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Assessment of Haemodialysis Adequacy among ESRD Patients in Port Harcourt

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Abstract
Background: *Chronic renal failure is the progressive loss of function of kidney and patient requires a long treatment in the form of renal replacement therapy. Haemodialysis is one of the modalities of renal replacement management, during which the body's waste products, including creatinine, urea and excess water, are removed. The purpose of the study is to elucidate the adequacy of haemodialysis among patients with ESRD in Port Harcourt.*
Materials and Methods*: This is a prospective study involving Seventy-four ESRD patients who are undergoing haemodialysis. 5mls of blood was collected from each patient pre-dialysis and post-dialysis to determine the level of urea and creatinine.Ureareduction ratio (URR) was calculated and used as a determinant of haemodialysis adequacy.*
Results*: Most of ESRD patients were within the age bracket of 51- 60 years (40%). The mean URR was 42%. URR of the first session (35%) was compared with URR after the second (41%) and third (39%) sessions and the p-value obtained was no statistically significant.However, the pre-dialysis urea and creatinine was significantly higher than that of the post-dialysis urea and creatinine.*
Conclusion*: The study revealed that haemodialysis is inadequate in the studied population after three sessions of haemodialysis, which may be attributed to cost, co-morbidity and late presentation to the hospital.*
Key Word: *Chronic renal failure, Haemodialysis, Creatinine, Urea, End-stage renal disease, Adequacy, Urea reduction ratio*

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I. Introduction

Chronic renal disease (CKD) is an increasing public health concern and it is among the most important cause of disability and death in many countries worldwide [1, 2]. Diseases of the kidney is a systemic disease that induces a slow and progressive decline in renal function due to various factors such as infection (HIV as a leading cause), hypertensive diseases, diabetes Mellitus, autoimmune diseases, cancer and nephrotoxic substances or chemicals [3]. Chronic renal failure occurs gradually over a period ranging from weeks, months, or years eventually leading to end-stage renal disease (ESRD) when the kidneys stop [4, 5].

Creatinine one of the metabolic wastes is a renal biomarker and is produced by the non-enzymatic changes of creatine and phosphocreatine in the muscles. The liver also has a significant role in the assemblage of creatinine through the process of methylation of guanidine aminoacetic acid. The normal serum creatinine level is between 60 to 110 µmol/L [6]. Another renal biomarker is urea, which is an organic compound, playing an important role in the metabolism of nitrogen-containing compounds. The normal serum urea level is 2.5 to 7.1 mmol/L [7]. The most common determinant of death in patients with ESRD is the accumulation of urea and nitrogenous waste in the blood and low level of serum albumin concentration.

Haemodialysis is a renal replacement therapy where urea, creatinine, electrolytes and free water from the blood are removed when there is impairment of renal function. The survival of patients with end-stage renal disease (ESRD) is made possible by removal of ureamic solutes by dialysis. The amount of dialysis that a patient receives and the amount of ureamic toxin removal can impact morbidity and mortality [8, 9].

Haemodialysis is recommended at least two to three times in a week and the time of dialysis (which is the time the patient stay on dialysis per session) ranges from two to four hours. Several factors determine the time of dialysis these include kidney function, amount of waste in the body, level of salts, co-morbidity and bodyweight yet mortality rate with haemodialysis remains high approximately eighteen to twenty percent per year due to some complication that may arise during the procedure [7].

The quantification of the dialysis dose is an integral element in the management of patients with ESRD because the adequacy of the dose has a profound effect on the patients by reducing the morbidity and mortality of patients with ESRD. Adequate of dialysisdenotesthe delivery of a dose of dialysis that is considered high

enough to stimulate an optimal long-term outcome [6]. The National Cooperative Dialysis Study (NCDS) established that higher dialysis dose resulted in reduced morbidity [7]. To evaluate dialysis adequacy of ESRD patients undergoing dialysis, Percentage Reduction in Urea (PRU) or urea reduction ratio (URR), and Kt/V are used. The purpose of this study is to assess the adequacy of haemodialysis among ESRD Patients undergoing haemodialysis in Port Harcourt.

II. Materials and Methods

Human Subjects

This study was a prospective study of patients living with end-stage renal disease (ESRD) who were able to undergo three sessions per week of haemodialysis in some dialysis centers in Port Harcourt, Rivers state. The study was conducted after ascertaining that all patients met the criteria for ESRD. The study was conducted between January and December 2019. All the patients were in stage five chronic kidney disease with glomerular filtration rate persistently below 15mls/min/1.73m2 for three months and patients are already undergoing haemodialysis. Patients that had regular 4 hourly sessions of dialysis for at least twice a week in two consecutive months were also included in the study. A total of 74 out of 110 patients (67%) with ESRD met the inclusion criteria.

Sample collection

Blood sample was collected for pre and post dialysis analysis of urea and serum albumin from the 74 patients. 5 ml of the blood was obtained from each patient before the index dialysis session for the determination of the pre-dialysis urea and at the end of each dialysis session, blood sample for the determination of post-dialysis urea was also obtained about three minutes after the dialysis from the arterial sampling port in orderto avoid the effect of access recirculation. Clotted blood was centrifuged to separate serum and was used for the estimation of creatinine and urea.

Urea estimation

Urea was measured by diacetylmonoximecolourimetric method and Berthelot reaction. In this method, the urea is converted to ammonia by an enzyme called urease. The ammonia produced is combined with 2-oxoglutarate and NADH in the presence of glutamate dehydrogenase (GDH), which yields L- Glutamate and NAD. The decrease in NADH absorbance is proportional to the urea concentration. The rate of decrease in the NADH concentration was directly proportional to the urea concentration in the serum sample which was photometrically determined using fully automated Cobas C311 analyzer [10].

Dialysis Adequacy Calculation

The urea reduction ratio (URR) iscalculated and was used as a measure of haemodialysis adequacy. The urea reduction ratio for each index dialysis session was calculated using the formula:

URR= (1- Urea post-dialysis/Urea pre-dialysis) x 100

Data collected was analyzed using statistical package for social sciences (SPSS) version 20. Frequencies and percentages were calculated, Student t test (independent t test and paired sample t-test) and ANOVA were used for comparison of data. The mean plus or minus standard error of mean (Mean ± SEM) of numerical variable were generated.

III. Results

Demographic characteristic of patients

A total of 74 patients were randomly selected for this study. Venous blood samples were collected for the estimation of their serum urea level, serum creatinine level and haemoglobin level. Figure 1 showed the age and gender-wise distribution. The highest occurrence of CKD was in the age group of 51-60 with 40% (24% male and 16% female).

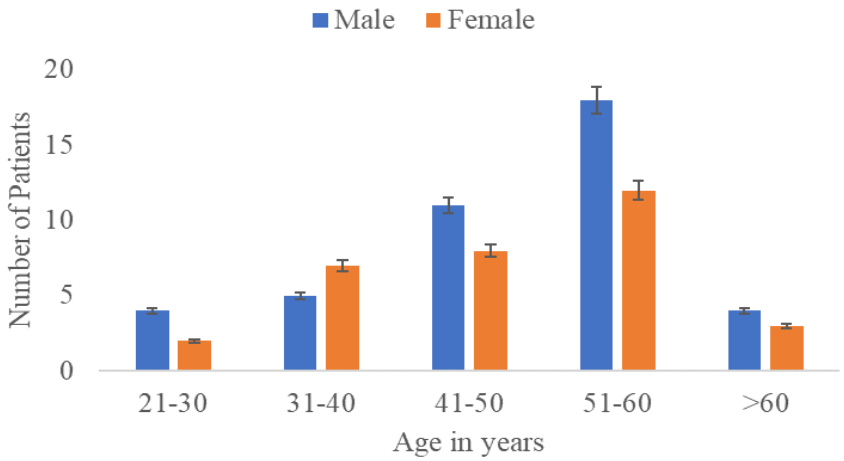

Fig 1: Age and gender wise distribution of CKD patients undergoing haemodialysis

Effect of Haemodialysis on Serum Urea Level

In chronic kidney disease (CKD) patients undergoing haemodialysis, the pre-dialysis serum urea level was significantly higher than the normal range (up to 31.8 mmol/L). Most of the patients (53 %) had a serum urea level of more than 15 mmol/L (Fig. 2). After haemodialysis there was a remarkable reduction in serum urea level as shown in Fig 2. The serum urea level in most of the patients was reduced to 6-10 mmol/L (54 %) and 11-15 mmol/L (27 %) and this fall below 15 mmol/L (81%) (Fig. 2).

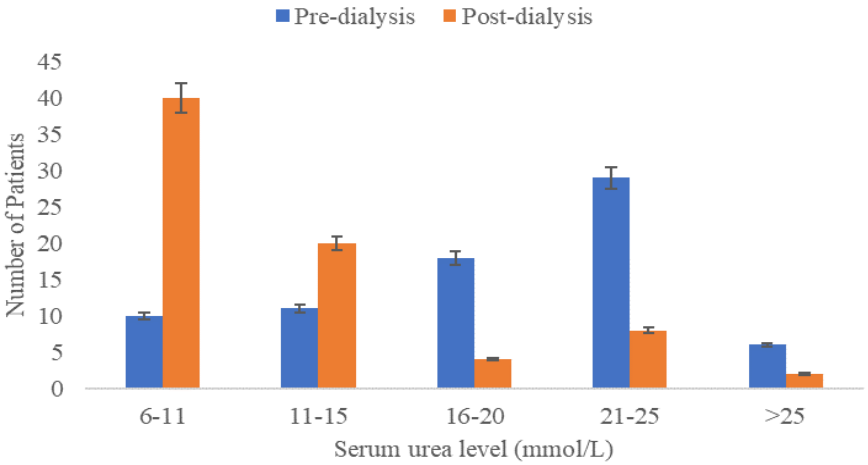

Fig 2: Pre- and Post-dialysis serum urea level of CKD patients undergoing haemodialysis

Adequacy of haemodialysis

As showed in table 1 below, the mean urea reduction ratio was 42%. The percentage of patients in the studied population receiving adequate haemodialysis among patients undergoing chronic haemodialysis was below 10% in both sexes, indicating a significantly high prevalence of inadequate haemodialysis dose. The results also showed that male has a higher prevalence of inadequate haemodialysis than female as indicated in table 2 below. Although there was no significant difference between male and female with regard to URR.

Table 1. Urea Reduction Ratio (%) in the Study Population

Session of dialysis	Male (n=42)	Female (n=32)	P Value
1	35±1.5	38±1.6	>0.05
2	41±1.8	56±2.0	>0.05
3	39±1.6	40±1.7	>0.05
Mean = 42%			

Values are mean ± standard error of mean; Level of significance is considered when $p<0.05$
n= number of subjects

Table 2: Demographic factors associated with inadequate haemodialysis

Factors	URR		
	Inadequate (%)	Adequate (%)	p-value
Age			
<50	34 (91%)	3 (9%)	0.657
≥50	35 (95%)	2 (5%)	
Sex			
Male	40 (95%)	2 (5%)	0.139
Female	29 (91%)	3 (9%)	

IV. Discussion

The present study is looking at the prevalence of inadequate haemodialysis in patients with ESRD in Port Harcourt. Haemodialysis plays a major role in the maintenance of life in patients with end-stage renal disease(ESRD). In this study, the mean urea reduction ratio (URR) was 42%. This indicates that ESRD patients achieve less than the haemodialysis target treatment set by Kidney Disease Outcome Quality Initiative guidelines (KDOQI) 2006 recommendation [11].

Conferring to the KDOQI forhaemodialysis patients, the minimally adequate dose ofdialysis should be a urea reduction ratio (URR) of at least 65% [12].The results in this study, therefore, indicate inadequatehaemodialysis dose in ESRD patients in undergoing haemodialysis in Port Harcourt.

This study revealed similar findings to those carried out in some other developing countries such as Brazil, Nepal, and Pakistan [13–17]. The resultsof inadequate haemodialysis conform to that described by three other related studiesin Nigeria. According to Agaba*et al* [18], the mean URR was found to be 45.3%, while the mean URR in the studies of Amira and Mamvem[12] and Chijioke*et al*. [19]was found to be 52.4% and 41.8% respectively. However, the findings in our study differ from those reported in some developed countries like theUnited States [20]. For instance, findings inIndia by Sunanda*et al*. [21] and Aggarwal *et al*. [22], found a mean URR value of 66.41% and 65.24%respectively which is in contrast with the findings in this study.

Several factors were identified as a contributing factorto theinadequacy of haemodialysis in this study such as poorsocio-economic status of the patients with a consequence of late presentation to the hospital, frequent blood transfusion due to chronic anaemia, co-morbidity andinability to sustain the recommended thrice-weeklyhaemodialysis due to financial constraint. These findings are similar with findings of Chijioke*et al*. [19]; Arogundade*et al*.[23]; Odufuwa and Fadupin[24].

During haemodialysis, excess urea and creatinine from the patient's blood are removed in order to avoid accumulation. It is observed that leafy green vegetables and meat might lead to an increase in the burden on the kidney and cause an increase in serum urea and creatinine level [18]. The process of haemodialysis carried out in the index patients was seeming to be efficient because it significantly reduced the levels of creatinine and urea by comparing the pre-dialysis and post-dialysis urea level. In a study conducted by Draczevski and Teixeira [19], the determined pre-dialysis and post-haemodialysis urea and creatinine levels, reflected a substantial reduction in serum urea levels, indicating that hemodialysis is an efficient technique in the reduction of serum urea and creatinine.

V. Conclusions

Patients with CKD have higher serum urea and creatinine levels. Accumulation of the waste leads to various forms of complications and worsening the progression of the disease. This study has established significantly low adequacy of haemodialysis among ESRD patients undergoing haemodialysis in Port Harcourt as compared with the recommended guidelines of the Kidney Disease Outcome Quality Initiative guidelines. The major contributing factors were the financial cost of haemodialysis, co-morbidity, late presentation of the patients to the hospital and anaemia.

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