EFFECTS OF SINGLE HEMODIALYSIS SESSION ON FLUID STATUS AND SPIROMETRIC PARAMETERS AMONG CHRONIC KIDNEY DISEASE PATIENTS ATTENDING AT MUHIMBILI NATIONAL HOSPITAL

Elvis Msaki (DDS)

A Dissertation Submitted in (Partial) Fulfillment of the Requirements for the Degree of Masters of Science in Physiology of The Muhimbili University of Health and Allied Sciences

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Department Of physiology

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CERTIFICATION

The undersigned certifies that he has read and hereby recommend for acceptance by the Muhimbili University of Health and Allied Sciences a dissertation entitled: **"Effects of single hemodialysis session on fluid status and spirometric parameters among chronic kidney patients attending at Muhimbili National Hospital",** in partial fulfillment of the requirements for Degree of Masters of Science in Physiology of Muhimbili University of Health and Allied Science

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DECLARATION AND COPYRIGHT

I, Elvis Msaki declare that this dissertation is my original work and that it has not been presented to any other University for a similar or any other degree award.

Signature ……………………………………. Date……………………………………….

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DEDICATION

To my family especially Judith N Mollel my wife and our children Agape, Evelyn, Samwel, and Joshua.

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ABSTRACT

Background:

End-Stage Renal Disease (ESRD) is associated with significant fluid retention, consequently causing fluid overload. This may lead to pulmonary congestion and substantial impairment in lung function. In patients with ESRD, hemodialysis is used to maintain normal fluid and solute status subsequently improving survival and quality of life. It is still not clear whether a single dialysis session can cause a substantial fluid reduction and acutely improve spirometric parameters

Objective: We aimed at assessing Effects of single hemodialysis session on fluid status and spirometric parameters among Chronic Kidney Disease patients attending at Muhimbili National Hospital

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Methodology: Forty-five (45) consecutively recruited patients with ESRD were prospectively followed during dialysis sessions. Fluid status was assessed using a Multifrequency bioelectrical impedance analysis (BIA) device, before and after 4 hours of dialysis. At the same time points, we also assessed sprirometric parameters using a digital spirometer. Data analysis was carried out using the Statistical Package for Social Sciences (SPSS), Version 23.

Results

We found a significant decrease ($p < 0.001$) in total body water (TBW) from 43.9± 6.3 SD to 40.1 ± 6.3, extracellular water (ECW) from19.4±2.6 SD to 17.8±2.4 SD intracellular water (ICW) from 22.2± 3.3 SD to 20.9±3.2, third space water (TSW) from 2.3±1.9 to 1.6±1.7. Despite reductions in fluids from all the compartments, the majority of patients (66%) did not attain a normal hydration status following a single dialysis session. There was a significant improvement of Forced Vital Capacity (FVC) and the percentage predicted FVC among females after single hemodialysis but not among males. However, we found no significant changes in other spirometry parameters such as Forced Expiratory Volume in one second (FEV1) Peak Expiratory Flow (PEF), Ratio of FEV1/FVC, and Forced Expiratory Flow (FEF 25-75) together with their percentage predicted values respectively after a single dialysis session in both females and males.

Conclusion

There was a significant reduction of fluids in all body compartments. ~~,h~~However there was no ~~lack of~~ improvement in spirometric parameters following a single hemodialysis session possibly due ~~, this could be linked~~ to ~~the~~ fluid overload that persisted even after the dialysis session

Recommendation

Monitoring hydration status before and after hemodialysis could be beneficial in normalizing the fluid status, and possibly bring improvement of the spirometric parameters among CKD patients. Therefore, follow-up studies on the effect of subsequent dialysis sessions with normalization of fluid status and spirometry are warranted

LIST OF ABBREVIATIONS

AKI	Acute kidney injury
AFV	Arteriovenous fistula
AVG	Arteriovenous graft
BIA	Bioelectrical impedance analysis
BMI	Body Mass Index
BIVA	Bioelectrical Impedance Vector Analysis.
CKD	Chronic kidney disease
CVC	Central venous catheter
ECW	Extracellular Water
ESRD	End-stage renal disease
FEV1	Forced Expiratory Volume in the first second
FVC	Forced Vital Capacity
GOLD	Global Initiative for Obstructive Lung Disease.
HD	Hemodialysis
ICW	Intracellular Water
MNH	Muhimbili National Hospital
MOHCDGEC	Ministry of Health Community Development Gender Elderly and Children
MUHAS	Muhimbili University of Health and Allied Sciences
OH	Overhydration
PD	Peritoneal dialysis
PEFR	Peak expiratory flow rate
RRT	Renal replacement therapy
TBW	Total Body Water
URR	Urea Reduction Ratio
VA	Vascular access

DEFINITION OF TERMS

Bioelectrical impedance analysis (BIA) is a simple, rapid, and noninvasive method used to determine body fluid status.

Bioelectrical Impedance Vector Analysis (BIVA) is the parameter that shows changes in tissue hydration as low as 500ml.

Chronic Kidney Disease is an irreversible and progressive disorder characterized by loss of kidney function persisting for more than 3 months.

Dehydration is Excessive loss of body fluids,presented with long vector displacement out of the upper pole of the 75% tolerance ellipse in the BIVA

Dialysis is an artificial process of removing waste products and extra water from the blood through diffusion across the semi-permeable membrane along an electrochemical concentration gradient to restore intracellular and extracellular fluid environment that is characteristic of normal kidney function.

Dialysis adequacy refers to how well toxins and waste products are removed from the patient's blood during a hemodialysis session. A patient will be considered adequately dialyzed if he/she has a Urea Reduction Ratio (URR) of $\geq$ 65%.

End-Stage Renal Disease (ESRD) is the situation when kidney function is insufficient to sustain life and there is then a need for Renal Replacement Therapy (RRT)

Forced vital capacity (FVC) is the volume of air that can be exhaled forcefully and rapidly after a maximal or deep inspiration

Forced expiratory volume in 1 second (FEV_1) is the volume of air that is expired forcefully in the first second

Normal Hydration/ Euhydration is the state or situation of being in water balance,presented with vector displacement within 50% and 75% tolerance ellipse in the BIVA

Pulmonary function tests are tests used to assess the functional status of the respiratory system both in physiological and pathological conditions.

Peak expiratory flow rate (PEFR) is the maximum rate at which the air can be expired after a deep inspiration.

Restrictive respiratory disease is an abnormal respiratory condition characterized by difficulty in inspiration. Expiration is not affected.

Spirometry is a method of assessing lung function by measuring the volume of air that the patient can expel from the lungs after maximum inspiration, it is a reliable method differentiating obstructive and restrictive lung disorders.

Obstructive respiratory disease is the abnormal respiratory condition characterized by difficulty in expiration

Overhydration is an excess of fluid in the body,presented with short vector displacement within the lower pole of the 95% ellipse in the BIVA

Severe overhydration is an excess of fluid in the body,presented with short vector displacement out of the lower pole of the 95% ellipse in the BIVA

Third Spacing refers to the abnormal accumulation of fluid within the body tissue.

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

Chronic kidney disease (CKD) can simply be described as an irreversible and progressive disorder characterized by loss of kidney function for more than 3 months (1).CKD can progress to End-Stage Renal Disease (ESRD) (2).

CKD is a worldwide public health problem. The Incidence of CKD is as high as 200 cases per million per year in many countries and is nearing 400 cases per million in the USA, Taiwan, and some regions in Mexico, and has risen fastest in older individuals(2). A study on Chronic Kidney Disease showed a global prevalence of 13.4%(11.7–15.1%)(2). In Tanzania, the prevalence of CKD was found to be 13.6%. (3)

The relationship between the lungs and kidneys is of clinical importance(4). In a state of normal hydration with no excess fluid, lean tissue (mainly muscle) consists of 70% water whilst the remaining mass is protein and minerals. Adipose tissue (the majority of which is lipid) consists of 20% water. In a state of overhydration, excess fluid is almost 100% extracellular water (5).End-stage renal disease (ESRD) is associated with fluid retention (6), the accumulation of fluid occurs in various parts of the body including the lungs, resulting in pulmonary edema.

The extracellular water in the lungs (pulmonary edema) may result in lung function impairment, thus increasing the risk of mortality among ESRD patients (7) This is explained by the effects of concentration of blood urea when it reaches above 20 mmol/dl, the effects of uremia on the respiratory system become evident leading to such complications as acute conditions of pulmonary edema, pleural effusion(8). Therefore, measurement of lung function with fluid status may be of prognostic importance among patients with ESRD.

Pulmonary Function in Patients with End-Stage Renal Disease due to fluid overload may be closely associated with both restrictive and obstructive respiratory abnormalities.

Typical spirometry findings in obstructive lung disease are reduced FEV_1 (< 80% of the predicted normal), reduced FVC (but to a lesser extent than FEV1) and FEV_1/FVC ratio reduced (<0.7) whereas restrictive lung disease is characterized by, reduced FEV_1 (<80% of the predicted normal) reduced FVC (<80% of the predicted normal) and FEV_1/FVC ratio normal or > 0.7) (9)

The study done in India on pulmonary function among End-Stage Renal Disease (ESRD) patients revealed the prevalence of restrictive disorders to be 82% whereas for obstructive disorders to be 6%(10).Study conducted in Denmark on Chronic Obstructive Pulmonary Disease (COPD) among patients with ESRD on hemodialysis reported the prevalence of COPD before HD to be 46% based on Global Initiative for Obstructive Lung Disease (GOLD) however after HD FEV1/FVC did not change (11).To date, limited data have been published in Tanzania regarding the prevalence of restrictive and obstructive lung disorders among Chronic Kidney Disease patients.

A study on lung function and fluid status shows that fluid over hydration lowers the lung function test FVC%, FEV1, FEV1%, FEF25–75, FEF25-75%, PEFR, and PEFR%(1). Thus, maintaining optimal fluid volume when treating patients on hemodialysis (HD)is important in preventing lung function abnormalities(5).

A similar study also revealed the same ESRD patients are chronically fluid overloaded, and fluid overload is an independent risk factor for mortality (12). Therefore by application of BIA which i**s** a simple, safe, novel, rapid, noninvasive, and promising method can be used for measuring fluid status among HD patients (1). There are different types of BIA such as single-frequency BIA, multi-frequency BIA, and bioimpedance spectroscopy (BIS)(13) however all these techniques use the electrical properties of the human body to alternate current flow and measures resistance values to estimate body water content and composition which means

Extracellular water (ECW), intracellular water, and total body water (TBW)(13)similarly this technique was used to assesses fluid overload as Overhydration (OH)/extracellular Water (ECW) % $\geq$ 0.7% (1) or as ECW/TBW and ECW-to-bodyweight ratios(13).

Hemodialysis (HD) as renal replacement therapy (RTT) has a beneficial effect on pulmonary function (1). The improvement in lung function may be related to a reduction of excess fluids from the lungs following HD. A study comparing fluid status before (pre-HD) and after HD (Post-HD) using Bioelectrical impedance analysis (BIA)shows significantly lower levels of body fluids post-HD compared to pre-HD(1), suggesting a reduction in excess fluids with subsequent improvement in lung function following HD.

Another study done in South Africa comparing BIA and other methods usually done in assessing fluid in HD patients using estimates done by HD staff such as measuring blood pressure; it was found that there is a clinically significant difference between the excess fluid measured per BIA versus the HD staff estimates(14). However, limited studies are documenting the relationship between lung function and hydration status among patients with CKD in Sub-Saharan Africa including Tanzania.

Therefore, the present study will determine the association between lung function and pre-and post-HD fluid ~~hydration~~ status among Chronic Kidney Disease ~~HD~~ patients undergoing HD in an African Setting. The study findings will provide useful information towards the management of patients with ESRD with lung function and their hydration status in the Tanzanian context.

CHAPTER TWO

2.0 Literature Review

Abnormalities in fluid balance are highly prevalent in patients with End-Stage Renal diseases(15,16). ESRD is associated with significant alterations in the homeostasis of body fluid which poses the greatest challenges (6) A persistent fluid overhydration may lead to pulmonary edema(7). The excess fluid must be removed during each dialysis session also on the same study indicated that information obtained from physical exams, such as body mass, blood pressure, and edema, may not be adequate for accurately determining the fluid status(6,14). Bioelectrical Impedance Analysis (BIA) detects fluid status with a 2–3% measurement error and it is useful by its immediate availability as a noninvasive, inexpensive, and highly versatile test that transforms electrical properties of tissues into clinical information. (17)

Measurement of Hydration Status

The hydration status/fluid dynamics could be assessed in different ways example Bioelectric Vector Analysis (BIVA) which allows a direct assessment of body fluid volume through patterns of vector analysis on the Resistance Reactance (R-Xc) graph as shown in **figure 1** indicating the predefined vector length categories on the 50%,75%, and 95% tolerance ellipses, BIVA aids physicians to make a fast and correct assessment in facilitating the management of hydration status, in which vectors within the 75% tolerance ellipse indicate normal hydration status(18,19), and using the OH/ECW% ratio to assess hydration status(1,20).

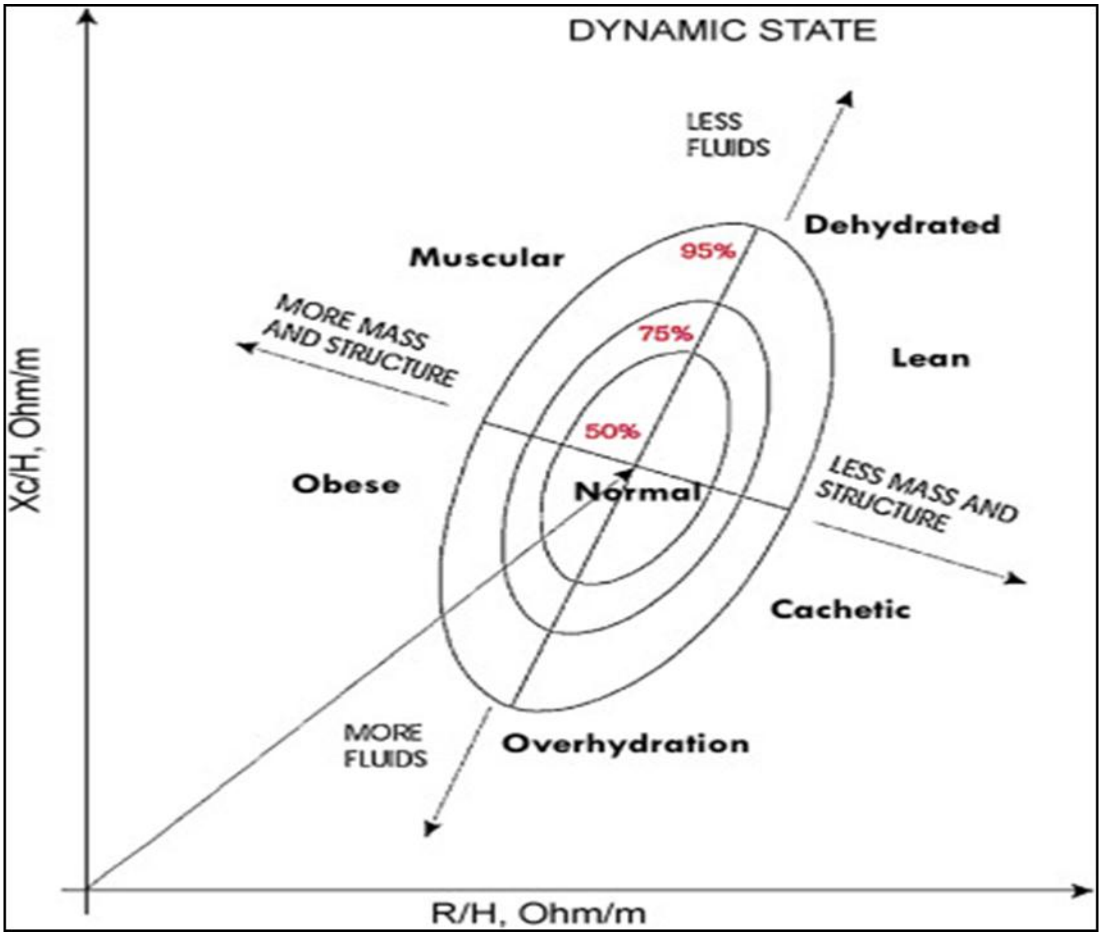

Figure 1: Patterns of vector analysis on the Resistance Reactance (R-Xc) graph

Effect of HD on Hydration Status

The effects of HD on patients with CKD relate mainly to changes to the volume of body fluid thus leading to a reduction of the amount of water in the body(10).

A study done in Mexico using BIVA revealed that pre and post HD patterns of a large number of patients had shortest vectors parallel to the major axis which indicates the volume overhydation that persisted after dialysis treatment even in the absence of clinical edema (21).

Similarly, a study using OH/ECW% ratio found a significant decrease of the ratio in post-HD compared to Pre-HD(13.3% vs 31.1%), suggestive of a reduction in body fluids after hemodialysis(20). Another revealed a similar pattern of reduction in fluid status post HD; Pre-HD TBW 31.2±9.9 Liters vs Post-HD TBW30.5±8.4 Liters, Pre-HD ECW 16.8±4.8 Liters vs Post HD ECW 15.5±4.4Liters, and

Pre-HD ICW15.4±6.4 Liters vs Post-HD ICW15.0±4.8Liters (22)

Effect of HD on Lung Function Profiles

Dialysis may have beneficial effects at least in the initial stages of some respiratory disorders among CKD patients without primary lung disease and also it may lead to improvement of respiratory symptoms and even pulmonary function test values. (10).

The study in Turkey among 54 patients who were on regular hemodialysis revealed that there is a significant increase of the Forced vital capacity (FVC) from 2.61±1.22 in pre-dialysis to2.80±1.12 post dialysis and FVC% from77.03±24.32pre dialysis to 81.61±23.33 on the same study other parameters such as forced expiratory volume in the first second (FEV1) FEV1%, and peak expiratory flow rate (PEFR), were also increased in post-dialysis compared to pre-dialysis (1). Similar study done in India on 50 ESRD patients undergoing hemodialysis were in which Spirometric pulmonary function tests were performed before and after four-hour hemodialysis sessions revealed significant improvements, but normal predicted values were still not achieved(10). Another study was done in Tehran, Iran Dialysis Acute Effects of Hemodialysis on Pulmonary Function in 26 Patients With End-stage Renal Disease revealed pulmonary function test especially FVC improved after a session of HD by 1.66 ± 0.29 pre HD and 1.79 ± 0.38 post HD(23)

Changes in spirometric patterns following HD

Studies on possible changes in spirometric patterns after hemodialysis sessions among adults, particularly in the African setting such as in Tanzania are limited. A Pediatric Respiratory Review done in the USA revealed that pulmonary congestion is highly prevalent among patients with ESRD treated with hemodialysis and is associated with a mixed restrictive-obstructive pattern on pulmonary function tests (24). Similar study suggested that pulmonary restrictive defects are most common among HD patients(10) however hemodialysis can lead to improvement in lung restriction, due to decreasing interstitial edema and bronchial wall decongestion(1)This Liquid accumulation close to airways and leads to obstruction and dysfunction(25)hence hemodialysis removes ultra-filtrate from the intravascular space causing fluid from the interstitial space to be removed however this will not be removed uniformly from the body and there will be some regional differences in the fluid loss. (26)

Fluid dynamics associated with changes in lung Functions

For clinical purposes, Total Body Water has two parts namely Extracellular Volume (ECV) and Intracellular Volume (ICV). The ECV is also subdivided into Interstitial Fluid Volume and blood volume (27,28) and these three compartments TBW, ECW, and ICW can be measured by BIA(29)

Excess ECV is a major clinical problem in patients with CKD as it causes pulmonary edema(30).

Factors affecting the fluid status and pulmonary function among patients undergoing HD

i. **Sex**

It has been shown that there is a more prominent improvement of pulmonary function among men compared to women following HD. In a study done in Iran; the estimated percentage of FEV1 in men pre-dialysis was 92.7 and 96.9 post-dialysis whereas in women FEV1 pre-dialysis was 81.2 and 82.2 post-dialysis. This could be explained probably due to muscle weakness seen more frequently in women compared to men among HD patients (31).

ii. **Duration of Hemodialysis**

Different studies have suggested cut points of the short-term and long-term duration of Hemodialysis. Long-term HD is defined as at least one year of hemodialysis(32). However, the effects of the duration of hemodialysis on pulmonary function are inconclusive. Some studies show a negative correlation with pulmonary function, for example with FVC values and FEV_1(33)whereas others revealed that there is no correlation between duration of hemodialysis and restrictive pattern of impaired lung function(34). Hence, more research is needed to establish the relationship between the duration of HD and its pulmonary effects.

iii. Dialysis adequacy:

Dialysis adequacy refers to how well toxins and waste products are removed from the patient's blood during a hemodialysis session. (3) A patient will be considered adequately dialyzed if he/she has a Urea Reduction Ratio (URR) $\geq$ of 65% (35). Dialysis delivery should be adequate to improve the adequacy of life and prolong survival(36). The URR is assessed by measuring the blood urea nitrogen levels before and after hemodialysis(37).

The study done in Dar es Salaam, Tanzania revealed that the proportion of patients receiving adequate hemodialysis is as low as 34.4% based on URR(3).

However, a similar study done in Dodoma, Tanzania revealed that the proportion of patients who received adequate hemodialysis based on URR was 72% (38). Nevertheless, there is limited information on the association of adequacy of hemodialysis and pulmonary function among HD patients.

iv. Fluid Restrictions.

Volume control and the means of achieving volume control are critical elements of dialysis care that likely to have huge implications for patient's morbidity and mortality(39). In addition, fluid control requires active attention from all members of the dialysis team, and especially the patients (39). The most challenging aspect of the hemodialysis treatment regimen involves extreme restrictions placed on the amount of fluid that can be safely consumed. Patients are instructed to ingest no more than 1 liter of fluid per day because of the intermittent nature of the fluid clearance accomplished by periodic dialysis treatment(40). A study done in Iran on Dietary and Fluid adherence on HD patients revealed that most of the patients (56%) did not adhere to fluid restrictions(41). Hemodialysis patients can return to the pre-dialysis period with hydration as a consequence of water overload (20). One of the major consequences is the accumulation of fluid during the inter-dialytic period that has a propensity to collect in the lungs, hence causing progressive pulmonary congestion (42).

v. Vascular Access (AV).

Well-functioning vascular access (AV) is the mainstay to perform an efficient HD, there are three main types of access namely arteriovenous graft (AVG), a central venous catheter (CVC further categorized as a permanent and temporary catheter), and arteriovenous fistula (AFV). AFV remains the first choice for chronic HD, this method has the best access for longevity and is strongly recommended by guidelines by different countries(43). Vascular access has been shown to associate with dialysis adequacy, which can positively influence the lung function of patients with CKD(44).To date, there is limited information regarding the association between VA and fluid status with pulmonary function among HD patients.

vi. Age

A study done in Iran using 26 HD patients for at least 3 months who underwent pulmonary function test before and after a 4-hour hemodialysis session, revealed that there is no association between changes in pulmonary function test with age(45). Another study done in Turkey revealed that the Overhydration (OH)/extracellular water (ECW) % ratio which is an indicator of fluid status together with an increase in age is independently associated with lower FVC(1)

1.3 Conceptual framework

Chronic Kidney Disease can progress to End-Stage Renal Disease, which leads to retention of fluid, causing edema which impairs the pulmonary function causing restrictive or obstructive patterns. However, Hemodialysis helps to remove excess water and improves pulmonary function commonly restrictive pattern, as shown in **figure 2.**

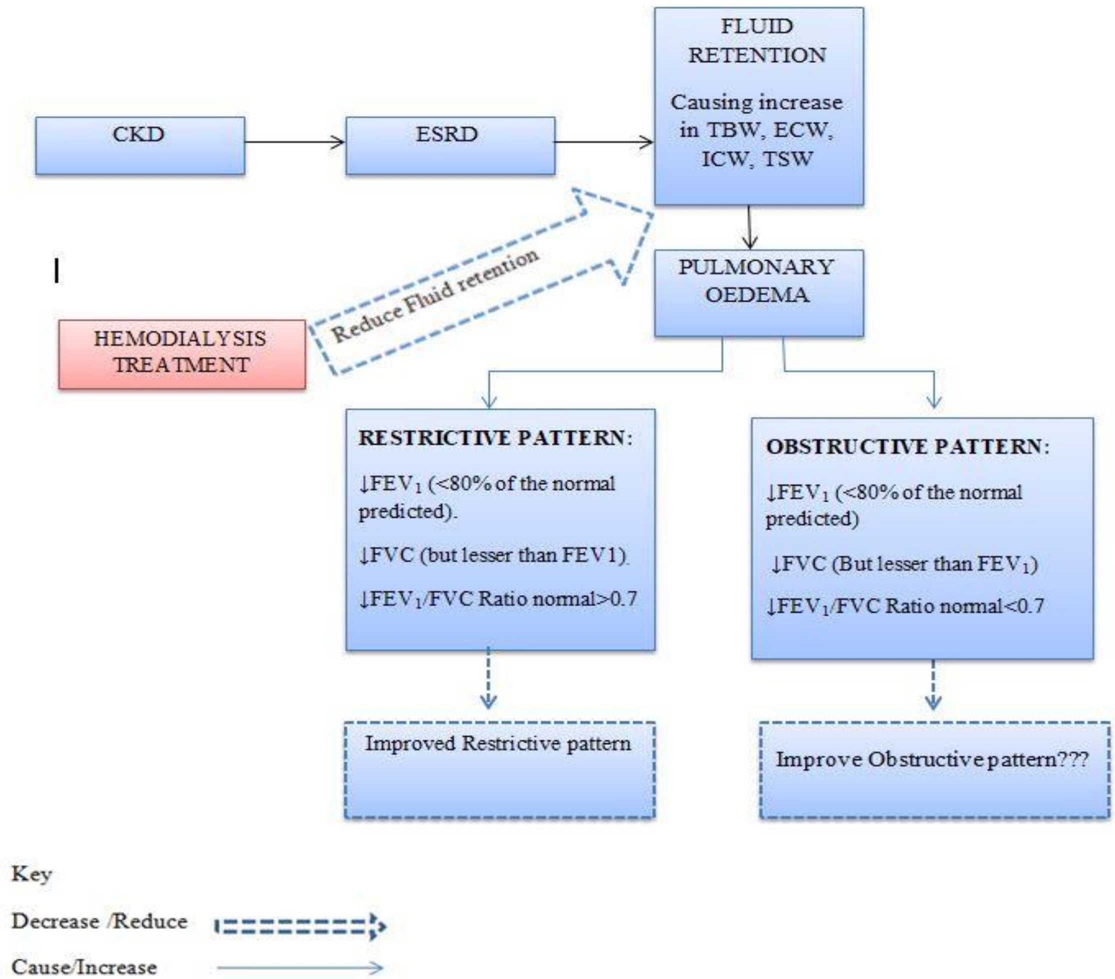

Figure 2: Conceptual framework

1.4 Problem statement

Chronic kidney disease remains a worldwide public health concern with increased mortality among patients with ESRD,in which global prevalence was found to be 13.4%(11.7–15.1%)(2). In Tanzania, the prevalence of CKD was found to be 13.6%. (3) Treatment for CKD is Renal Replacent Therapy among which HD is commonly in Tanzania. Patients on HD are chronically volume overloaded, and that volume overload is an independent risk factor for mortality(12). In addition, overhydration is the major clinical problem among CKD patients and may be associated with impaired lung function due to pulmonary edema. Hemodialysis which is performed to correct the fluid overload and other kidney functions may result in improvements in lung function. It is however not clear whether the acute fluid changes following dialysis brings about immediate changes in lung function. Furthermore, given the mixed spirometric pattern (restrictive and obstructive) in CKD patients with fluid overload, it is not clear which of the two patterns changes following an acute fluid dynamic. In addition, hemodialysis may result in an excessive shift of fluid from the intracellular space, which might harm overall patient health status. The effect of dialysis on fluid status and whether post-dialysis fluid status influences lung function has also not been studied in Tanzania. Thus the effect of HD on overall hydration and pulmonary function remains unknown.

1.5 Rationale

The upsurge of the prevalence of CKD consequently leads to a greater need for RRT. As kidney transplants and PD are relatively uncommon in Tanzania it leaves us with HD as the therapy of choice. Despite the available evidence supporting the effects of fluid retention on reducing pulmonary function, and the role of hemodialysis on improving this retention, the effects of HD on overall hydration and pulmonary function have not been studied in the Tanzanian population. Furthermore, the effects of dialysis-related fluid dynamics on common spirometric patterns (found in CKD patients) following HD remain unexplored in this population. These are important to understand whether the fluid dynamics caused by HD result in beneficial effects on overall hydration, lung function, and health in general.

The results emanating from this study will contribute to setting up standards for effective and beneficial dialysis in Tanzania.

1.6 Research Question

This study aims to answer the following questions.

i. What is the fluid status among patients with CKD pre-and-post –hemodialysis?
ii. What are spirometric parameters in patients with CKD pre-and post- hemodialysis?
iii. What are spirometric lung patterns (restrictive versus obstructive) changes following HD?
iv. What are factors affecting the fluid status and spirometric parameters among patients undergoing HD
v. What are the determinants of post hemodialysis FVC and FEV1

1.7 Objectives

1.7.1 Broad objective:

To assess effects of single hemodialysis session on fluid status and spirometric parameters among Chronic Kidney Disease patients attending at Muhimbili National Hospital

1.7.2 Specific objectives:

i. To compare fluid status among patients with CKD pre- and post-hemodialysis
ii. To compare spirometric parameters among patients with CKD patients pre-and post-HD
iii. To determine spirometric lung patterns pre and post HD
iv. To determine Factors affecting the fluid status and spirometric parameters among patients undergoing HD

v. To determime the determinants of post hemodialysis FVC and FEV1

1.8 Hypothesis

The study will be undertaken with a hypothesis that

i. Patient with CKD has an increased body fluid (TBW, ECW, ICW, and Third Space Water) at the start of Hemodialysis which cause restrictive lung patterns.
ii. Body fluid (TBW, ECW, ICW, and Third Space Water) decrease at the end of Hemodialysis and improve the restrictive lung patterns.
iii. Unfavorable post Hemodialysis fluid status is associated with unfavorable spirometric patterns.

CHAPTER TWO

2.0 METHODOLOGY

2.1 Study design

This was a hospital-based prospective longitudinal study at the Muhimbili National Hospital hemodialysis unit to assess effects of single hemodialysis session on fluid status and spirometric parameters among chronic kidney patients

2.2 Study duration

The study was conducted for a duration of 4 months, from March 2021 to June 2021

2.3 Study area

The study was conducted at the dialysis unit Muhimbili National Hospital (MNH) at Upanga Campus, in the city of Dar Es Salaam, Tanzania. The hospital serves patients referred from other regional hospitals in the country.

MNH is the only hospital with the largest dialysis center in Tanzania with about 55 hemodialysis machines of which 12 machines are located at Mloganzila Campus and 43 machines at Upanga Campus. The patients attending hemodialysis services are under government health insurance (NHIF) and others on private coverage, patients normally have three sessions of dialysis lasting for 4 hours per session. The dialysis schedule for each patient is individualized

2.4 Study population

All patients with Chronic Kidney Disease (CKD) attending hemodialysis for more than 3 months at MNH.

2.5 Inclusion criteria

i. All CKD patients doing hemodialysis at MNH and have consented
ii. Aged above 18years old and have been on HD for a minimum period of 3 months

2.6 Study Sample

Patient with Chronic Kidney Disease on maintenance hemodialysis at MNH – Upanga campus who will fulfill the inclusion criteria and consent.

2.7 Exclusion criteria

Looking at the patient's file the following were excluded from the study

i. Patients with histories of smoking (current or previous)
ii. Patients diagnosed with acute pulmonary infection, acute renal failure, chronic lung disease, tuberculosis, skeletal muscle abnormality, decompensated heart failure, arrhythmias, liver cirrhosis
iii. Patients in severe respiratory distress or who were unable to undergo pulmonary function tests as assessed by the clinician administering the treatment will be excluded from the study.

2.8 Study variables

2.8.1 Dependent Variables

The dependent variables were;

i. Total Body Water-(TBW)
ii. Extracellular Water- (ECW)
iii. Intracellular Water (ICW)
iv. Third Space Water
v. Bioelectrical Impedance Vector Analysis (BIVA)

vi. Forced Expiratory Volume in one second -(FEV_1)
vii. Forced Vital Capacity -(FVC)
viii. Peak Expiratory Flow –(PEF)
ix. Forced Expiratory Flow (FEF 25-75)
x. The ratio of Forced Expiratory Volume in one second to Forced Vital Capacity (FEV_1/FVC)
xi. Percentage Predicted Forced Expiratory Volume in one second (FEV1%)
xii. Percentage Predicted Forced Vital Capacity (FVC %)
xiii. Percentage Predicted ratio of Forced Expiratory Volume in one second to Forced Vital Capacity (FEV1/FVC %)
xiv. Percentage Predicted Peak Expiratory Flow (PEF %)
xv. Percentage Predicted Forced Expiratory Flow in percentage (FEF25-75%)

2.8.2 Independent Variables

i. Adequacy of Dialysis (Urea Reduction Ratio)
ii. Duration of Hemodialysis
iii. Body Mass Index (BMI)
iv. Age
v. Sex

2.9 Sample size

A sample size of 45 patients achieves more than 90% power to detect a difference in mean FVC% (from 77 pre HD (1) to 78 post HD)with an estimated standard deviation of the paired difference of 1, assuming 15% drop out and with a significance level (alpha) of 0.050 using a two-sided paired t-test.

2.10 Sampling techniques

A consecutive sampling technique was used whereby patients attending HD services at MNH Upanga campus were consecutively enrolled in the study until the sample size was reached.

2.11 Enrolment of study participants

All patients who fulfilled inclusion criteria were identified through the patient's file in the dialysis unit. Upon arriving at the dialysis center for a dialysis session; the objective of the study was explained to the patients who meet the inclusion criteria, and those who consent to participate were provided with informed consent for the study and recruited in the study. Before the beginning of a dialysis session the patient's height, weight, spirometric parameters and fluid status were measured. The patient was connected to the dialysis machine and undergo a four hours dialysis session; at the end of the hemodialysis session spirometric parameters and fluid status were measured again. Data was collected by checklist by measurement which lasted for about 30 minutes on which 15 minutes pre HD and 15 minutes post HD

2.12 Data collection tool

The checklist was used to collect Anthropometric, spirometric parameters, and body fluid measurements

Blood Urea Nitrogen Testing

Blood urea nitrogen (BUN) was measured using blood samples taken from the permanent arterial catheter insitu. Sterility was observed while taking a blood sample.

Adequacy of dialysis was tested per ten samples only due to financial constraints using Urea Reduction Ratio (URR). Therefore, blood was sampled pre-HD and post –HD, and URR was used to measure the adequacy of HD as shown below;

$$\text{URR}= \left(\frac{\text{Predialysis BUN}-\text{Post dialysis BUN}}{\text{Pre dialysis BUN}}\right) \text{x}100\%$$

A participant was considered adequately dialyzed if URR was greater than or equal to 65% (URR$\geq$ 65%).

Anthropometric Measurements

Measuring height was done using a height board. This is a rigid vertical surface with an attached scale in centimeters and a horizontal mobile surface at right angles, which slides freely vertically along the scale. The participant was asked to stand with their back to the vertical scale so that their heels, buttocks, and head are in contact with it. The heels were kept together and shoulder relaxed and were asked to look forward at eye level.

The mobile horizontal surface was then slid downwards to the top of the head of the participant. The reading was then taken from the vertical scale in meters (m). The weight in kilograms (kg) was measured without shoes using a standard weighing scale. The BMI was then computed by dividing a person's weight in kg by the square of the person's height in meters and classified according to the WHO classification system.

Table 1: BMI Classification

BMI in kg/m2	**Classification**
<18.5	Underweight
18.5-24.9	Normal
25-29.9	Over weight
30-39.9	Obese

Spirometric Measurement

In both pre HD and post HD spirometric measurement was performed using a Computerized EasyOne® spirometer in which forced expiratory volume in one second (FEV1), forced vital capacity (FVC), peak expiratory flow (PEF), FEV1/FVC ratio and Forced Expiratory Flow (FEF 25-75) together with their percentage predicted values respectively were determined.

Spirometric measurements were performed following the American Thoracic Society/European Respiratory Society (ATS/ERS) procedures for standardization of spirometry(46). The test was performed in a sitting position to avoid lightheadedness without nose clip.

The patient was requested to take a deep breath in, as large as possible, and blows out as hard and as fast as possible, and keeps going until there is no air left, Patient was encouraged, particularly near the end of the maneuver to keep blowing until no more air comes out. The maneuver was performed three times and the best value was chosen and recorded. (47). All lung function tests at the MNH-Upanga campus were performed by the same researcher to minimize inter-observer variability. All safety measures on infection control such as COVID 19 were observed. Such measures included sterilization of equipment, the use of sanitizers, hand washing, wearing masks (before and after the test), and the use of disposable spirettes for each study participant.

Table 2: Categorization of sprirometric lung patterns in the study

Patterns	**FEV1/FVC**	**Predicted FVC (%)**
Normal	>70%	>80%
Obstructive	<70%	>80%
Restrictive	>70%	<80%
Mixed	<70%	<80%

Source: American Thoracic society standardized pulmonary function report(48).American Academy of the family physician. Stepwise interpretation of lung function(49)

Body Composition Measurements

BIA, Multifrequency Quadscan 4000 analyzer (Bodystat, Isle of Man, UK) was used by the same operator; in standardized conditions (quiet environment, ambient temperature) to record Total Body Water (TBW), Extracellular Water (ECW), Intracellular Water (ICW) and Third Space Water.

However other parameters such as Bioelectrical Impedance Vector Analysis (BIVA) were also recorded and used in the analysis. Bioelectrical Impedance Vector Analysis (BIVA) shows changes in tissue hydration as low as 500ml(50)

The participant was requested to remove potential causes of bias concerning the placement of electrodes and laying on her/ his back. Concerning the placement of electrodes, inner sensing electrodes were attached on the dorsal surface of the participant's wrist, and an outer source electrode was placed on the dorsal surface of the third metacarpal bone. The second pair of electrodes were positioned on the anterior surface of the ankle and the third metatarsal bone respectively.

The electrodes were left in place from pre-HD to the end of the post-HD period, with the connection to the device disrupted after each measurement. (51).

Testing of the Checklist

The checklist was submitted to the experts (1 Nephrologist, 1 Pulmonologist, and 1 dialysis nurse) for their expert opinion later it was accepted

Pre Study Survey

A pre-study survey was conducted at MNH- HD unit, two weeks before the actual study. It was done after obtaining approval from the ethical committee and was conducted in the same manner as the actual study. Quality and practicability of the checklist were assessed; suitability of statistical method and relevance of the study were assessed. The pre-study was be conducted among 5 CKD patients, equivalent to 10% of all participants.

The participants involved in the pilot study were not part of the actual study.

2.13 Data management and statistical analysis

Data analyses were performed using the Statistical Package for Social Sciences (SPSS), Version 25. The variables were investigated using visual (histograms and probability plots) and analytical (Kolmogorov- Smirnov test) methods whether or not they were normally distributed. Normally distributed variables were presented as means and standard deviations, and non-normally distributed variables were presented as median and range (maximum and minimum). Comparisons between groups were performed using the Student's t-test.

The paired Student's t-test was used to compare the pre-HD and post-HD measurements. The McNemar tests were used to compare proportions in different groups. The Pearson correlations were used for simple regression analysis. Stepwise multiple linear regression analyses were performed to identify the independent determinants of post hemodialysis FVC and FEV1 among CKD patients. P values <0.05 were considered statistically significant.

2.14 Ethical clearance

Ethical clearance was obtained from the Institution Review Board of Muhimbili University of Health and Allied Sciences (MUHAS). The permission to conduct this study was obtained from relevant authorities at MNH. A formal written informed consent, in Swahili, was provided to the participants and requested to sign before recruitment. Non-consenting patients and those not eligible for the study were not recruited. Demographical characteristics were recorded and anthropometric, spirometric parameters and fluid status results were measured. Patients' names were not used, information collected in the checklist was entered into a computer using identification numbers to maintain confidentiality

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2.15. Potential confounders

The potential confounders of the study include age, height, and weight. Information concerning these cofounder variables was collected using the checklist and regression analysis was used to determine their effects on our results.

2.16 Study limitations and mitigation

Patients with CKD are likely to hesitate because of tiredness with hemodialysis procedures, and study requiring exertion. This was addressed by educating them on the importance and benefit of the study.

2.16 Dissemination of study results

The result for this study will be disseminated to:

1. The Muhimbili University of Health and Allied Sciences library for further references
2. Publication to journals and presentations at National and International scientific conferences.

CHAPTER THREE

3.0 RESULTS

3.1 Demographic and clinical characteristics of the study participants

A total of 69 participants were recruited for the study. Forty-five (45) participants met the inclusion criteria and thus were included in the study (**Figure 3)**

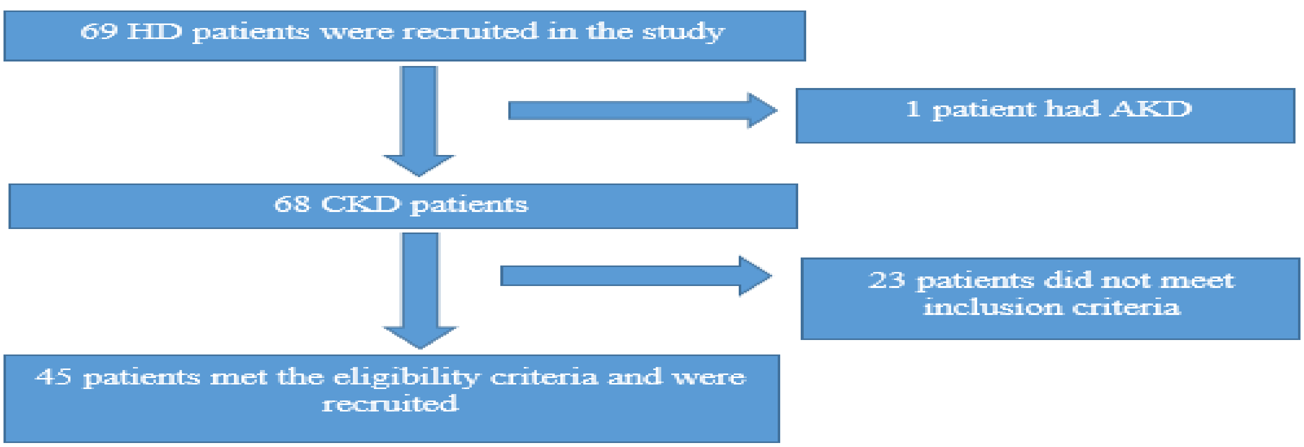

Figure 3: Recruitment Procedure

The mean age of the study participants was 47±14 years. The majority of the study participants were males (66 %) and females (31 %).

The blood samples from 11 participants collected during pre and post-dialysis for assessment of the adequacy of dialysis using the Urea Reduction Ratio (URR) revealed that 82%of the participants achieved dialysis adequacy with a URR of ≥ 65%.

Regarding fluid intake among the study participants; 64 % of the study participants reported fluid intake of less than one liter per day (**Table 3**)

In this study,equal proportions of patients had Arterio-venous Fistula and Permanent Central Venous Catheters 40 %(95% CI: 26% -56 %) and low proportion of the patients had Temporary Central Venous Catheters 20% (95% CI: 10%-35 %) (**Figure 5**)

Table 3: Demographic and clinical characteristics of the study participants

Variable	Category	Frequency (n)	Percent (%)
Age group (years)	18 - 35	10	22.2
	36 - 45	11	24.4
	46 - 60	16	35.6
	>60	8	17.8
Mean age in years (± SD)		47 (± 14)	
Sex	Male	31	68.9
	Female	14	31.1
Hemodialysis session/Week	Two (2) times	21	46.7
	Three (3) times	24	53.3
Duration of Hemodialysis	3 months-1 year	16	35.6
	1-5 years	25	55.6
	More than 5 years	4	8.9
Pre dialysis BMI (Kg/m^2)	Normal (18.5 – 24.9)	26	57.8
	Overweight (25.0 – 29.9)	12	26.7
	Obese (≥30)	7	15.6
Pre dialysis median BMI (Kg/m^2) (IQR)		23.68 (20.5, 28.3)	
Post dialysis BMI (Kg/m^2	Underweight (< 18.5)	5	11.1
	Normal (18.5 – 24.9)	22	48.9
	Overweight (25.0 – 29.9)	14	31.1
	Obese (≥30)	4	8.9
Median post dialysis BMI (Kg/m^2) (IQR)		22.63 (19.8, 27.4)	
Fluid intake litres per day	≤ 1	29	64.4
	>1	16	35.6
Adequacy of dialysis (URR)	< 65%	2	18.8
	≥ 65%	9	81.8

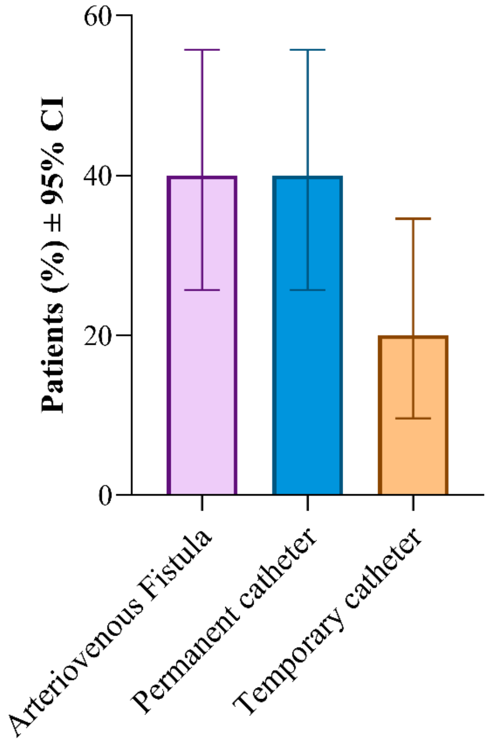

Figure 4: Types of the vascular access

3.3 Comparison of body fluid status in Pre and Post HD

A paired t-test comparing pre and post hemodialysis body fluid status revealed a significant reduction in all body fluid compartments(**Table 4)**.Similarly the mean BIVA variables were significantly increased post Hemodialysis

Despite reduction in fluids from all the compartments, (50%) of the patients who were severely overhydrated remained in the same status post HD **(Table 5).** Similary (36%) of the patients who were overhydrated remained in the same status post HD.

Table 4: Comparison of body fluid status in Pre and Post HD

	Values			95% CI of difference			
Parameters	Pre HD	Post HD	Δ Mean	Lower	Upper	P - values	t-values
TBW(L)	43.90±6.75	40.09±6.31	3.81	3.12	4.50	P<0.001	11.174
ECW(L)	19.42±2.55	17.77±2.37	1.65	1.39	1.91	P<0.001	12.737
ICW(L)	22.22±3.25	20.94±3.16	1.28	1.10	1.51	P<0.001	11.305
TSW(L)	2.26±1.90	1.55±1.74	0.71	0.55	0.88	P<0.001	8.603
BIVA(Ohm/M)	253.90±47.76	290.67±58.46	-36.77	-43.13	-30.41	P<0.001	-11.659

Table 5: Pre and Post HD Hydration status

	Post- dialysis			
Pre dialysis	**Normal hydration (%)**	**Over hydration (%)**	**Severe over hydration (%)**	**Dehydration (%)**
Normal hydration (n = 13)	12 (92.3)	0 (0.0)	0 (0.0)	1 (7.7)
Over hydration (n = 14)	9 (64.3)	5 (35.7)	0 (0.0)	0 (0.0)
Severe over hydration (n = 18)	2 (11.1)	7 (38.9)	9 (50.0)	0 (0.0)

3.4 Spiromeric parameters Pre and Post HD

There were no statistically significant differences in all spirometric parameters between Pre and Post HD when gender was not considered (**Table 6)**. However, there were statistically significant improvements of FVC and FVC% of the predicted value in Post HD for females (**Table7)**. In men, there was no statistically significant improvement in spirometric parameters in post HD (**Table 8)**

Table 6: Comparison of Spirometry Parameters in Pre and Post HD regardless of gender

Parameters	Values		Δ Mean	95% CI of difference		P -values
	Pre HD	Post HD		Lower	Upper	
FVC (L)	2.59±1.12	2.52±0.85	0.07	-0.14	0.28	0.51
FEV1 (L)	1.85±0.68	1.85±0.66	0.004	-0.08	0.08	0.92
FEV1/FVC	0.74±0.11	0.74±0.12	-0.003	-0.04	0.04	0.87
PEF (L/s)	307.70±122.29	319.90±122.62	-12.20	-34.83	10.44	0.28
FEF 25 – 75 (L/s)	1.52±0.88	1.55±0.79	-0.03	-0.23	0.18	0.80
Predicted FVC%	73.49±24.49	72.02±19.03	1.47	-4.20	7.13	0.60
Predicted FEV1%	66.07±20.48	66.38±19.48	-0.31	-4.03	3.41	0.87
Predicted FEV1/FVC%	91.40±14.21	91.80±14.81	-0.40	-5.48	4.68	0.88
Predicted PEF%	69.56±22.42	71.11±22.69	-1.56	-6.99	3.88	0.57
Predicted FEF25-75%	54.07±33.45	54.96±28.03	-0.89	-9.61	7.83	0.84

Table 7: Comparison of Spirometry Parameters in Pre and Post HD in females

Parameters	Values		Δ Mean	95% CI of difference		P - values
	Pre HD	Post HD		Lower	Upper	
FVC (L)	1.65±0.71	1.88±0.67	-0.23	-0.42	-0.03	0.027
FEV1 (L)	1.32±0.60	1.42±0.61	-0.09	-0.32	0.15	0.437
FEV1/FVC	0.79±0.02	0.74±0.05	0.05	-0.06	0.15	0.358
PEF (L/s)	221.79±25.77	246.04±29.37	-24.26	-74.02	25.50	0.311
FEF 25 – 75 (L/s)	1.37±0.24	1.42±0.18	-0.04	-0.52	0.44	0.852
Predicted FVC (%)	61.93±24.29	70.64±21.33	-8.71	-16.88	-0.55	0.038
Predicted FEV1%	61.64±26.95	66.36±24.79	-4.71	-16.64	7.21	0.409
Predicted FEV1/FVC%	96.93±10.37	91.79±21.93	5.14	-7.81	18.09	0.407
Predicted PEF%	63.86±24.98	70.86±26.93	-7.00	-22.02	8.02	0.332
Predicted FEF25-75%	61.76±42.36	64.43±30.10	-2.64	-27.24	21.96	0.820

Table 8: Comparison of Spirometry Parameters in Pre and Post HD in males

Parameters	Values		Δ Mean	95% CI of difference		P - values
	Pre HD	Post HD		Lower	Upper	
FVC (L)	3.01±1.01	2.81±0.76	0.20	-0.08	0.49	0.156
FEV1 (L)	2.09±0.57	2.05±0.59	0.04	-0.013	0.10	0.123
FEV1/FVC	0.72±0.12	0.74±0.08	-0.03	-0.067	0.014	0.200
PEF (L/s)	346.51±113.6	353.26±114.54	-6.75	-32.71	19.20	0.599
FEF 25 – 75 (L/s)	1.59±0.88	1.61±0.85	-0.02	-0.25	0.21	0.865
Predicted FVC%	78.71±23.1	72.65±18.24	6.06	-0.93	13.06	0.087
Predicted FEV1%	68.06±16.94	66.39±17.04	1.68	-0.23	3.59	0.083
Predicted FEV1/FVC%	88.90±15.13	91.81±10.64	-2.90	-7.84	2.04	0.239
Predicted PEF%	72.13±21.09	71.23±20.99	0.90	-3.82	5.63	0.699
Predicted FEF25-75%	50.58±28.69	50.68±26.44	-0.1	-7.84	7.65	0.980

3.5 Spirometric lung patterns Pre and Post HD

When analyzed by the McNemar test, the results revealed that there were no statistically significant changes in Pre and post HD lung patterns (P=0.825).However the majority of patients (72%) who had restrictive lung pattern remained in the same status post HD (**Table 9**)

Table 9: Spirometric lung patterns Pre and Post HD

Pre-dialysis	Post dialysis			
	Normal (%)	Obstructive (%)	Restrictive (%)	Mixed (%)
Normal(n=13)	8 (61.5)	2 (15.4)	2 (15.4)	1 (7.7)
Obstructive(n=7)	3 (42.9)	2 (28.6)	1 (14.3)	1 (14.3)
Restrictive(n=18)	2 (11.1)	1 (5.6)	13 (72.2)	2 (11.1)
Mixed(n=7)	0 (0.0)	0 (0.0)	4 (57.1)	3 (42.9)

3.6 Determinants of post hemodialysis FVC and FEV1

Modeled stepwise forward multiple linear regression analysis was performed, in which age, sex, duration of hemodialysis, hemodialysis session per week, Pre Dialysis hydration status, Vascular Access, Pre Dialysis Total Body Water, Pre Dialysis Third Space Water, and Pre Dialysis Vector Length were included into the model to define independent determinants of post hemodialysis FVC and FEV1

Being male was independently associated with higher FVC whereas Change in Pre HD Hydrations status from normal to severe overhydration was independently associated with lower FVC (**Table 10**).

However other factors were not independently associated with FVC.

Table 10: Estimated regression coefficient from the multiple linear regression models to predict FVC

	Unstandardized Coefficients		Standardized		95.0% CI		
Variables	**B**	**Standard error**	**Coefficient β**	**t**	**Lower**	**Upper**	**p-value**
Sex (Male)	0.912	0.224	0.502	4.074	0.46	1.36	< 0.001
Severe over hydration	-0.540	0.212	-0.315	-2.555	-0.97	-0.11	< 0.001

Being male was independently associated with higher FEV1 whereas Pre HD Hydrations status from normal to severe overhydration was independently associated with lower and duration of hemodialysis more than 5 years was independently associated with lower.**(Table 11)**

However other factors were not independently associated with FEV1

Table 11: Estimated regression coefficient from the multiple linear regression models to predict FEV 1

	Unstandardized Coefficients		Standardized		95.0% CI		
Variables	**B**	**Standard error**	**Coefficient β**	**t**	**Lower**	**Upper**	**p-value**
Sex(male)	0.570	0.165	0.404	3.458	0.24	0.90	**0.001**
Severe over hydration	-0.509	0.155	0.382	-3.286	-0.82	-0.20	**0.002**
Duration of HD ≥ 5 years	-0.664	0.268	-0.290	-2.475	-1.21	-0.12	**0.018**

CHAPTER FOUR

4.0 DISCUSSION

We found a significant fluid reduction in body fluid compartments following hemodialysis. These findings are in agreement with the findings reported by Tangvoraphonkchai et al(22). This indicates that one of the targets of HD treatment is correcting fluid overload among patients with CKD. Another important finding was that while assessing the hydration status using the Bioelectric Impendence Vector Analysis (BIVA), is that we found a significant increase of the vector length (ohm per meter) in post-dialysis. However, the vector length was still short similar to the finding reported by Cuevas et al(21). The short vector lengths are suggestive of volume overload among CKD patients (21). However, the majority of the patients (66%) who were either over hydrated or severely overhydrated remained in the same conditions even after HD. These findings suggest that although the HD treatment reduces a significant amount of water however does not bring the overhydrated patients to normal hydration in a single dialysis session.

The present study found no statistically significant change in the measured pulmonary function test values in the mean FEV1, FVC, and FEV1/FVC in between pre and post-HD when all participants were analyzed regardless of gender. This finding is similar to the observation made by Anees et al(52) that showed no significant difference between pre and post FEV1, FVC, and FEV1/FVC. However, a study was done by Sharma et al (10) and Chelala et al (53)showed a significant improvement of FEV1 and FVC after HD. Rahgoshai et al(23) reported that only FVC was significantly improved after HD

Similarly, there was no statistically significant change in the PEF and FEF 25-75 in between pre and post HD, this was also reported by Res et al(54). The probable reasons for contradictory results in the measured Pulmonary Function (PFT) values may be fluid volume was not adequately removed in a single HD session, disease severity of the lungs of these patients as severe uremia may cause a decrease in muscle strength causing ventilatory defect leading to declining of all lung parameters of the lungs as documented by Tarasuik et al(55)or exhaustion after a four hours HD session.

The current study, comparing separate analyses of males and females, showed that there was a statistically significant improvement of Post HD FVC among females but not among males. This finding is contrary to the finding reported by Zahedan et al(54) that shows an improvement of FVC in post HD among males. The possible explanation of the discrepancy in the improvement of FVC in the current study could be related to disease severity, underlying disease conditions, and inclusion criteria for study participants in the previous studies. However, the exclusion of patients with histories of smoking (current or previous), diagnosed of acute pulmonary infection, acute renal failure, chronic lung disease, tuberculosis, skeletal muscle abnormality, decompensated heart failure, arrhythmias, liver cirrhosis, and patients with severe respiratory distress or who were unable to undergo pulmonary function test as assessed by the clinician in the current study reduced the possibility of confounders, thus representing actual lung conditions with hydration status.

Similarly, we found no statistically significant changes in the mean FVC%, FEV1% FEV1/FVC% PEF% and FEF25-75% of the predicted values regardless of gender in Pre and Post HD, these were contrary to the findings done by Shaikh et al(56) in the study that involved 30 patients on ESRD, in which there was statistical highly significant improvement of FVC%, FEV1% FEV1/FVC% PEF% and FEF25-75% of the predicted value in Post HD. This may be explained by the fact that the populations involved in these studies differ in ethnicity from our present study, and the fact that the fluid reduction was not adequate to cause changes in the post HD predicted values of the lung function.

In addition**,** the present study revealed that there was no statistically significant change in Pre and post-dialysis lung patterns. However, the restrictive lung pattern was most common among the study participants. This finding was consistent with the study done by Anees et al(52) showing that the restrictive pattern was the most common among CKD patients. The possible explanations for this finding could be due to pleural effusion, extravascular volume, and pulmonary hypertension (57).

In our study we found that the change of Pre Dialysis Hydrations status from normal to severe overhydration was independently associated with lower FEV1, these findings are in agreement with the study done by Yilmaz et al(1). The probable explanation for this finding may be the accumulation of fluid during the interdialytic period, which tends to collect in the lungs and lead to progressive pulmonary congestion(42)

Several factors can affect the fluid status and pulmonary function among HD patients such as dialysis adequacy, duration of hemodialysis, sessions of dialysis per week, age, sex, fluid restriction, and vascular access as reported in different studies (38, 3, 12,34,53).

Dialysis adequacy refers to how well toxins and waste products are removed from the patient's blood during a hemodialysis session. In the present study, the majority(82%) of the study participants achieved dialysis adequacy with a URR of ≥ 65% meaning that BUN was statistical significantly reduced in post HD. A similar finding was revealed by Bakari et al(38) that the majority (72%) of the patients had URR≥65%.On the contrary, the finding was different from the study done by Somji et al(3) where the minority of the study participants achieved dialysis adequacy. However, the majority (66%) of the patients who were overhydrated and severely overhydrated remained almost in the same condition in Post HD in the present study, suggesting that a single dialysis session can achieve adequacy but not normal hydration status. This finding is similar to the study done by Tangvoraphonkchai et al(12)that revealed fluid overload as an independent risk factor for mortality.

In our study, we found that a Duration of HD of more than 5 years was independently associated with lower FEV1only whereas the number of sessions of HD per week was not independently associated with FVC and FEV1. A similar observation was made by Lang SM et al(34). However, a study conducted by Chelala et al(53) in Egypt found an increment in frequency and duration of dialysis sessions were associated with significant improvement in FVC and FEV1. The probable reasons for contradictory results may be patient selection criteria, setting of the study, and HD procedure characteristics.

Likewise, the present study showed that being male was independently associated with higher FVC and FEV1, these findings were consistent with the study done by Moghaddam MP et al(31) and Yilmaz et al(1)This could be due to muscle weakness seen more frequently in females compared to males among HD patients in addition to the physiological difference in lung function parameters existing between males and female; whereby males have relatively higher lung function compared to females.

Regarding fluid restriction; the majority of our study participants (64 %) had a fluid intake of less than one liter per day contrary to the study done by Rambod M et al(41) who reported most (56%) of the patients did not adhere to the fluid restriction of less than one liter per day. However, there was no statistically significant association between fluid intake per day and post dialysis FVC and FEV1. It has been reported by Yilmaz et al(20) that many patients return to the pre-dialysis period with over hydration as a consequence of fluid overload as the fluid intake accumulates. This may account for the reasons why our study participants presented with restrictive-obstructive patterns of the pulmonary function.

The present study revealed age had no statistically significant association with post-dialysis FEV1 and FVC**,** these findings are in agreement with the study done by Rahgoshai R et al (45) in Iran using 26 HD patients. However, the finding is contrary to the finding reported by Yilmaz et al(1)in Turkey revealing that increase in age is independently associated with lower FVC, even though our study participants had relatively similar age with those in the study done by Kara et al. The probable reason for contradictory results may be selection criteria of the study participants, in which Kara et al used only those who attend hemodialysis treatment (session per week) three times per week whereas in our study and in the study done by Rahgoshai et al combine both those who attend two times and three times per week, thus affecting our results.

On top of that, there was no association between the type of vascular access and lung function profile (post-HD FEV1 and FVC). Studies on vascular access and spirometry are scarce. However, previous studies showed that Arterio-venous Fistula (AVF) remains the first choice for chronic HD (43) and that vascular access has been shown to associate with dialysis adequacy(44), which can positively influence the lung function of patients with CKD. The findings of no association between vascular access and spirometry in the present study need confirmation by other studies.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATION

Conclusion

There was a significant reduction of fluids in all body compartments,however there was lack of improvement in spirometric parameters following a single hemodialysis session, this could be linked to the fluid overload that persisted even after the dialysis session

Recommendation

Monitoring hydration status before and after hemodialysis could be beneficial in normalizing the fluid status, and possibly bring improvement of the spirometric parameters among CKD patients. Therefore, follow-up studies on the effect of subsequent dialysis sessions with normalization of fluid status and spirometry are warranted

Weakness of the Study

The sample size was small and other parameters such as Total lung capacity, Hemoglobin levels, were not assessed due to financial constraints and time, which could have an impact on the study results.

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APPENDICES:

APPENDIX I: Consent Explanation – English Version

Consent to participate in the study of assessing the effects of single hemodialysis session on fluid status and spirometric parameters among Chronic Kidney Disease patients attending at Muhimbili National Hospital

Purpose of the study:

I, Dr. Elvis Msaki am undertaking this study of assessing the effects of single hemodialysis session on fluid status and spirometric parameters among Chronic Kidney Disease patients attending atMuhimbili National Hospital

How to participate:

You are being asked to participate in this study of of assessing the effects of single hemodialysis session on fluid status and spirometric parameters among Chronic Kidney Disease patients attending at Muhimbili National Hospital

If you agree to participate, I will explain to you about the study and ask you to sign a consent form. Then I will ask you to participate in a research that will take about 30 minutes.

There will be measurements of weight and height together with spirometric test and fluid status in Pre and Post hemodialysis.

Risk to you as a participant:

There is no risk that you will be exposed

Benefit:

This study will provide an opportunity to know your Body Mass Index, the Spirometric Parameters as well as fluid status in both Pre and Post Hemodialysis. This will improve quality hemodialysis and prevent pulmonary function complication.

Right to refuse:

Your participation is voluntary; you will be free to withdraw from the measurement any time and shall not be discriminated upon. You can ask questions prior to signing the consent and during the procedure.

If you agree to participate, you are kindly requested to sign the consent form.

Thank you.

APPENDIX II: Consent (English)

I………………………………consent to participate in the study of of assessing the effects of single hemodialysis session on fluid status and spirometric parameters among Chronic Kidney Disease patients attending at Muhimbili National Hospital.

I do this with the knowledge of the purposes of the study and the procedures thereof. The purpose of the study has been explained to me clearly by Dr. Elvis Msaki. I am also aware that I can withdraw from this study without losing any benefits and quality of care of my medical condition.

Signature of the participant…………………………………Date……………………………….Signature of witness…………………………………… Date………………………………..

If you have any questions during the course of the study, you may contact the following.

Dr. Elvis Msaki
Principal investigator
Muhimbili University of health and Allied Sciences (MUHAS)
Department of Physiology
P.O.BOX 65001 Dar-es-salaam
Mobile: 0713 143 959

OR

Dr. Alexander M. Tungu
Supervisor of this research
Muhimbili University of Health and Allied Sciences (MUHAS)
Department of Physiology
P.O BOX 65001 Dar-es-salaam
Mobile 0713 170 409

In case of any ethical concerns please contact
Director of Research and Publication-MUHAS
P.O BOX 65001 Dar-es-salaam, Tel. +255-022-2152489

APPENDIX III: Maelezo Ya Idhini Wa Ushiriki Wa Utafiti

Uchunguzi wa badiliko lahali ya maji na ufanyaji kazi wa mapafu na kwa wagonjwa wa figo wanaosafisha damu (diyalisisi) katika Hospitali ya Taifa Muhimbili kitengo cha figo.

Madhumuni ya utafiti:

Mimi Dkt Elvis Msaki nafanya utafiti wa Uchunguzi wa Uchunguzi wa badiliko la hali ya maji na ufanyaji kazi wa mapafu na kwa wagonjwa wa figo wanaosafisha damu (diyalisisi) katika Hospitali ya Taifa Muhimbili kitengo cha figo.

Utaratibu

Naomba idhini yako ya kushiriki katika utafiti huu ambao utachukua muda wa dakika thelathini. Ukikubali kujiunga na utafiti huu, nitakupa fomu ya makubaliano,utie sahihi. Baada ya hapo utapimwa urefu,uzito pamoja na kipimo cha kupima ufanyaji kazi wa mapafu na hali ya maji kabla na baada ya usafishaji wa damu (diyalisisi)

Athari kwa mshiriki:

Hakuna athari utakayopitia ukijiunga na utafiti huu.

Faida ya utafiti huu:

Utafiti huu utasaidia kutambua uwiano wa uzito na urefu,hali ya ufanyaji kazi wa mapafu na hali ya maji mwilini. Hii itasaidia kuimarisha matibabu ya wagonjwa na kupunguza madhara ya matatizo katika mapafu yatokanayo na uwingi wa maji.

Haki ya kutokushiriki:

Kujiunga na utafiti huu ni kwa hiari na una uhuru wa kujiondoa kushiriki bila kubaguliwa au kuathiri matibabu yako. Una uhuru wa kuuliza maswali yeyote kuhusu utafiti huu kabla ya kutia sahihi fomu yamakubaliano.

Ukikubali kujiunga na utafiti huu, tafadhali tia sahihi fomu hii.

Asante

APPENDIX IV: Fomu Ya Maelezo Ya Ridhaa Kwa Mgonjwa

Mimi………………………………nimekubali kushiriki katika utafiti wa.Uchunguzi wa badiliko la hali ya maji na ufanyaji kazi wa mapafu na kwa wagonjwa wa figo wanaosafisha damu (diyalisisi) katika Hospitali ya Taifa Muhimbili kitengo cha figo.Ninafanya hivi nikiwa na taarifa ya madhumuni na taratibu za utafiti huu, zimeelezwa wazi na Dk Elvis Msaki pia ninafahamu kwamba naweza kujitoa katika utafiti huu bila kupoteza faida yoyote ya huduma ya kimatibabu.

Sahihi ya mgonjwa……………………………..…Tarehe……………………………….

Sahihi yashahidi….…………………….……………Tarehe………………………………….

Ukiwa na maswali wakati wowote wa utafiti huu unaweza wasiliana na anwani uliopewa.

Dk Elvis Msaki

Mtafiti mkuu

Chuo kikuu cha afya na tiba shirikishi Muhimbili

Idara ya Fiziologia

S.L.P 65001 Dar-es-salaam

Namba ya simu: 0713143 959

AU

Dkt Alexander M. Tungu

Msimamizi wa utafiti huu

Chuo kikuu cha afya na tiba shirikishi Muhimbili

Idara ya Fiziologia

S.L.P 65001 Dar-es-salaam

Nambari ya simu: 0713 170 409

Kwa mawasiliano zaidi kuhusiana na haki zako kwenye utafiti huu kama mshiriki, tafadhali wasiliana na;

Mwenyekiti wa tume ya tafiti na uchapishaji wa tafiti

Chuo kikuu cha afya na tiba shirikishi Muhimbili

S.L.P 65001 Dar-es-salaam, Nambari ya simu.022-2152489

APPENDIX-V Checklist

Data collection tool for assessing the effects of single hemodialysis session on fluid status and spirometric parameters among Chronic Kidney Disease patients attending at Muhimbili National Hospital

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ID…………………………………..   Date……………………………..

A:Demographic characteristics and Anthropometry		
Age ………………	Pre HD Body Weight in Kg……………….	Post HD Body Weight in Kg……………….
Sex……………….	Pre HD BMI in Kg/m^2………………….	Post HD BMI in Kg/m^2………………
Height in (m)………		

B: Duration of hemodialysis (Put appropriate tick on the blank)	
>3 months but <1year	
≥ 1year but <2 years	
≥ 2years but <3 years	
≥ 3 years but <5years	
More than 5 years	

C: Hemodialysis sessions per week **(Put appropriate tick on the blank)**	
2 times	
3 times	
4 times	

D:Fluid Intake per day **(Put appropriate tick on the blank)**	
≤ 1 liter	
>1 liter	

E: Vascular Access **(Put appropriate tick on the blank)**	
Arterio venous Fistula (AVF)	
Arterio venous Graft (AVG)	
Central Venous Catheter (CVC)/ Permanrnt Catheter	
Temporary Catheter	

F:Adequacy of Dialysis			
Pre Dialysis BUN		Urea Reduction Ratio (URR) $=\frac{\text{Pre Dialysis BUN} - \text{Post Dialysis BUN}}{\text{Pre Dialysis BUN}}$ x 100%	
Post Dialysis BUN			

G:Body Composition Measurement		
Parameter	Pre Hemodialysis	Post Hemodialysis
Extracellular Water(ECW)		
Intracellular Water(ICW)		
Total Body Water(TBW)		
Third Space Water		
Bioelectrical Impedance Vector Analysis (BIVA)		

H:Spirometric Measurements		
Parameter	Pre Hemodialysis	Post Hemodialysis
FEV_1		
FVC		
FEV_1/FVC		
PEF		
FEF 25-75		
% Predicted FEV_1		
% Predicted FVC		
% Predicted FEV_1/FVC		
% Predicted PEF		
% Predicted FEF 25-75		

Appendix VI: Ethical clearance

UNITED REPUBLIC OF TANZANIA

MINISTRY OF EDUCATION, SCIENCE AND TECHNOLOGY

MUHIMBILI UNIVERSITY OF HEALTH AND ALLIED SCIENCES

OFFICE OF THE DIRECTOR - RESEARCH AND PUBLICATIONS

Ref. No.DA.282/298/01.C/ Date: 25/03/2021

MUHAS-REC-03-2021-534

Elvis Msaki,
MSc in Physiology,
School of Medicine
MUHAS

RE: APPROVAL FOR ETHICAL CLEARANCE FOR A STUDY TITLED: EFFECTS OF ACUTE FLUID CHANGES ON PULMONARY FUNCTION AMONG PATIENTS UNDERGOING HEMODIALYSIS AT MUHIMBILI NATIONAL HOSPITAL

Reference is made to the above heading.

I am pleased to inform you that the Chairman has on behalf of the University Senate, approved ethical clearance of the above-mentioned study, on recommendations of the Senate Research and Publications Committee meeting accordance with MUHAS research policy and Tanzania regulations governing human and animal subjects research.

APPROVAL DATE: 25/03/2021
EXPIRATION DATE OF APPROVAL: 24/03/2022

STUDY DESCRIPTION:
Purpose:
The purpose of this prospective longitudinal study is to assess the Effects of Acute Fluid changes on Pulmonary Function among patients undergoing Hemodialysis at Muhimbili National Hospital.

The approved protocol and procedures for this study is attached and stamped with this letter, and can be found in the link provided: https://irb.muhas.ac.tz/storage/Certificates/Certificate%20-%20472.pdf and in the MUHAS archives.

The PI is required to:

1. Submit bi-annual progress reports and final report upon completion of the study.
2. Report to the IRB any unanticipated problem involving risks to subjects or others including adverse events where applicable.
3. Apply for renewal of approval of ethical clearance one (1) month prior its expiration if the study is not completed at the end of this ethical approval. You may not continue with any research activity beyond the expiration date without the approval of the IRB. Failure to receive approval for continuation before the expiration date will result in automatic termination of the approval for this study on the expiration date.
4. Obtain IRB amendment (s) approval for any changes to any aspect of this study before they can be implemented.
5. Data security is ultimately the responsibility of the investigator.
6. Apply for and obtain data transfer agreement (DTA) from NIMR if data will be transferred to a foreign country.
7. Apply for and obtain material transfer agreement (MTA) from NIMR, if research materials (samples) will be shipped to a foreign country,
8. Any researcher, who contravenes or fail to comply with these conditions, shall be guilty of an offence and shall be liable on conviction to a fine as per NIMR Act No. 23 of 1979, PART III section 10 (2)
9. The PI is required to ensure that the findings of the study are disseminated to relevant stake holders.
10. PI is required to be versed with necessary laws and regulatory policies that govern research in Tanzania. Some guidance is available on our website https://drp.muhas.ac.tz/.

Dr. Bruno Sunguya
Chairman, MUHAS Research and Ethics Committee

Muhimbili University of Health and Allied Sciences
DIRECTOR
Research &
Publications
Box 65001

Cc: Director of Postgraduate Studies

9 United Nations Road; Upanga West; P.O. Box 65001, Dar Es Salaam: Tel. G/Line: +255-22-2150302/6; Ext. 1038; Direct Line:+255-22-2152489;Telefax:+255-22-2152489;E-mail:drp@muhas.ac.tz;Web:https://www.muhas.ac.tz

Appendix VII: Permission letter

THE UNITED REPUBLIC OF TANZANI

MINISTRY OF HEALTH, COMMUNITY DEVELOPMENT, GENDER, ELDERLY AND CHILDREN

MUHIMBILI NATIONAL HOSPITAL

In reply please quote;

Ref. No.: MNH/TRCU/Perm/2021/098

Date: 19th April, 2021

Head of Department
Internal Medicine
Muhimbili National Hospital

RE: PERMISSION TO COLLECT DATA AT MNH.

Name of Student	**Dr. Elvis Msaki**
Title	**"Effects of Acute Fluid Changes on Pulmonary Function Among Patients Undergoing Hemodialysis at Muhimbili National Hospital".**
Institution	MUHAS
Supervisor	Dr. Alexander M. Tungu
Period	19th April 2021, to 20th July, 2021

Approval has been granted to the above mentioned student to collect data at MNH.

Kindly ensure that the student abide to the ethical principles and other conditions of the research approval.

HEAD TEACHING, RESEARCH & CONSULTANCY UNIT
P.O. Box 65000
DAR-ES-SALAAM
MUHIMBILI NATIONAL HOSPITAL

Sincerely,

Reid B. Mchome
Coordinator –Teaching, Research and Consultancy Unit

c.c DMS
c.c Dr. Elvis Msaki

P.O. BOX 65000 Dar es Salaam, Tanzania