rothwell DM, Fung K, Hux JE, Lok CE. Late creation of vascular access for hemodialysis and increased risk of sepsis. J Am Soc Nephrol JASN. 2004 Jul;15(7):1936–42.

25. Lee M, Roberts MA, Smith M-R, Chuen J, Mount PF. Clinical Outcomes after Arteriovenous Fistula Creation in Chronic Kidney Disease. Blood Purif. 2014;37(3):163–71.

26. Miyamoto M, Kurita N, Suemitsu K, Murakami M. Fistula and Survival Outcomes after Fistula Creation among Predialysis Chronic Kidney Disease Stage 5 Patients. Am J Nephrol. 2017;45(4):356–64.

27. Saran R, Dykstra DM, Pisoni RL, Akiba T, Akizawa T, Canaud B, et al. Timing of first cannulation and vascular access failure in haemodialysis: an analysis of practice patterns at dialysis facilities in the DOPPS. Nephrol Dial Transplant Off Publ Eur Dial Transpl Assoc - Eur Ren Assoc. 2004 Sep;19(9):2334–40.

28. Allon M, Robbin ML. Increasing arteriovenous fistulas in hemodialysis patients: Problems and solutions. Kidney Int. 2002 Oct;62(4):1109–24.

29. Clinical practice guidelines for vascular access [Internet]. Vol. 48 Suppl 1, American journal of kidney diseases : the official journal of the National Kidney Foundation. Am J Kidney Dis; 2006 [cited 2021 Jan 17]. Available from: https://pubmed.ncbi.nlm.nih.gov/16813991/

30. Kukita K, Ohira S, Amano I, Naito H, Azuma N, Ikeda K, et al. 2011 update Japanese Society for Dialysis Therapy Guidelines of Vascular Access Construction and Repair for Chronic Hemodialysis. Ther Apher Dial. 2015;19(S1):1–39.

31. Jindal K, Chan CT, Deziel C, Hirsch D, Soroka SD, Tonelli M, et al. Hemodialysis clinical practice guidelines for the Canadian Society of Nephrology. J Am Soc Nephrol JASN. 2006 Mar;17(3 Suppl 1):S1-27.

32. Tordoir J, Canaud B, Haage P, Konner K, Basci A, Fouque D, et al. EBPG on Vascular Access. Nephrol Dial Transplant. 2007 May 1;22(Supplement 2):ii88–117.

33. MacRae JM, Oliver M, Clark E, Dipchand C, Hiremath S, Kappel J, et al. Arteriovenous Vascular Access Selection and Evaluation. Can J Kidney Health Dis [Internet]. 2016 [cited 2021 Jan 17];3. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5332074/

34. Michael B. Silva J, Ii RWH, Pappas PJ, Jamil Z, Araki CT, Goldberg MC, et al. A strategy for increasing use of autogenous hemodialysis access procedures: Impact of preoperative noninvasive evaluation. J Vasc Surg. 1998 Feb 1;27(2):302–8.

35. Khadatkar A, Mahakalkar C, Pradhan T, Bora A. Comparative analysis of radiocephalic versus brachiocephalic native arteriovenous fistula for hemodialysis in end stage renal disease. Int J Res Med Sci. 2016 Dec 19;5(1):171–6.

36. Arteriovenous fistula creation for hemodialysis and its complications - UpToDate [Internet]. [cited 2021 Jan 21]. Available from: https://www.uptodate.com/contents/arteriovenous-fistula-creation-for-hemodialysis-and-its-complications?search=arteriovenous%20fistula%20hemodialysis&source=search_result&selectedTitle=1~58&usage_type=default&display_rank=1#H1761013269

37. Schmidli J, Widmer MK, Basile C, Donato G de, Gallieni M, Gibbons CP, et al. Editor's Choice – Vascular Access: 2018 Clinical Practice Guidelines of the European Society for Vascular Surgery (ESVS). Eur J Vasc Endovasc Surg. 2018 Jun 1;55(6):757–818.

38. Segal M, Qaja E. Types of Arteriovenous Fistulas. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2020 [cited 2021 Jan 21]. Available from: http://www.ncbi.nlm.nih.gov/books/NBK493195/

39. International Differences in the Location and Use of Arteriovenous Accesses Created for Hemodialysis: Results From the Dialysis Outcomes and Practice Patterns Study (DOPPS) | Elsevier Enhanced Reader [Internet]. [cited 2021 Jan 17]. Available from: https://reader.elsevier.com/reader/sd/pii/S0272638617310053?token=D17304EC99CBC5C42AB0B3AA4916B8A1A5C477E30DA8C8180C8FDC56E905B6C7319CB8EED7CEE863AA538BD79CF15F28

40. Konner K, Nonnast-Daniel B, Ritz E. The Arteriovenous Fistula. J Am Soc Nephrol. 2003 Jun 1;14(6):1669–80.

41. Maturation and evaluation of the newly created hemodialysis arteriovenous fistula - UpToDate [Internet]. [cited 2021 Jan 22]. Available from: https://www.uptodate.com/contents/maturation-and-evaluation-of-the-newly-created-hemodialysis-arteriovenous-fistula?search=arteriovenous%20fistula%20maturation&source=search_result&selectedTitle=1~16&usage_type=default&display_rank=1

42. Robbin ML, Greene T, Allon M, Dember LM, Imrey PB, Cheung AK, et al. Prediction of Arteriovenous Fistula Clinical Maturation from Postoperative Ultrasound Measurements: Findings from the Hemodialysis Fistula Maturation Study. J Am Soc Nephrol. 2018 Nov 1;29(11):2735–44.

43. Robbin ML, Chamberlain NE, Lockhart ME, Gallichio MH, Young CJ, Deierhoi MH, et al. Hemodialysis arteriovenous fistula maturity: US evaluation. Radiology. 2002 Oct;225(1):59–64.

44. Beathard GA. Physical Examination of the Dialysis Vascular Access. Semin Dial. 1998;11(4):231–6.

45. Salman L, Beathard G. Interventional Nephrology: Physical Examination as a Tool for Surveillance for the Hemodialysis Arteriovenous Access. Clin J Am Soc Nephrol. 2013 Jul 3;8(7):1220–7.

46. Rayner HC, Pisoni RL, Gillespie BW, Goodkin DA, Akiba T, Akizawa T, et al. Creation, cannulation and survival of arteriovenous fistulae: data from the Dialysis Outcomes and Practice Patterns Study. Kidney Int. 2003 Jan;63(1):323–30.

47. Lok CE, Huber TS, Lee T, Shenoy S, Yevzlin AS, Abreo K, et al. KDOQI Clinical Practice Guideline for Vascular Access: 2019 Update. Am J Kidney Dis. 2020 Apr;75(4):S1–164.

48. Clinical practice guideline on peri- and postoperative care of arteriovenous fistulas and grafts for haemodialysis in adults | Nephrology Dialysis Transplantation | Oxford Academic [Internet]. [cited 2021 Mar 23]. Available from: https://academic.oup.com/ndt/article/34/Supplement_2/ii1/5514502

49. Miller PE, Tolwani A, Luscy CP, Deierhoi MH, Bailey R, Redden DT, et al. Predictors of adequacy of arteriovenous fistulas in hemodialysis patients. Kidney Int. 1999 Jul 1;56(1):275–80.

50. Lee T, Mokrzycki M, Moist L, Maya I, Vazquez M, Lok C. Standardized Definitions for Hemodialysis Vascular Access. Semin Dial. 2011;24(5):515–24.

51. Hentschel DM. Determinants of Arteriovenous Fistula Maturation. Clin J Am Soc Nephrol. 2018 Sep 7;13(9):1307–8.

52. Zhu Y-L, Ding H, Fan P-L, Gu Q-L, Teng J, Wang W-P. Predicting the maturity of haemodialysis arteriovenous fistulas with colour Doppler ultrasound: a single-centre study from China. Clin Radiol. 2016 Jun;71(6):576–82.

53. Stolic R. Most Important Chronic Complications of Arteriovenous Fistulas for Hemodialysis. Med Princ Pract. 2013;22(3):220–8.

54. Al-Jaishi AA, Liu AR, Lok CE, Zhang JC, Moist LM. Complications of the Arteriovenous Fistula: A Systematic Review. J Am Soc Nephrol. 2017 Jun 1;28(6):1839–50.

55. Saxena AK, Panhotra BR, Al-Mulhim AS. Vascular Access Related Infections in Hemodialysis Patients. Saudi J Kidney Dis Transplant. 2005 Jan 1;16(1):46.

56. Asif A, Gadalean FN, Merrill D, Cherla G, Cipleu CD, Epstein DL, et al. Inflow stenosis in arteriovenous fistulas and grafts: a multicenter, prospective study. Kidney Int. 2005 May;67(5):1986–92.

57. Quencer KB, Arici M. Arteriovenous Fistulas and Their Characteristic Sites of Stenosis. Am J Roentgenol. 2015 Sep 23;205(4):726–34.

58. Siddiky A, Sarwar K, Ahmad N, Gilbert J. Management of arteriovenous fistulas. BMJ. 2014 Oct 30;349(oct30 4):g6262–g6262.

59. Reddy YNV, Obokata M, Dean PG, Melenovsky V, Nath KA, Borlaug BA. Long-term cardiovascular changes following creation of arteriovenous fistula in patients with end stage renal disease. Eur Heart J. 2017 Jun 21;38(24):1913–23.

60. Alkhouli M, Sandhu P, Boobes K, Hatahet K, Raza F, Boobes Y. Cardiac complications of arteriovenous fistulas in patients with end-stage renal disease. Nefrol Engl Ed. 2015 May 1;35(3):234–45.

61. London GM. Left ventricular alterations and end- stage renal disease. Nephrol Dial Transplant. 2002 Jan 1;17(suppl_1):29–36.

62. Schier T, Göbel G, Bösmüller C, Gruber I, Tiefenthaler M. Incidence of arteriovenous fistula closure due to high-output cardiac failure in kidney-transplanted patients. Clin Transplant. 2013 Dec;27(6):858–65.

63. MacRae JM, Dipchand C, Oliver M, Moist L, Lok C, Clark E, et al. Arteriovenous Access Failure, Stenosis, and Thrombosis. Can J Kidney Health Dis. 2016 Jan 1;3:2054358116669126.

64. Huijbregts HJT, Bots ML, Wittens CHA, Schrama YC, Moll FL, Blankestijn PJ. Hemodialysis Arteriovenous Fistula Patency Revisited: Results of a Prospective, Multicenter Initiative. Clin J Am Soc Nephrol. 2008 May 1;3(3):714–9.

65. Asif A, Roy-Chaudhury P, Beathard GA. Early Arteriovenous Fistula Failure: A Logical Proposal for When and How to Intervene. Clin J Am Soc Nephrol. 2006 Mar 1;1(2):332–9.

66. Dember LM, Imrey PB, Beck GJ, Cheung AK, Himmelfarb J, Huber TS, et al. Objectives and Design of the Hemodialysis Fistula Maturation Study. Am J Kidney Dis Off J Natl Kidney Found. 2014 Jan;63(1):104–12.

67. Kinnaert P, Vereerstraeten P, Toussaint C, Van Geertruyden J. Nine years' experience with internal arteriovenous fistulas for haemodialysis: a study of some factors influencing the results. Br J Surg. 1977 Apr;64(4):242–6.

68. Voorzaat BM, van der Bogt KEA, Janmaat CJ, van Schaik J, Dekker FW, Rotmans JI. Arteriovenous Fistula Maturation Failure in a Large Cohort of Hemodialysis Patients in the Netherlands. World J Surg. 2018;42(6):1895–903.

69. Alhassan SU, Adamu B, Abdu A, Aji SA. Outcome and complications of permanent hemodialysis vascular access in Nigerians: A single centre experience. Ann Afr Med. 2013 Apr 1;12(2):127.

70. Salako AA, Badmus TA, Igbokwe MC, David RA, Laoye A, Akinbola IA, et al. Experience with arteriovenous fistula creation for maintenance hemodialysis in a tertiary hospital in South-Western Nigeria. Saudi J Kidney Dis Transplant Off Publ Saudi Cent Organ Transplant Saudi Arab. 2018 Aug;29(4):924–9.

71. Allon M, Litovsky S, Young CJ, Deierhoi MH, Goodman J, Hanaway M, et al. Medial Fibrosis, Vascular Calcification, Intimal Hyperplasia, and Arteriovenous Fistula Maturation. Am J Kidney Dis Off J Natl Kidney Found. 2011 Sep;58(3):437–43.

72. Dember LM, Dixon BS. Early Fistula Failure: Back to Basics. Am J Kidney Dis. 2007 Nov;50(5):696–9.

73. Nagarik DrAP, S SS, Gopalkishan A, S RA. Incidence and Risk factors for primary AV fistula failure. Int J Surg Sci. 2020 Apr 1;4(2):21–4.

74. Wen M, Li Z, Li J, Zhou W, Liu Y, Liu H, et al. Risk Factors for Primary Arteriovenous Fistula Dysfunction in Hemodialysis Patients: A Retrospective Survival Analysis in Multiple Medical Centers. Blood Purif. 2019;48(3):276–82.

75. Lok CE, Oliver MJ, Su J, Bhola C, Hannigan N, Jassal SV. Arteriovenous fistula outcomes in the era of the elderly dialysis population. Kidney Int. 2005 Jun 1;67(6):2462–9.

76. Jennings WC, Landis L, Taubman KE, Parker DE. Creating functional autogenous vascular access in older patients. J Vasc Surg. 2011 Mar;53(3):713–9.

77. Gender differences in vascular access in hemodialysis patients in the United States: developing strategies for improving access outcome. - Abstract - Europe PMC [Internet]. [cited 2021 Jan 31]. Available from: https://europepmc.org/article/med/18022587

78. Amerling R, Ronco C, Kuhlman M, Winchester JF. Arteriovenous fistula toxicity. Blood Purif. 2011;31(1–3):113–20.

79. Arogundade F, Sanusi A, Hassan M, Akinsola A. The pattern, clinical characteristics and outcome of ESRD in Ile-Ife, Nigeria: Is there a change in trend? Afr Health Sci. 2011 Dec;11(4):594–601.

80. Arogundade FA, Barsoum RS. CKD prevention in Sub-Saharan Africa: a call for governmental, nongovernmental, and community support. Am J Kidney Dis Off J Natl Kidney Found. 2008 Mar;51(3):515–23.

81. Mtaturu GF, Nyongole OV, Akoko LO, Shirima GV, Shoo J, Sensa VP, et al. A single centre experience of arteriovenous fistula creation for hemodialysis access in Dar es Salaam, Tanzania. World J Adv Res Rev. 2020;8(1):279–83.

82. Okyere I, Okyere P, Dadzie Ephraim RK, Hutton Mensah KA, Attakora J, Essuman G, et al. Vascular access for haemodialysis in Ghana: a single centre experience. PAMJ Clin Med [Internet]. 2021 [cited 2021 Oct 30];6. Available from: https://www.clinical-medicine.panafrican-med-journal.com/content/article/6/2/full

83. Akinsola W, Odesanmi WO, Ogunniyi JO, Ladipo GO. Diseases causing chronic renal failure in Nigerians--a prospective study of 100 cases. Afr J Med Med Sci. 1989 Jun;18(2):131–7.

84. Matekole M, Affram K, Lee SJ, Howie AJ, Michael J, Adu D. Hypertension and end-stage renal failure in tropical Africa. J Hum Hypertens. 1993 Oct;7(5):443–6.

85. Bashar K, Zafar A, Elsheikh S, Healy DA, Clarke-Moloney M, Casserly L, et al. Predictive Parameters of Arteriovenous Fistula Functional Maturation in a Population of Patients with End-Stage Renal Disease. PLOS ONE. 2015 Mar 13;10(3):e0119958.

86. Salmela B, Hartman J, Peltonen S, Albäck A, Lassila R. Thrombophilia and Arteriovenous Fistula Survival in ESRD. Clin J Am Soc Nephrol. 2013 Jun 7;8(6):962–8.

87. Conte MS, Nugent HM, Gaccione P, Roy-Chaudhury P, Lawson JH. Influence of diabetes and perivascular allogeneic endothelial cell implants on arteriovenous fistula remodeling. J Vasc Surg. 2011 Nov;54(5):1383–9.

## APPENDICES

## APPENDIX 1: STUDY PROFORMA

### EXPERINCE WITH ARTERIOVENOUS FISTULAE IN CHRONIC HEMODIALYSIS PATIENTS AT THE KEYATTA NATIONAL HOSPITAL

A. **Identification details**

**A1**. IP Number ……………………. **A2.** Unique identifier………………

**A3**. Year of birth (dd/mm/year) …………….. **A4.** Sex: [1] male [2] female

**A5.** Marital status [1] single [2] married [3] widowed [4] divorced/separated

B. **Medical history**

**B1.** Cause(s) of ESRD as documented in the file

**B1.1** Diabetes mellitus [1] Yes [2] No
**B1.2** Hypertension [1] Yes [2] No
**B1.3** Glomerulonephritis [1] Yes [2] No
**B1.4** Autoimmune [1] Yes [2] No
**B1.5** Obstructive uropathy [1] Yes [2] No
**B1.6** Infections [1] Yes [2] No
**B1.7** Malignancy [1] Yes [2] No
**B1.8** Cystic kidney disease [1] Yes [2] No
**B1.99** Others (specify): …………………………………………...

C. **Haemodialysis history**

**C1.** Date initiated on haemodialysis ………. /…………….. (mm/yyyy)

**C2.** Initial haemodialysis vascular access

**C2.1** Acute internal jugular catheter [1] Yes [2] No
**C2.2** Acute subclavian vein catheter [1] Yes [2] No
**C2.3** Acute femoral vein catheter [1] Yes [2] No
**C2.4** Cuffed tunneled catheter [1] Yes [2] No
**C2.5** Arteriovenous fistula [1] Yes [2] No
**C2.6** Arteriovenous graft [1] Yes [2] No
**C2.99** Others (specify): ……………………………………………….

**C3. Vascular access history during the whole period of haemodialysis**

**C3.1** Acute internal jugular catheter [1] Yes [2] No

**C3.2** Acute subclavian vein catheter [1] Yes [2] No

**C3.3** Acute femoral vein catheter [1] Yes [2] No

**C3.4** Cuffed tunneled catheter [1] Yes [2] No

**C3.5** Arteriovenous fistula [1] Yes [2] No

**C3.6** Arteriovenous graft [1] Yes [2] No

**3.99** Others (specify): ……………………….……………………...

**C4. Current haemodialysis vascular access**

**[1]** Acute internal jugular catheter **[2]** Acute subclavian vein catheter

**[3]** Acute femoral vein catheter **[4]** Cuffed tunneled catheter

**[5]** Arteriovenous fistula **[6]** Arteriovenous graft

**[99]** Others (specify): ………………………………………………...

**D. <u>Current AVF history</u>**

**D.1** Date of surgery for current AVF ………………... (Mm/yyyy)

**D2.** Anatomical site of the AVF

**D2.1**. upper Limb: **[1]** Right **[2]** Left

**D2.2.** Vascular anastomosis

**[1]** Radiocepahalic

**[2]** Brachioceplalic

**[99]** Others (specify): ………………

**E. <u>Arteriovenous fistula outcomes</u>**

**E1.** Date of first successful AVF cannulation …………………... (dd/mm/yyyy)

**E2.** Time from AVF creation to first cannulation ……………. (dd)

**E4.** Primary AVF failure [1] Yes [2] No

**E5.** Status of AVF at the time of study [1] In use [2] Not in use

**E6**. Date last used ……………………………….... (dd/mm/yyyy)

**E7.** Duration of functional primary patency ………………………… (dd)

## APENDIX II: VERBAL CONSENT FORM

**TITLE OF STUDY: EXPERIENCE WITH ARTERIOVENOUS FISTULAE IN LONG TERM HEMODIALYSIS PATIENTS AT THE KENYATTA NATIONAL HOSPITAL**

Hello, my name is my name is Dr. Juliet Akoth Ooko, I am studying to be a kidney specialist at the East Africa kidney institute – UON, attached to the Kenyatta national hospital renal unit.

You have been chosen at random to be in a study about the experience with arteriovenous fistulae in patients with kidney disease on long term hemodialysis. The purpose of this research is to document the cause of your kidney disease, the site on your arm where you had arteriovenous fistula surgery, when the fistulae was first used for hemodialysis and whether it is still in use or not. This will take approximately ten minutes of your time. If you choose to be in the study, I will ask you a few questions whose answers I will fill in a study form.

There are no foreseeable risks or benefits to you for participating in this study. There is no cost or payment to you. If you have questions while taking part, please stop me and ask. We will do our best to keep your information confidential but we cannot guarantee absolute anonymity. We will link your answers to you initially by assigning a unique code to your study form but this link will be removed later in order to protect you.

If you have questions about this research study you may contact Dr. Juliet Akoth at 0703 830 396. In case you as if you were not treated well during this study, or have questions concerning your rights as a research participant call The Secretary/Chairperson KNH-UoN ERC on Tel. No. 2726300 Ext 44102. Your participation in this research is voluntary, and you will not be penalized or lose benefits if you refuse to participate or decide to stop. May I continue? YES / NO

I certify that I have consented the participant (code no.) ______________________________

Researcher's name: ____________________________________________________________

Signature: ____________________________________________________________________

Date: ________________________________________________________________________

This study has approval by The Kenyatta National Hospital-University of Nairobi Ethics and Research Committee protocol No. __________________________