THE ADEQUACY OF HAEMODIALYSIS IN END STAGE RENAL DISEASE AT KENYATTA NATIONAL HOSPITAL

A dissertation submitted in part fulfilment of the requirements for the degree of Master of Medicine in Internal Medicine by:

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DECLARATION

I certify that this dissertation is my own original work and has not been presented for a degree at any other university.

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ACRONYMS AND ABBREVIATION LIST

BMI	Body Mass Index.
BCG	Bromcresol Green.
BCP	Bromcresol Purple.
BUN	Blood Urea Nitrogen.
CAPD	Continuous Ambulatory Peritoneal Dialysis.
CANUSA	Canada/United States Peritoneal Dialysis Study.
CRF	Chronic Renal Failure.
CRP	C-reactive protein.
DOQI	Dialysis Outcome Quality Initiative.
ESRD	End Stage Renal Disease.
HDP	Haemodialysis Product
KNH	Kenyatta National Hospital.
Kt/V	A Measure of Dialysis
KPS	Kanofsky performance scale
MHD	Maintenance Haemodialysis.
PD	Peritoneal Dialysis.
PEM	Protein Energy Malnutrition.
RRT	Renal Replacement Therapy.
RPA'S	Renal Physician Association.
SGA	Subjective Global Assessment.
USRDS	US Renal Data System.
USA	United States of America.
URR	Urea Reduction Ratio.

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DEDICATION

To my wife Husna, whose inner qualities never cease to amaze me. My parents for their patient support over the years and last but not least my children, Amal, Shaima, Haitham and Talal.

Abstract

BACKGROUND: Inadequate dialysis dose is closely related to mortality and morbidity of maintenance haemodialysis patients. Knowledge of patient related risk factors for inadequate delivery of haemodialysis would be helpful in selecting patient subgroups for intensive control of dialysis adequacy. The usual way to determine the adequacy of haemodialysis is based on measures of intradialytic urea reduction; the fractional clearance of urea (Kt/V) and Urea reduction ratio (URR). The minimum optimal dose, targeted for adequacy of haemodialysis is Kt/V of ≥1.8 for patient on twice-weekly haemodialysis session and Kt/V of ≥1.2 for thrice weekly dialysis patient. While the minimum optimal dose, targeted for URR is 65% for thrice weekly dialysis patients and 80% for twice weekly dialysis. Haemodialysis product (HDP) is also used to assess adequacy of dialysis. A product of less than 45 is considered inadequate dialysis. Functional status of life as measured by Karnosky performance scale (KPS) and Modified Subjective global assessment (SGA) has been theorized to reflect adequacy of dialysis. Since these methods are easy to assess, hence the need to demonstrate any possible correlation with calculated adequacy of haemodialysis. Compliance of haemodialysis prescription is the major barrier to the adequacy of haemodialysis in patients with End stage renal disease (ESRD) in some of haemodialysis centers.

OBJECTIVES: The main objective of this study was to determine the level of adequacy of haemodialysis in patients with ESRD at Kenyatta National hospital (KNH) renal unit. Other objectives included possible correlation between functional status of life, (as measured by KPS), modified SGA with adequacy of haemodialysis.

METHODS: All patients who met the inclusion criteria were recruited into the study. The study site was the renal unit of the KNH. Data, including demographic characteristics, dialysis data, compliance data, modified SGA and KPS were obtained from each patient. Blood for predialysis and post dialysis BUN sample were collected according to recommended procedures for dialysis quantification, in a single haemodialysis session. Urea reduction, using Kt / V and URR, and HDP was calculated for each patient.

RESULTS: Sixty-six patients were recruited. The male to female ratio was 2:1. The mean age group was 47 ± 14 years old. 82% of the patients underwent twice weekly dialysis schedule, and 13.6% underwent once weekly dialysis.83% had been dialysed for less than one year . The mean Kt/V and URR were 1.75 ± 0.72 and 72.36 ± 11.8% respectively. When using Kt/V, 34.8% (n=23) of the patients were adequately dialysed, and when assessed by URR, 22.7% (n=15) were adequately dialysed.There was a strong statistically significant correlation between Kt/V and URR (p=<0.001,r=0.742).Females, younger (less than 45

years) and underweight patients were more likely to have inadequate dialysis using URR and/or Kt/V (P value < 0. 05). Conversely, patients dialysed once weekly (89%) and those with fistula (89%, n=17) were inadequately dialysed. All patients were inadequately dialysed when assessed by HDP method (HDP less than 45). There was no statistical correlation between adequacy of dialysis and KPS and SGA. Thirty-four percent of the patients were non-compliant to haemodialysis therapy, and the main reason was financial constraint in 91.3% of them.

CONCLUSIONS: The level of adequacy of haemodialysis in our patients at KNH renal unit, is still very low compared to other haemodialysis centres. Functional status of life had no correlation with adequacy of dialysis and the utility of modified SGA, cannot be used as surrogate marker of adequacy of haemodialysis.

1. LITERATURE REVIEW

1.1 INTRODUCTION

Chronic renal failure is defined as the irreversible, substantial, and usually long-standing loss of renal function causing uraemia. End -stage renal failure (ESRD) is the degree of chronic renal failure that without renal replacement therapy would result in death (1). ESRD occurs when glomerular filtration rate (GFR) approaches 10-15 mL/min and the nephrons are lost to the extent that the retention of non-volatile, metabolic waste products, salt, and water is potentially fatal (1,2). The treatments available are life-long, complex, and costly (2).

The renal replacement therapy (RRT) entails the replacement of renal function by therapeutic modalities, which include dialysis, haemoperfusion, haemofiltration and transplantation. (3). The excretory function of the kidney can be partially replaced by dialysis or haemofiltration while the endocrine function and metabolic can only be achieved by renal transplantation (1).

ESRD can be treated by extra-corporeal blood purification (haemodialysis, haemofiltration), body purification (peritoneal dialysis, CAPD) or by kidney transplantation. A successful RRT restores renal function sufficiently for the *patient to return to a normal life, with few restrictions, albeit with the need to take*

drugs and for complications such as hypertension. Transplantation remains the treatment of choice for suitable patients (2).

It is estimated that ESRD in the tropics to be between 90-120 per million population (4,5). In East Africa with a population of 100 million, around 9,000 12,000 people have ESRD, and would benefit from RRT. Presently in Kenya, the unit cost of haemodialysis is approximately US $125 (K.Sh 9375) whereas the unit cost of haemodialysis in developed countries is only US $25 (K.Sh1875). Therefore due to socio-economical drawbacks such as lack of resources, poor infrastructure and financial constraints, the percentage of ESRD patients receiving haemodialysis in Kenya is lower compared to other countries (6).

The true prevalence of chronic renal failure (of all degrees of severity) is unknown because many patients are asymptomatic or its presence has not been recognised (1). Therefore its prevalence nationally has not been accurately determined. Most data available currently emanates from the developed world and this may not accurately reflect our situation due to major socio-cultural, economic and environmental differences. The statistics of the South African Dialysis and transplant Registry (SADTR) estimated that in 1994,a total number of 3,399 patients (per million population) were on treatment for ESRD in South Africa; the total population for this period was 34.4 million (7).

The incidence of ESRD increases at the rate of 5-10 % per year in many countries (8). Generally, the incidence is higher in less-developed countries (9). The incidence increases with age; in United Kingdom, the incidence increases six-fold to ten-fold from age 30-50 to age 70-90 (2). Although the overall incidence of ESRD in USA is 140–180 cases per million people per year, blacks have a disproportionately high incidence, as compared with whites (10).

In spite of the incidence of ESRD associated with Glomerulopathies remaining static, there is an increase of ESRD from hypertension and diabetes (7,8). The proportions of recognised aetiologies of chronic renal failure in our population, as described by Kayima, showed that chronic glomerulonephritis makes up 36%, hypertension 23%, diabetes mellitus 23%, and other causes make up 8% (8). In the USA, Diabetes mellitus is the leading cause of ESRD (approximately 35% of newly diagnosed cases of ESRD are caused by diabetes), followed closely by hypertension (approximately 30%). But among black Americans, ESRD attributed to hypertension is the most common (11).

Human immunodeficiency virus (HIV) infection is an increasingly common cause of ESRD. Officially it accounts for only 1-2% of cases of ESRD, but an epidemic of HIV- related ESRD may be occurring among young black men (12). AIDS was the third commonest cause of ESRD at 10% (after diabetes mellitus and hypertension) in the USRDS in 1995 in Afro-American males aged 20-60 years

(13). In some inner-city dialysis units in USA, the prevalence of HIV maybe as high as 38% (14).

The annual mortality rate reported for ESRD ranges from 10-20% (15). Patients undergoing MHD have a mortality rate many fold greater than that of individuals of the same age and sex without renal failure (16). An increased risk for death in MHD patients has been associated with older age, male sex, white race, non-renal medical co-morbidities, and such modifiable risk factors as lower dose of dialysis and lower haematocrit levels (17,18).

Patient survival on maintenance haemodialysis (MHD) has previously been shown to be associated with the presence of co-morbid condition on entrance to haemodialysis therapy. The significant co-morbidity conditions are atherosclerotic heart disease (ASHD), cerebral vascular disease (CVD), non-skin malignancy, chronic obstructive pulmonary disease (COPD), diabetes mellitus, and the patient's age on entrance to dialysis (15). The presence of co-morbid condition in the diabetic is high and may account for the increased death rate (15). Death is due mainly to cardiovascular disease and infection (approximately 50% and 15% of death respectively). Hypertension continues to be a major risk factor for CVD (19). Other common risk factor for CVD includes depressed high-density lipoprotein cholesterol (HDL) level, coronary artery calcification, diabetics and left ventricular hypertrophy (LVH) (19,20). Amongst other causes of death in patients on MHD are dialysis related factors, which includes; inadequate dose of dialysis,

malnutrition, non-compliance, re-use membrane dialyser and dialysis related complications (21).

As a result of these and other studies, the National Kidney Foundation (NKF)(22) developed guidelines suggesting minimal levels of dialysis dose needed to provide adequate care for MHD patients. Data from the Health Care Financing Administration (HCFA) Core Indicators Project have shown that despite improvements in the proportion of haemodialysis patients achieving an adequate dose of dialysis and haematocrit in recent years, the percentage of patients who did not meet NKF-Dialysis Outcomes Quality Initiative (DOQI) guidelines for dialysis dose and anaemia were 20% and 40% in 1998, respectively (23). It recently proposed that the quality of care received before the initiation of dialysis therapy might affect the morbidity and mortality of dialysis patients (24). It is known that patients with a lower serum albumin level at the start of dialysis therapy have greater mortality and morbidity rates (25,26): however, less is known about other parameters at dialysis therapy initiation. In another interesting study by McClellan et al correlate the functional quality of life, as assessed by Kanofsky performance scale, with mortality in haemodialysis patients (27).

Malnutrition has been estimated to be present in up to 48.1% of patient with ESRD on dialysis at KHN renal unit (28). Malnutrition in ESRD patients is independently associated with increase morbidity and mortality (29). In fact a depressed serum albumin level, reflecting poor nutritional status, is the laboratory

abnormality most strongly correlated with excess risk of death in this population (30).

In 1993, Owen et al showed that inadequate dialysis and poor nutrition are the major factors contributing to the excessive mortality of patient treated with haemodialysis in the USA. Inadequate dialysis has also been associated with high morbidity and mortality in ESRD patient receiving maintenance haemodialysis (30). The accurate dose estimation of dialysis adequacy, as quantified by the parameter Kt/V or URR corresponds strongly with survival.

Ashwini et al showed that inadequate dialysis dose is independently associated with increased hospitalisation, hospital days and Medical inpatient expenditures (31). They found that improving dialysis adequacy might decrease patient morbidity and health care cost. Furthermore, they showed that for every 0.1 decrease in Kt/V, there was an independently associated with more hospitalisation; increase hospital days and higher inpatient expenditures.

Several observational studies have shown improved patient survival with higher level of delivered dialysis dose. The current study of a USA national sample of 2,311 patients from 347-dialysis units estimated the relationship of delivered haemodialysis dose to mortality, with a statistical adjustment for an extensive list of co-morbidity or risk factors (32). Haemodialysis patient mortality showed a strong and robust inverse correlation with delivered haemodialysis dose whether

measured by Kt/V or by URR (whereby Kt/V of 1.2 and URR of >65% indicate adequate dialysis). Mortality risk was lowered by 7% (P=0.001) with each 0.1 higher level of delivered Kt/V. Above a URR of 70% or Kt/V of 1.3 the data did not provide statistically evidence of further reduction in mortality.

From the USRDS data there was a linear estimate between mortality risk and dose of dialysis, showing that for every 0.1 unit increase in Kt/V, the relative risk of mortality in the USA dialysis population decrease by 7%. For each 5 unit increase in the URR the relative risk of mortality decrease by 8% (P<0.01) (32). In another independent studies done by Collins et al and Gotch et al, shows that it is indisputable that the delivered dose of haemodialysis is a significant predictor of the patient's outcome (30,33,34) and the dose of haemodialysis provide to many patient can and should be increased to reduce mortality and morbidity (35,36-38).

Nephrologists have responded to these challenges by improving both the delivered service and the out come of patient over the several years. Hence the average URR rose from 60% (1990) to 67% (1996) (39), and dialys s time have increased. Concomitantly the adjusted mortality rate (the number of death per 100 patient year at risk) fell from 25.5% in 1995 to 21.8 in 1998 (10). Unfortunately, more than 30% of patients still have a URR of less than 65% (Kt/V of <1.2), indicating the need for improvement in the delivered dose of haemodialysis (38).

In 1993 a population based cohort study of 13,500 adults with ESRD in the USA, it was noted that only 36% of the patients received URR of 65% (64% were inadequately dialysed). The USA news and world reports, describe this state of care as "Deadly Dialysis" (40). These findings were confirmed and extended by the ESRD Core Indicators Project, a nationwide quality improvement project, and conducted by the Health Care Financing Administration (HCFA) using the ESRD Networks. A random national sample of adult, ESRD patients from October to December 1993 showed that only 43% of the patients had URR of 65%; the mean URR was 62.7%(37). From 1993 to 1997, the mean URR increased from 62.7% to 68%. Improvement of a similar magnitude was observed in another USA national data set; the median URR increased from 58.9% ± 9.8% to 69.5% ± 8.75% from 1990 to 1997(36).

In response to these dismal statistics the National Kidney Foundation (NKF), has called for an effort to reduce the annual overall mortality rate to 15% (41), and has published the Dialysis Outcome Quality Initiative (DOQI), a set of guidelines based on the literature and opinion of experts on ESRD (42,43). Ultimately these guidelines should improve the care of patient undergoing Dialysis by establishing uniform standards.

1.2 ADEQUACY OF DIALYSIS

Haemodialysis adequacy is defined as the level of treatment by which the sign and symptoms of uraemia are eradicated and the patient is fully rehabilitated (44). Inadequate dialysis not only shortens survival, but also leads to malnutrition, anaemia and functional impairment. This results in frequent hospitalisation that escalates the cost of health care (44). However inadequate dialysis is often undetected unless it is severe and prolonged. If haemodialysis is to be judged a successful treatment, it should control blood pressure and restore protein anabolism, well being, and appetite of the patients. The patient should be able to resume the degree of activity that a person of that age and abilities might expect if there was no renal failure (2).

Clinical signs and symptoms (due to uraemia) alone are not sufficient and reliable indicators of haemodialysis adequacy (46). Therefore in addition to uraemic signs and symptoms, patient nutrition and patient survival appear to best reflect dialysis adequacy (47).

Uraemia toxicity is due to both small and large molecular weight solutes, although removal of small molecular weight toxins is of great importance. For this reason, the amount of dialysis prescribed is based on small toxins removal as

represented by removal of urea. The amount of urea removal is related to dialysis session length but can be increased substantially by using a high KOA (mass transfer area urea coefficient) dialyser and a rapid blood flow rate (48).

The National Cooperative Dialysis Study (NCDS), which was the first prospective trial trying to determine haemodialysis adequacy, used kinetic modelling using urea as the marker for uraemia toxins (48). Urea was chosen as the clearance marker for the Kt/V since it is a reflection of both dietary protein intake and of the efficiency of small uraemia toxin.

Urea kinetic is based on urea (molecular weight of 60 Dalton), which is the substance that is most often monitored in clinical practice as a surrogate for measurement of the clearance of small solute in general. Reasons for this are that urea is a small, readily dialysed solute that is the bulk catabolite of dietary protein, (urea generation is proportion to protein breakdown or the protein catabolic rate, PCR), constitutes 90% of waste nitrogen accumulated in body water between haemodialysis treatments (49,50), is easily measured in blood, and that the fractional clearance of urea in body water correlates with patient outcomes, such as mortality (30, 51) and morbidity (52,53).

The indices of urea removal include Kt/V and URR. This urea kinetic modelling is the primary measure of urea removal (54), and is used to determine haemodialysis adequacy. Determining the adequacy of dialysis therapy requires

more than routine laboratory studies; malnourished and anorectic patient will make less urea and have a smaller muscle mass with deceptively low BUN and creatinine concentration (54).

Measurement of the "delivered dose" of dialysis has therefore focused on the removal of urea. The conventional methods of quantifying the prescribed or delivered haemodialysis dose begin by estimating the difference in predialysis and post-dialysis urea concentration by sampling a patient's blood before and after a single dialysis session (22).

Individualizing the haemodialysis prescription to a particular patient's needs using Kt/V and can be a useful tool in providing a safe and cost-effective dialysis treatment (55). This can be accomplished with urea kinetic modelling (UKM), which allows for variation in dialysis time, use of larger, high efficiency, high flux dialyser, and optimisation of dietary protein need. UKM is a method for verifying that the amount of dialysis prescribed (the prescribed Kt/V) equals the amount of dialysis delivered (the effective Kt/V). Kinetic modelling also quantifies urea generated, which is a marker of the protein catabolic rate and therefore of protein intake (47).

Therefore based on a review of the literature published by Renal Physician Association (RPA'S) Clinical Practice Guideline on adequacy of haemodialysis, formal UKM was the best method to determine haemodialysis adequacy in adult,

especially when using a single pool variable model (22). The RPA recommended that the variable volume, single-pool model of UKM should be measured monthly to ensure the adequacy of haemodialysis.

Recently, Scribner et al propose a new index of adequacy of haemodialysis called Haemodialysis Product (HDP) This new index incorporates frequency, which is the most important variable (56).

1.2.1 Kt/V AND URR:

The dose of haemodialysis is best described as the fractional clearance of urea as a function of its distribution volume, (**Kt/V**). The fractional clearance is operationally defined as the product of dialyser clearance (expressed as **K** and measured in litre per minute (L/min)) and the treatment time (expressed as **t** and measured in minutes) divided by the volume of distribution of urea is expressed as **V** and measured in **L**, which is approximately equal to the total body water (22,57). I.e.

$$\textbf{Kt/V} = \frac{\text{Dialyser clearance (}\textbf{K}\text{) X duration of dialysis treatment (}\textbf{t}\text{)}}{\text{Volume of distribution of urea in the body (}\textbf{V}\text{)}}$$

$$= \frac{\textbf{K}\ \text{(L/hr)} \times \textbf{t}\ \text{(hr)}}{\text{L}} = \textbf{Ratio}$$

Where,

Kt/V	=	Fractional Urea Clearance
K	=	Dialyser Clearance (ml/min or l/hr)
t	=	Dialysis Time (min or hr)
V	=	Distribution Volume of Urea (ml or l)

Kt/V may be determined by formal urea kinetic modelling (UKM) or by extrapolation from the fractional change in blood urea concentration during a dialysis session. The delivered dose of haemodialysis can also be assessed using the URR (22).

When using formal UKM, Kt/V may be calculated from either a single pool variable or a double pool variable. Of the single pool, variable volume mathematical analyses for quantitation of urea removal during a single haemodialysis session, formal UKM was considered to be the most accurate and complete method to determine Kt/V (22).

However, it is the least simple to implement. Despite being the most accurate method to determine haemodialysis adequacy, Kt/V can be affected by several factors including urea generation during the dialysis, dialysis-induced changes in total body water, urea rebound and recirculation. Therefore when calculating Kt/V these factors should be considered. The main problem is that the so-called single pool methods (non equilibrated Kt/V) assume that urea is present in one homogenous distribution volume. This is actually not the case, as is evident from

the significant increase in BUN concentration after the termination of dialysis (urea rebound). This post-dialytic urea rebound varies greatly between individuals, and it may lead to significant errors in the estimation of dialysis dose, if solely calculated by the single pool method (58).

A post dialysis urea sample that reflects the equilibration of muscle and blood urea is called an equilibrated sample (equilibrated Kt/V), representing the blood and muscle cell pool of urea within the body (the double pool of urea). Therefore in this two-pool modelling program, incorporates a factor that corrects for urea rebound. The degree of rebound is different among patients and is exaggerated in ESRD patients who are small stature and during haemodialysis session that are complicated by intradialytic hypotension. Therefore this program usually requires that rebound be measured on one or more occasion. This is then used to derive a mathematical constant for that patient, which is designed to predict the amount of rebound in any dialysis situation. The two-pool modelling is best suited for unit's performing short session dialysis and to model patient with poor peripheral perfusion (58,59).

The urea concentration measured with the equilibrated sample is higher than that observed in the non-equilibrated sample, hence the equilibrated double pool Kt/V is lower than the non-equilibrated single pool Kt/V. This difference is approximately 0.21 for the usual range of delivery doses of haemodialysis (60). Because of the inability to predict which patient will have significant urea

rebound, and in view of the potential deleterious impact of urea rebound on calculation of the delivered dose of haemodialysis, the HD Work Group examined the applicability of the double pool, variable volume UKM. Although this model may more accurately quantify intradialytic urea removal (hence Kt/V) and may results in a more precise NPCR (Normalized protein catabolic rate) because of the more accurate assessment of V (in comparison to an anthropometrics value), but the need to obtain the post dialysis BUN sample 30 to 60 minutes after completion of haemodialysis (equilibrated post dialysis sample) make it impractical in the conventional outpatient haemodialysis setting. In an attempt to overcome the practical problem, a mathematical alogarithm that estimates the dose of haemodialysis from the predialysis BUN concentration and the equilibrated post dialysis BUN concentration has been developed by Smye (Smye formula) and Daugirdas (Daugirdas rate formula) (22,57,61).

In a report from the National Institutes of Health's Haemodialysis Pilot study that compared the accuracy of blood side measurement of the equilibrated Kt/V, the Daugirdas rate formula was found to more closely correspond to the equilibrated Kt/V calculated using a 30-minute post dialysis BUN sample (22).

There are three main causes of rebound after dialysis:

1. The first type of rebound (early phase urea rebound), occurring within 15-30 seconds after the end of the dialysis is a result of access recirculation (62).

2. The second type of rebound is a result of cardiopulmonary recirculation, which takes place until 1-2 minutes after the end of dialysis (63).

3. The third type of rebound (late phase of urea rebound), which appears to be a result of disequilibrium of urea distribution within different body pools, is not finished until 30-60 min after the end of dialysis (64,65).

Because of urea rebound, the post dialysis BUN concentration and the resultant Kt/V and URR will vary greatly depending upon the timing of the acquisition of the blood sample (60). For example the postdialysis BUN concentration will be higher, and the resultant Kt/V and URR will be higher, with increased time after completion of haemodialysis. Although the most accurate way to resolve this problem would be uniformly wait 30-60 minutes after the completion of haemodialysis before drawing a post dialysis BUN sample. This approach is impractical for patient and busy dialysis facilities (39,66). The haemodialysis adequacy Work Group recommended the use of slow or stop pump sampling technique to account of the urea rebound (see Appendix VI).

There are several methods of measuring delivered dose of dialysis (Kt/V) from formal UKM. Recent literature suggests that only one alternative method for calculating Kt/V (Kt/V natural logarithm formula) and one other measurement of the delivered dose of haemodialysis (URR) should be considered for routine use in adults respectively. These are:

Equation 1 (for single pool variable)

Kt/V natural logarithm formula (61)

Kt/V = - Ln (R – 0.008 x T) + (4-3.5xR) x UF/W

In which **Ln** is the natural logarithm

R (*Ct/Co*) is the postdialysis BUN (***Ct***) divided by predialysis BUN (***Co***)

t is the dialysis session length in hours

UF is the ultra filtration volume in litre and

W is the patient post dialysis weight in kilogram

Equation 2

Urea reduction ratio (URR) (22,30,57)

A simple model uses the urea reduction ratio.

URR = 100 x (1 – R)

In which **R** is the post dialysis BUN (***Ct***) divided by predialysis BUN (***Co*).**

That is: **R = *Ct/Co***

Current clinical practice guidelines from the RPA's and the National Kidney Foundation (NKF) recommend the routine measurement of the delivered dose of haemodialysis, such that a minimum delivered dose of haemodialysis measured as the urea reduction ratio (URR) of 65% is provided (67).

The URR is the fractional removal of urea during a single haemodialysis treatment, so it is a function of treatment-specific prescription and patient-specific variables (67). Factors in the haemodialysis prescription that influence the URR are the duration of the haemodialysis treatment (t), and the dialyser's urea clearance characteristics (K), which is in turn a function of its membrane mass transfer permeability to urea times the dialyser surface area (KoA), and the blood and dialysate flow rates. These variables may be mathematically combined as the clearance-time product (Kt). The most significant patient-related variable is the volume of urea distribution (V), which is presumed to be total body water and is in turn influenced by body size, age, and gender (68,69,70). Therefore, the URR is a function of Kt and V. The relationship between urea clearance, treatment time, volume, and URR can be expressed as (30, 71):

$$\ln (1 - URR/100) = e\text{-}Kt/V$$

This relationship describes that for a given V, increasing t and/or K will yield a greater URR, with a curvilinear relationship between URR and Kt/V. Based on these mathematical constructs, a survey of the components of URR across patient subgroups may provide specific insights into why URR is lower in some groups than others. Domains that can be modified to improve URR could be identified and the value of URR as a measure of dialysis dose evaluated.

The prevalence of haemodialysis patients with a URR less than 65%(for thrice weekly dialysis session) is not uniformly distributed among demographic subgroups with ESRD (72). Younger patients and blacks are more likely to have a URR less than 65%, and within all racial groups, males have lower URR's than females. It is uncertain why substantial numbers of haemodialysis patients continue to receive haemodialysis treatments that deliver less than the recommended minimum dose, or why demographic patterns to this deficiency exist (72).

In 1996 Frankenfield et al analysis report examined the relationship between body weight and URR in a representative sample of US adult haemodialysis patients. A strong statistical association was observed between body weight and URR Other variables significantly associated inadequacy included fewer years on dialysis, male gender, younger age, lowest quartile of serum albumin values, black race, and shorter dialysis session length (73).

The haemodialysis adequacy Work Group acknowledges the ease of calculation and the resultant popularity of the URR. It is the simplest to execute and it has been shown to be a statistically significant predictor of mortality for ESRD patient. Because of its ease of calculation, URR is frequently utilized in epidemiological studies (34).

Although the URR is useful as an epidemiological tool, its efficiency in individual patient is more limited because of a relatively broad range of Kt/V that maybe seen at a given URR. Most important among these is that the URR does not account for the contribution of ultra filtration (UF) to the final delivered dose of haemodialysis, in contrast to formal UKM (Equation 1) (59,74). This is because the convective transfer of urea that occurs by ultra filtration does not result in a decreased in the BUN concentration, although urea removal into the dialysate has occurred. The result is that URR is less accurate in estimating the delivered dose of haemodialysis than the single pool, variable volume Kt/V calculated by formal UKM (equation 1).

The relative inaccuracy of URR, compromises its use as the sole measure of delivered dose of dialysis in individual ESRD patients. One study, for example, found that a median URR of 0.62 was associated with modern Kt/V of 1.12 (59). However, Kt/V values below 1.0 and above 1.30 were each seen in 10% of cases with this URR value. This variability in part results from urea removal during ultrafiltration (UF), which is not considered in the URR. A large UF requirement alone can raise the Kt/V by 0.2 (59).

Other formulas, which can be used for calculating Kt/V, are based on R (*Ct/Co*) and UF/W. These formulas were derived by linear correlation to the Kt/V derived from total dialysate collection and from formal UKM (75,76,77). The

haemodialysis Work Group does not recommend the above formulas, as a substitute for the more complete formula noted in equation 1 (59,74,78).

For double pool model, equilibrated Kt/V can be calculated using Smye or Daugirdas formula (22,65).

1.2.2 HAEMODIALYSIS PRODUCT (HDP).

Scribner el at incorporated the uses of HDP, as a better index of dialysis adequacy than Kt/V (56). The ADEMEX study (Adequacy of Peritoneal Dialysis in Mexico) demonstrated that increasing the dose of CAPD, as measured by Kt/V and weekly creatinine clearance, among anuric CAPD patients had no effect on patient survival when compared to a control group on a lower dose of dialysis (79).

Therefore from this study, Scribner et al postulate that Kt/V is inefficient in removing toxic middle molecules. He also suggested that the removal of these middle molecules, rather than urea, correlates with survival and well being among patient on MHD. Short haemodialysis may give a false impression of highly efficient haemodialysis by removing fast-diffusing urea and, thus, resulting in a high Kt/V. However, removal of toxic middle molecules and phosphates is reduced because of the shortened time.

They proposed a new index of adequacy of haemodialysis called the Haemodialysis Product (HDP). The HDP is a simple to comprehend index that already has been validated (56).

$$\text{HDP} = (\text{hours/dialysis session}) \times (\text{sessions/week})^2$$

The normal values for average-sized adults, as well as the corresponding expected clinical result is shown in table 1. Since the HDP does not take patient size into account, large adults will require a higher HDP, especially in the critical range below 60. As for the lower values in table 1, the corresponding high incidence of PEM and death provides the validation that these low values represent inadequate dialysis.

The HDP has three important advantages over Kt/V and URR as guides to an effective dose of dialysis (56). First, the HDP does not depend on blood tests, while Kt/V depends on blood tests that tend to err towards a falsely high value. Second, the HDP is easy for patients to comprehend. The third advantage is that the higher the value, the better the chance of obtaining blood pressure (BP) control using the dry weight method. Table 1 shows various values of HDP, as well as the corresponding expected clinical findings.

Table 1. Various values of the HDP, as well as the corresponding expected Clinical findings (56).

Hours per dialysis session	**Dialysis sessions pre week**	**HDP**	**Clinical results**
3	3	27	Totally inadequate. Severe malnutrition.
4	3	36	Inadequate.
5	3	45	Borderline. Some malnutrition, BP control difficult.
8	3	72	Proven adequate
5	4	80	No data available
6	2	36	No data available
8	6	288	Best so far

1.2.3 OPTIMAL DOSE OF HAEMODIALYSIS:

There is no universally accepted method to measure Kt/V nor is there a universally accepted target value (22). Numerous peer-reviewed studies have confirmed the association between the adequacy of the delivered dose of haemodialysis and patient outcome (30,40,41).

1.2.3.1 Thrice weekly dialysis cycle:

In a three times per week dialysis sessions, using urea kinetics modelling (UKM), a Kt/V of 0.8 was initially thought to represent adequate dialysis (NCDS study) (80). Reanalysis of the primary data from the NCDS study showed that Kt/V <0.8 was associated with a relatively high rate of patient morbidity, whereas Kt/V values between 1.0 and 1.2 were associated with low rate of morbidity (80). A recent study demonstrating a decrease in patient survival at URR below 60% (Kt/V less than 1.2) is compatible with the need to more intensive dialysis (30).

The authors of RPA's clinical practice guidelines on adequacy of haemodialysis found that in uncontrolled retrospective study suggested an improved survival with greater delivered dose of haemodialysis (up to Kt/V >1.2 and URR of 65%). Therefore RPA's recommended that the delivered Kt/V should be at least 1.2 (for a single pool variable volume) for both adult and paediatric haemodialysis

patient. For those using the URR, the delivered dose should be equivalent to a Kt/V of 1.2 i.e. an average URR of 65% (22).

1.2.3.2 Twice weekly cycle:

All haemodialysis adequacy Work Group recommendation regarding haemodialysis dose are based on the assumption that haemodialysis treatment are delivered three times per week. There is no clinically derived information about once or twice weekly dialysis (41,54) A recent study in Egypt has shown that the survival rate of patient having thrice weekly dialysis is more than double that of patients dialysed twice weekly (81).

Twice weekly haemodialysis is usually inadequate unless there is a reasonable amount of residual kidney function (GFR > 5ml/min). Because residual renal function in haemodialysis patient falls quickly, a twice-weekly schedule should be thought of primarily as a transitional treatment strategy (22,54). Unless close monitoring of the patient residual kidney function can be routinely and serially provided, the Work Group recommends haemodialysis thrice weekly for all patient who requires haemodialysis (22).

An analysis based on urea kinetic modelling has suggested that the Kt/V for each of twice weekly sessions should $\geq$ 1.8, whereas URR of $\geq$ 80% (R of about 0.20)

(54). The Work Group also recommends that the delivered dose of haemodialysis should be measured at least once a month in all adults. It should be increased when patient are non-compliant with their haemodialysis prescription, frequent problems are noted in delivery of the prescribed dose of haemodialysis and when haemodialysis prescription is modified (30,41,45).

1.2.4. PRESCRIBED DOSE OF HAEMODIALYSIS.

Most patients on MHD do not receive their prescribed dose of haemodialysis (46,47,73). A local study suggested that only 20% of ESRD patients in Kenyatta National Hospital actually received adequate haemodialysis dose (28). To ensure that patient received the minimum adequate dose of haemodialysis at all levels of treatment, Nephrologists or health care providers should prescribe doses of haemodialysis that are higher than the aforementioned minimum delivered levels i.e. for a single pool model Kt/V 1.3 and URR of 70% (22).

A variety of factors may result in the actual delivered dose of haemodialysis falling below the prescribed dose. These common factors include, compromised urea clearance, reduction in treatment time and laboratory or blood sampling errors (73,82).

1.2.5 BUN SAMPLING.

Under DOQI guidelines, predialysis and post dialysis sample should be drawn with great care. Otherwise its urea concentration may be falsely low due to cardiopulmonary or access recirculation or both. Another source of error maybe a rebound in the plasma BUN that occurs post-dialysis due to different degree of urea removal from various regional circulation during dialysis (65,66).

The predialysis or post dialysis BUN measurements may not reflect the true systemic urea concentration at the time haemodialysis was initiated and terminated, respectively, due to errors in sampling procedure and/or laboratory errors. Reason for error in measurement of BUN concentration include (22,66):

1. A dilution of predialysis BUN sample with saline.
2. Drawing predialysis BUN blood sample after the start of dialysis.
3. Laboratory error due to calibrated or equipment problems.
4. Drawing post dialysis BUN concentration before the end of dialysis
5. Drawing post dialysis BUN blood sample more than 5 minutes after dialysis.
6. Laboratory error in BUN measurement.

The pre and post blood sample for measurement patient BUN level must be drawn at the same haemodialysis session and in a particular acceptable manner.

The ideal and accurate measurements of the delivered Kt/V and URR requires that:

1. Predialysis BUN is measured before haemodialysis begins and should be obtained without dilution of the blood sample (66).

2. Postdialysis BUN should be measured after haemodialysis ends and angioaccess recirculation has resolved (65).

3. Laboratory processing of BUN sample is accurate (83).

1.2.5.1 PREDIALYSIS BUN:

The predialysis blood sample procedures should be accurate and must be drawn before dialysis is started to prevent this sample from reflecting any impact of dialysis (66). Also dilution of the predialysis sample with saline or heparin must be avoided or the predialysis BUN will be artificially low, resulting in a falsely low Kt/V and/or URR, an incorrectly elevated V, and a falsely reduced K. The recommended method for drawing predialysis BUN blood is shown in appendix V (22).

1.2.5.2 POST-DIALYSIS BUN:

It is unfortunate, that incorrect sampling of post dialysis BUN is common and may result in erroneous conclusion concerning the correlation between patient outcome and delivery dose (22). As part of a study examining the delivery of dialysis in ESRD in the USA, very little consistency and a large degree of improper blood sample was observed in a sample of participating dialysis unit, 33% of haemodialysis unit drew the post BUN immediately before the end of the session, 25% drew the sample immediately after the session and 42% drew the sample more than 5 min after the reinfusion of blood (84).

Therefore the most important issue to determine HD adequacy is the time at which the post dialysis BUN should be measured (66). Within 2 minutes after dialysis, both access and cardiopulmonary recirculation have dissipated, and the difference in arterial and venous urea concentration have largely resolved. Most studies have recommended that post dialysis sample be measured between one and five minutes after dialysis or during slow down (22). Another important factor that affects post-dialysis BUN concentration is urea rebound, which has an impact on the "true" Kt/V being delivered. Hence the calculated Kt/V may exceed the true value by approximately 0.2 with 2 to 4 hours of high flux dialysis (85,86). The most accurate way to resolve urea rebound is to uniformly wait 30-60 min after the completion of haemodialysis before drawing a post-dialysis BUN

sample; although the equilibrated post dialysis BUN is too difficult to perform in the clinical setting, it can be estimated by (22):

1. Measuring the BUN 30 seconds and 2 minute after dialysis, the slope of this line can be used to predict its value. Or,
2. The slow flow or stop pump sampling technique (see Appendix VI), this Procedure is consistent with the recently published DOQI guidelines.

Successful application of the slow flow sampling technique has several advantages (22):

1. There is minimal technical variability between blood drawing sessions.

2. Use of a single pool model for formal UKM mandates that post dialysis BUN be measured without the effect of access recirculation and before a significant amount of urea rebound has occur.

The haemodialysis adequacy Work Group discourage other alternative methods of post dialysis BUN sampling e.g. the blood reinfusion sampling technique in which post dialysis BUN sample is drawn after the patient has been completely reinfused (87).

1.3 NUTRITION

Protein energy malnutrition, PEM, is very common among patients with advanced chronic renal failure, and those undergoing maintenance dialysis (MHD) therapy worldwide (88,89). The link between under-dialysis and malnutrition is well documented; it contributes to morbidity and mortality. In adults on MHD, the presence of PEM is one of the strongest predictor of morbidity and mortality (90). In MHD, it is a major negative prognostic factor in dialysis patients (91).

During progressive renal failure, catabolism and anorexia lead to loss of lean body mass. At the initiation of haemodialysis, many patients are malnourished. However once adequate dialysis has been attained, patients usually regain a healthy appetite (88).

There is a strong indirect evidence linking survival on dialysis with nutritional status both at initiation of dialysis and during longitudinal follow up (90). In addition there is strong evidence suggesting that quality and quantity of dialysis influences nutrition (90).

Therefore an adequate renal therapy is necessary to attain a normal appetite and metabolism. Thus nutrition problem may reflect inadequate dialysis, which if corrected, may lead to subsequent improved outcome. Although nutritional status

is influenced by many non-dialysis related factors, appetite suppression, nausea, and vomiting are major clinical features of uraemia and inadequate dialysis. Therefore, nutrition status is also an important measure of dialysis adequacy.

There are many causes of PEM in a patient with ESRD on haemodialysis (90, 92-94):

1. Inadequacy food intake
2. The catabolic response to superimposed illness.
3. The dialysis procedure itself, which may promote wasting by removing nutrients and may also promote protein catabolism due to bio-incompatibility,

Notwithstanding the many causes of PEM in patients with CRF, provision of adequate dialysis and nutrition is a key component of the prevention and treatment of PEM on adult receiving MHD.

1.3.1 SGA AND ALBUMIN

Malnutrition is generally diagnosed by finding specific changes in serum protein composition, subjective global assessment (SGA) or in anthropometrical measurement. Specifically reduced serum concentration of albumin, or loss of muscle is used as an indicator of malnutrition. (90). There is ample data suggesting that complementary indicator of nutritional status exhibit independent

association with mortality and morbidity in MHD. For example, the serum albumin and BMI are independently associated with survival (94). Data from the USRDS confirm these findings using the serum albumin, and body mass index (BMI, kg/m^2) (95). In the Canada-United states peritoneal dialysis study (CANUSA) studies, both the serum albumin and SGA, were independent predictors of death or treatment failure (96).

In a French survey study they found that survival in haemodialysis patients, was significantly influenced by age, presence of diabetes and by concentration of albumin. These results indicate that nutritional protein concentrations were predictive of dialysis outcome (97).

Serum albumin level has been used extensively to assess nutritional status of individuals with or without CRF and it is recommended for routine measurement (98). Hypoalbuminimia is highly predictive of future mortality risk when present at the time of initiation of chronic dialysis as well as during the course of MHD (30,88,99). Serum albumin may fall modestly with a sustained decrease in dietary protein, and energy intake may rise with increased protein or energy intake (100). Conversely, serum albumin being a negative acute phase protein may fall acutely with inflammation or acute or chronic stress, and increase following resolution or recovery (101). However other non-nutritional factors that affect serum albumin include patient hydration status, peritoneal or urinary albumin losses and acidemia (101,102). Hence hypoalbuminimia in MHD patient

do not necessarily indicate PEM, and persistence of hypoalbuminimia despite adequate nutrition intake is evidence of non-nutritional causes of hypoalbuminimia.

Albumin concentration in a patient on dialysis is negatively correlated with the level of positive acute phase proteins (102). As indicated above, positive acute protein reactants are not nutritional parameters but may be used to identify the presence of inflammation (103) in individual with low serum albumin or prealbumin and possibly predicting outcome. a1–AG is more specific than CRP for detecting inflammation in MHD patient (104).

Although no single ideal measure of nutritional status exist, the serum albumin concentration is considered to be useful indication of PEM status in MHD patient. In addition the measurement of serum albumin is inexpensive, easy to perform and widely available (90). (See Appendix III method for measuring serum albumin). Sometimes, other clinical markers normally used to diagnose malnutrition are found to be present simultaneously with marker of inflammation. Stenrin Kel et al established that patient with pre ESRD who were judged to be malnourished by measurement of SGA also had markers consistent with the presence of inflammation (105). Both CRP and fibrinogen were significantly greater in-group of patient with SGA >30 (malnourished).

Serum prealbumin (transthyretin) has been used in individuals with or without CRF as a marker of protein-energy nutritional status (106). It has been suggested that the serum prealbumin may be more sensitive than albumin as indicator of nutritional status (107,108).

Subjective global assessment (SGA) is a reproducible and useful instrument for assessing nutritional status and well being of MHD patients (109,110). It is a simple technique that is based on subjective and objective aspects of the medical history and physical examination. SGA was initially developed to determine the nutritional status of patient undergoing gastrointestinal surgery and subsequently was applied to other populations (111).

SGA is recommended because it gives a comprehensive over view of nutritional intake and body composition including a rough assessment of both muscles and fat mass and because it is correlated with mortality rate (90,91). Among the benefits of using the SGA are that it is inexpensive, can be performed rapidly, *simple*, *non invasive*, *requires only brief training* and gives a global score or summation of protein-energy nutritional status. Disadvantages of the SGA include the fact that visceral protein levels are not included in the assessment (110). It is subjective, and its sensitivity, precision, and reproducibility over time have not been extensively studied in MHD patients.

Several studies have validated that the SGA accurately reflects nutritional status in dialysis patient. Also in the CANUSA study, a higher SGA was associated with higher risk of death. In Oduor study done at KNH dialysis unit, there was a positive correlation between SGA and PEM (28). He showed that the positive predictive value of SGA (as a parameter of PEM) to be 65%, with a negative predictive value of 79%, sensitivity of 74% and specificity of 71% (28).

A modified quantitative SGA of nutrition (malnutrition score) using the same components of the conventional SGA was developed by Kalantar ZK et al, with a full quantitative scoring system (the dialysis nutrition score) and may be a superior to SGA (112). The modified SGA consisting of seven variables and each component is assigned a score from 1 (normal) to 5 (very severe). See Appendix IV.

1.4. COMPLIANCE

Non-compliances are a major problem associated with virtually all-medical therapies but is an especially important issue in MHD. Haemodialysis Adequacy Work Group recognizes that a major barrier for providing adequate haemodialysis is patient nonadherence. Compliance has not been assessed often using well-conceptualised and quantified parameters, and the relationship of compliance to the preceding factors has been incompletely determined. This non-compliance will result in inadequate haemodialysis and eventually increases the mortality and morbidity in MHD patient (113).

Non-compliant treatment behaviour among haemodialysis patients has been broadly classified as missing treatment (MT) behaviour or shortened treatment (ST) behaviour. Missing or shortening treatment obviously decreases the delivery of dialysis as surely as decreasing the presented Kt/V. When this problem is severe, uraemic manifestation will result with high level of morbidity and mortality (82,114).

Kimmel et al and Walter's et al found that patients who misses dialysis session significantly increases their chance of mortality, while those who shortened dialysis session is associated with high morbidity (115,116). Compliance measures have been categorized as objective (from the patients history) and subjective (from laboratory measuring) (117). There is no gold standard method

to assess the compliance of haemodialysis patient, but manifestations of non-compliance are most often seen in three areas:

1. Patients may regularly curtail treatment by arriving late or leaving the haemodialysis session prematurely or they may miss their session entirely. In one multicentre study, 50% of the patient missed or shortened at least one treatment during a 3-month period (118- 120).

2. Doses of medication may be omitted (121)

3. Dietary restriction in fluid, sodium, potassium and phosphate may not be followed (117). Consequently hyperkalaemia, hyperphosphatemia and increase interdialytic weight gain may ensure (Subjective measures of compliance).

The main cause of non-adherence to haemodialysis include:

1. **Lack of patient education**. This is a major factor in that patient are often inadequately educated or lack an understanding of what is expected (117).

2. **Medical reasons**: Due to physical discomfort associated with haemodialysis treatment many patients miss sessions more often and

terminate their haemodialysis sessions prematurely (114). Other psychological problems may also play a role as well, including the need to be in control, the desire for attention from the staff, or the presence of a personality disorder (117).

3. **Socio-economical** reason is another major cause of non- compliance (117). Sometimes patients would like to be compliant but cannot because of financial constraints that make it impossible to afford the prescribed medication, diet or haemodialysis sessions. A large percentage of the ESRD population is unemployed (121) or unable to work, (122,123) perhaps in part because of the age of the population, but undoubtedly because of the extent of medical illness and social disincentives. Employment status, perhaps because of the financial and social benefits conveyed or due to the enhancement of the role of the worker in family, dialysis unit, and community, may contribute to outcome over and above the benefits associated with improved functional status (124-126). Also some patients may be financially forced to rely on public transportation. Accessibility to the hospital is another important reason for missing treatment (117).

1.5 The Karnofsky performance status

Functional status of the patient could also be a meaningful measure of survival in MHD (27). Functional status or performance status evaluates the patient's ability to perform activities of daily living and is clearly related to the patient's underlying physical condition.

Karnofsky performance scale (KPS) is commonly used to measure performance status in chronic disease patients. KPS is a valid prognostic indicator of functional status and its reliability and validity have been used in several research setting (27,127). A fundamental concept is that patients' perceptions may be critically associated with the extent and severity of their illness, compounding treatment ramifications.

Karnofsky Performance Status Scale functional scores were first developed to evaluate chemotherapy in patients with cancer (128). However, they have been the bellwether of many and pioneering studies in quality of life and psychosocial status in dialysis patients. (112,129). The Karnofsky scale presents a stark spectrum from normal, fully functional status, to the need for different levels of assistance, to the need for institutionalisation to death (128). Although some have found methodological problems with the scale (127) many have found it easy to use and reproducible. Although it is often related to age and severity of illness, it is an independent predictor of survival.

The Karnofsky score, assessed by healthcare workers, has been used frequently as a measure of the degree to which MHD patients are physically rehabilitated (130-133). The Karnofsky score provides a rating of the patient's functional Capacities ranging from normality (100) to death (zero) in 10-point decrements. Intermediate ratings focus on the patient's ability to work, ability to care for self, and the need for hospitalisation or institutionalisation. The scale has been extensively used in studies of patients with ESRD (129, 134).

McClellan et al investigated the association between functional status and quality of life in newly entered dialysis patients and the subsequent risk of mortality. They concluded that functional status and quality of life are strong independent risk factors for subsequent mortality in new dialysis patients. These are easily measured indicators, which may serve to predict subsequent risk of mortality (27).

2. JUSTIFICATION OF THE STUDY:

Dialysis adequacy, nutritional factors, and functional quality of life are associated with patient outcome. These factors have been shown to increase morbidity and mortality in ESRD patient on MHD. Therefore factors, which may be amenable to correction, deserve scrutiny.

Several studies have demonstrated that many patients on MHD are under-dialyzed and malnourished, therefore there is a need to establish the magnitude of this problem locally.

As suggested by HD Adequacy Work Group, twice or once weekly dialysis schedule is usually inadequate unless there is a reasonable amount of residual kidney function. The practise at KNH utilizes a twice-weekly dialysis schedule that reflects among other factors, the lack of financial and human resources at that time. From reviewed literature, it seems that this schedule may not be sufficient to provide adequate dialysis.

The study proposes to objectively evaluate whether the schedule at KNH is adequate for our patients. It is noteworthy that there is insufficient local data regarding the haemodialysis adequacy of ESRD patients in Kenya. The only data available come from Odour study. Most data available currently emanates from

developed world and this may not accurately reflect our situation due to major socio-cultural, economic and environmental differences.

The cost burden on patient and healthcare provider for those ESRD patients on haemodialysis is very high. This necessitates the introduction of methods that are efficient, reliable, easy, and cost effective to determine haemodialysis adequacy. Inadequate dialysis not only shortens survival, but also leads to feeling unwell, malnutrition (both assessed by SGA) and functional impairment (assessed by KPS), resulting in frequent hospitalisation that escalates the cost of health care. A modified SGA, which is an inexpensive method that has proven to be reliable in accessing nutritional and functional status of patients on dialysis, can be used as a possible alternative method to determine haemodialysis adequacy.

KPS has been used to predict mortality in MHD patients. As shown from the literature review, the haemodialysis patient mortality showed a strong and robust inverse correlation with delivered haemodialysis dose whether measured by Kt/V or URR. Therefore the need to demonstrate any possible correlation between KPS and above parameters delineating adequacy of haemodialysis.

KNH is the only national hospital in the whole country that has haemodialysis facilities. Most patients are poor and the hospital has poor funding support for haemodialysis. Hence patients are forced to travel long distances to seek

haemodialysis treatment. Consequently, patients are often late, must leave early, or usually fail to show up for treatment at all.

Therefore the data generated from this study will hopefully bring out pertinent information about adequacy of MHD patient that may lead to further improvement in quality and survival of patients on haemodialysis.

3 OBJECTIVES

3.1 BROAD OBJECTIVE:

The main objective was to assess the level of adequacy of haemodialysis in ESRD at Kenyatta National Hospital (KNH).

3.2 SPECIFIC OBJECTIVES

1. To determine the adequacy of haemodialysis using Kt/V, HDP and URR (in a single pool variable.

2. To determine the correlation between the adequacy of haemodialysis and the functional status of life, as measured by KPS.

3. To determine the utility of modified SGA, as a possible surrogate marker of adequacy of haemodialysis.

4 MATERIALS AND METHODS

4.1. STUDY DESIGN:

This was a hospital based, cross-sectional study.

4.2. STUDY SITE:

The study was carried out in the Renal Unit at the Kenyatta National Hospital (KNH), which is the major referral and teaching hospital in Nairobi, Kenya.

4.3. DURATION OF STUDY:

The study was carried out between August 2003 and December 2003

4.4. SAMPLE: SIZE AND TECHNIQUE:

All consecutive patients who satisfied the study criteria during the study period were recruited into the study.

4.5. STUDY POPULATION:

All patients with confirmed ESRD on maintenance haemodialysis at Kenyatta National Hospital satisfying the inclusion criteria was recruited.

4.5.1. INCLUSION CRITERIA:

Patients was recruited based on the inclusion criteria of:

1. A duly signed informed written consent.
2. A confirmed diagnosis of ESRD.
3. Age above 18 years.
4. Patient who had been on maintenance haemodialysis for a minimum period of 6 months.

4.5.2. EXCLUSION CRITERIA:

1. Any patient who had acute febrile illness (Temperature ≥37.8).
2. Patients with documented liver disease.
3. Patient with HIV infection.
4. Any patient who refused to enter the study.
5. Known protein loosing enteropathy

4.6. ETHICAL CONSIDERATION:

1. An informed and written consent was obtained from every patient who took part in this study. The consent also ensured that the patient fully understood the nature of the study, as laid out in appendix I.

2. The study was undertaken only after approval the Department of medicine, University of Nairobi, and Ethical and Scientific Review Committee, Kenyatta National Hospital.

4.7. METHODOLOGY

The principal investigator under the guidance of his supervisors carried out the study. Consecutive patients, who came for MHD in the renal unit, were enrolled for the study. Both dialysis file and medical records file of the patients on MHD were obtained from renal unit and medical records office respectively.

The patient's files were studied and all patients were reviewed. Those who did not meet the inclusion criteria were left out, ultimately remaining with files of patients who were eligible for the study.

Data was prospectively obtained via a standard questionnaire administered by the principal investigator.

A complete medical history was obtained and a complete physical examination was performed in each patient. Pertinent clinical and demographic data was recorded. Shown in appendix VIII. The data obtained included:

4.7.1 SOCIO-DEMOGRAPHIC DATA including age, sex, occupation, and level of secular education.

4.7.2. DIALYSIS DATA, which entailed the causes and duration of ESRD, vascular access, dialysis frequency per week, and duration of dialysis treatment. In addition, the type of dialysis machine used, type of membrane and Dialysate, and the manufacturer's reported ultrafiltration coefficient (KUf) of the dialyser for that treatment, blood flow and Dialysate type and flow, complications during dialysis were also taken.

4.7.3 COMPLIANCE DATA –: including Interruption of dialysis schedule, reasons of missed dialysis and behaviour compliance pattern.

Non-compliance was defined as: Patient who missed or shortened haemodialysis session, at least one treatment during the last three-month period (117).

4.7.4. MODIFIED SGA DATA –: including weight change for the last 6 months, dietary intake, gastro intestinal symptoms, functional capacity and assessment of subcutaneous and muscle mass. This was used for obtaining the modified SGA score, the lower the value the better the nutritional status and the well being of the patient. (Appendix IV).

4.7.5. ANTHROPOMETRIC DATA including weight in kilograms (predialysis and post dialysis), height in meter. Body mass index (BMI-wt/h²) was calculated in Kg/m² and graded according to WHO grading. Appendix II.

BMI (Kg/m²)	Grading
<20	Underweight.
20 – 24.9	Normal
>25	Overweight

4.7.6. FUNCTIONAL STATUS ASSESSMENT DATA: A focused history on the patient's ability to care for self, and the need for hospitalisation or institutionalisation, was obtained (as elaborated in the proforma), which were used to score KPS. The Kanofsky score was used to assess the functional status of the patient (as in the appendix VII). The higher the score the better the functional status of the patient. A score of 80-100 is within normal while below 80 is a poor score (133,134).

4.7.7. LABORATORY INVESTIGATION

Blood samples were taken for predialysis BUN, serum albumin, CRP, and post dialysis BUN in a single dialysis session.

Predialysis sampling was drawn immediately prior to the dialysis using a technique that avoids dilution of blood sample with saline and heparin. (Appendix V).

Postdialysis BUN sample was drawn using the slow-flow technique to prevent sample dilution with re-circulated blood and to minimise the confounding effects of urea. (Appendix VI).

Urea was measured using Glutamate Dehydrogenase method (135), while predialysis albumin using Bromcresol Green method (136). Normal values of albumin were 35-45 g/l (As shown in the appendix III).

Predialysis C-reactive protein was determined using EUROTEX CRP slide based on principles of agglutination (137). Positive indicates presence of an infection or inflammation.

All the laboratory investigations were carried out at the Biochemistry and immunology laboratory of KNH. It was unfortunate that the renal unit laboratory was not functioning during the study period.

4.7.8. UREA KINETIC MODELLING.

The single predialysis and post dialysis urea and other parameters were used to calculate URR and Kt/V using a single pool variable method (see appendix VII).

The **URR** method used is

URR = 100 x (1-R)

Where **URR** is the urea reduction ratio

R = post dialysis BUN (***Ct)*** divided by predialysis BUN (***Co***)

= ***Ct/Co***

The minimum optimal dose, targeted for adequacy of MHD was: URR of 65% for thrice weekly dialysis patients, while 80% for once or twice weekly dialysis.

Kt/V: Kt/V natural Logarithm formula will be used i.e.,

Kt/V = -Ln (R- 0.008 x t) +[(4- 3.5 x R) – (UF/W)]

Kt/V	=	Dialysis adequacy
Ln	=	Natural logarithm
R	=	Post dialysis BUN (***Ct***) / pre dialysis BUN (***Co***).
UF	=	Ultra filtration volume
t	=	Dialysis session length in hours.
W	=	Post dialysis weight

The minimum optimal dose, targeted for adequacy of MHD was: **Kt/V of ≥1.8** for patient on once or twice weekly haemodialysis session and **Kt/V of ≥1.2** for thrice weekly dialysis patient.

4.7.9. HAEMODIALYSIS PRODUCT:

The HDP was calculated from duration (in hours) and frequency of dialysis (per week). The formula used was;

$$\textbf{HDP= (hours/dialysis session)} \times \textbf{(session/week)}^{2}$$

An HDP of $\geq$ 45 and above indicated adequate dialysis.

5 DATA MANAGEMENT

All data emanating from this study was entered into a computer database and analaysed using Statistical Package for Social Sciences (SPSS) version 10.0 (SPSS Inc. Chicago, USA). Data validation was performed before the analysis.

Continuous data was analysed using means, standard deviations, medians, proportions and frequency distributions while categorical data was analysed using percentages, with their corresponding confidence interval.

The analysed data was presented in the form of tables, pie charts and graphs. To establish the correlation between variable of interest, chi-square, Fisher's exact probability test or Pearson's correlation coefficient (r) were used where applicable.

A p-value of less than or equal to 0.05 was considered as statistical significance.

6. RESULTS

6.1 RECRUITMENT

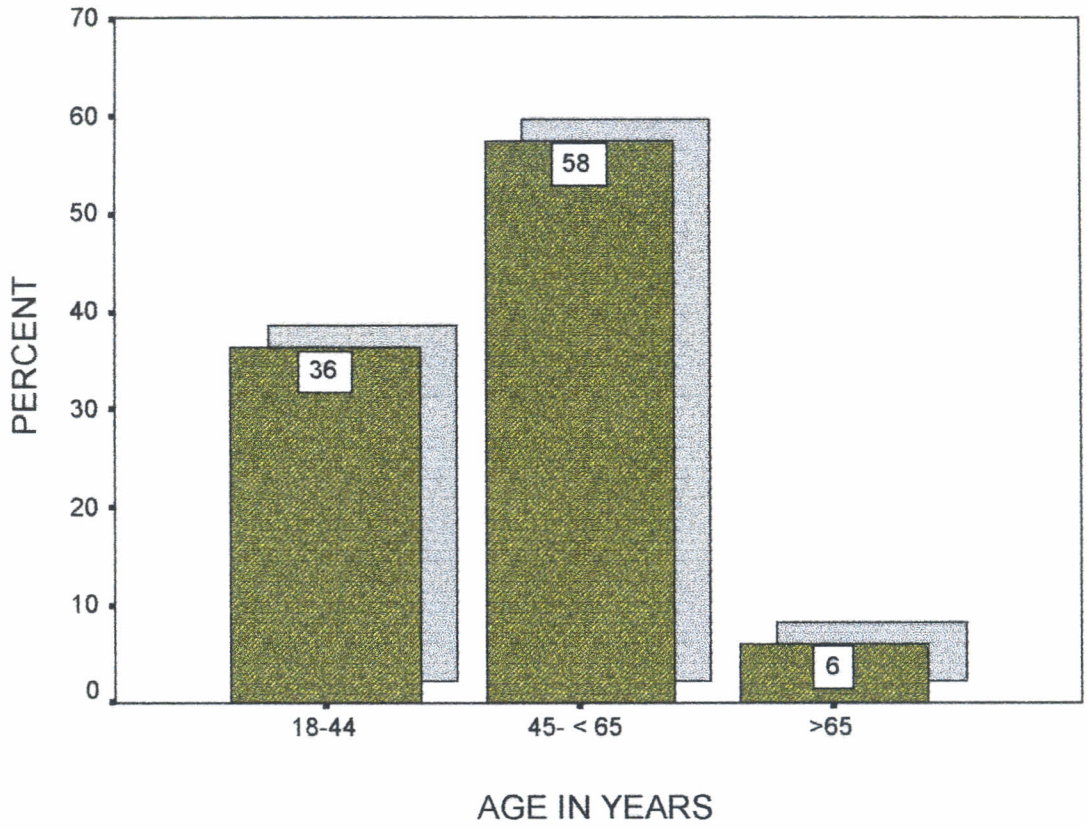
Recruitment into the study began on 28th June 2002 and ended on 8th December 2002. Ninety-nine patients were dialysed during this period in the Renal Unit of the Kenyatta National Hospital in Nairobi. Sixty-six (66.7%) out of the 99 patients satisfied the inclusion criteria. Thirty-three patients were excluded from the study, of which 21 patients had received dialysis of less than six months duration, eight patients had liver disease, three patients could not be weighed and one patient declined to participate in the study.

6.2 DEMOGRAPHIC DATA

6.2.1. SEX AND AGE DISTRIBUTION

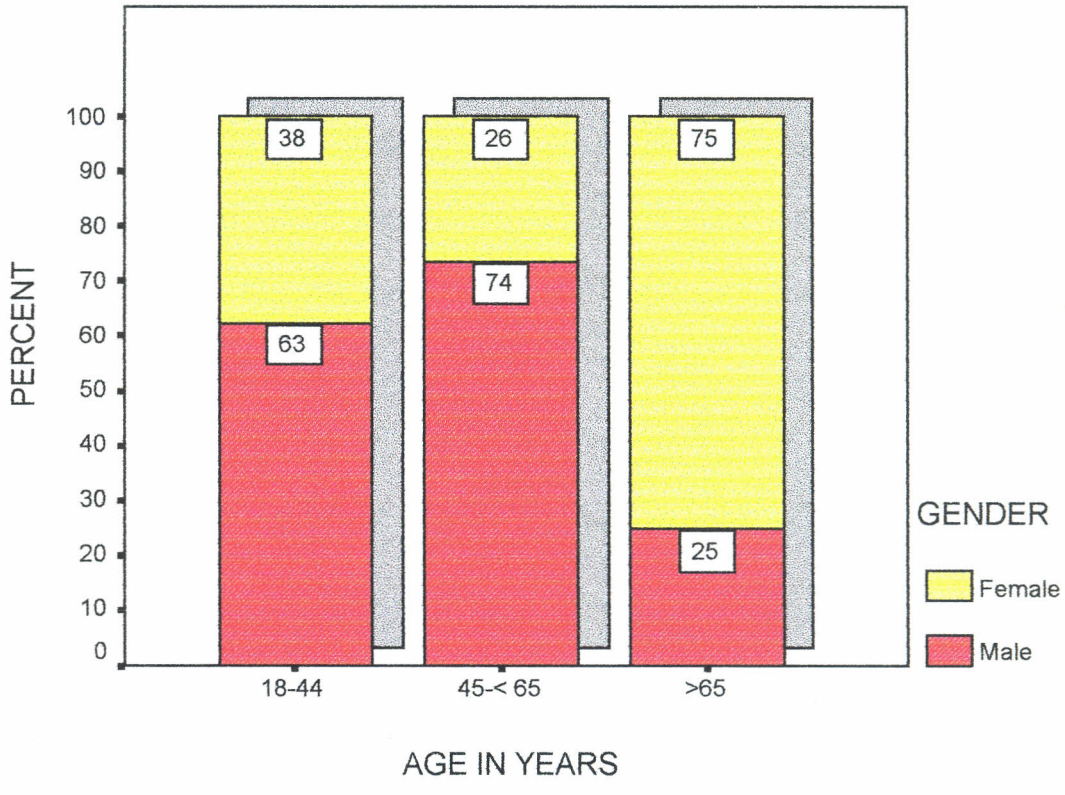
There were 44 (66.7%) males and 22 females (33.3%) in the study group, giving a male: female ratio of 2:1. The age ranged from 18 to 75 years with a mean of 47 ±14 years. The majority 63.6% (n=42) of the patients were 45 years or older (Figure 1).

FIGURE 1. AGE DISTRIBUTION OF HAEMODIALYSIS PATIENTS



The mean age for males was 48.1 ± 13.4 while that of females was 44.4 ± 15.1. There was no significant difference in the mean age between males and females (p=>0. 05). The age and gender distribution of the patients are shown in figure 2. The difference between gender and age was not statistically significant (p=0.125).

FIGURE 2. AGE AND GENDER DISTRIBUTION OF DIALYSIS PATIENTS



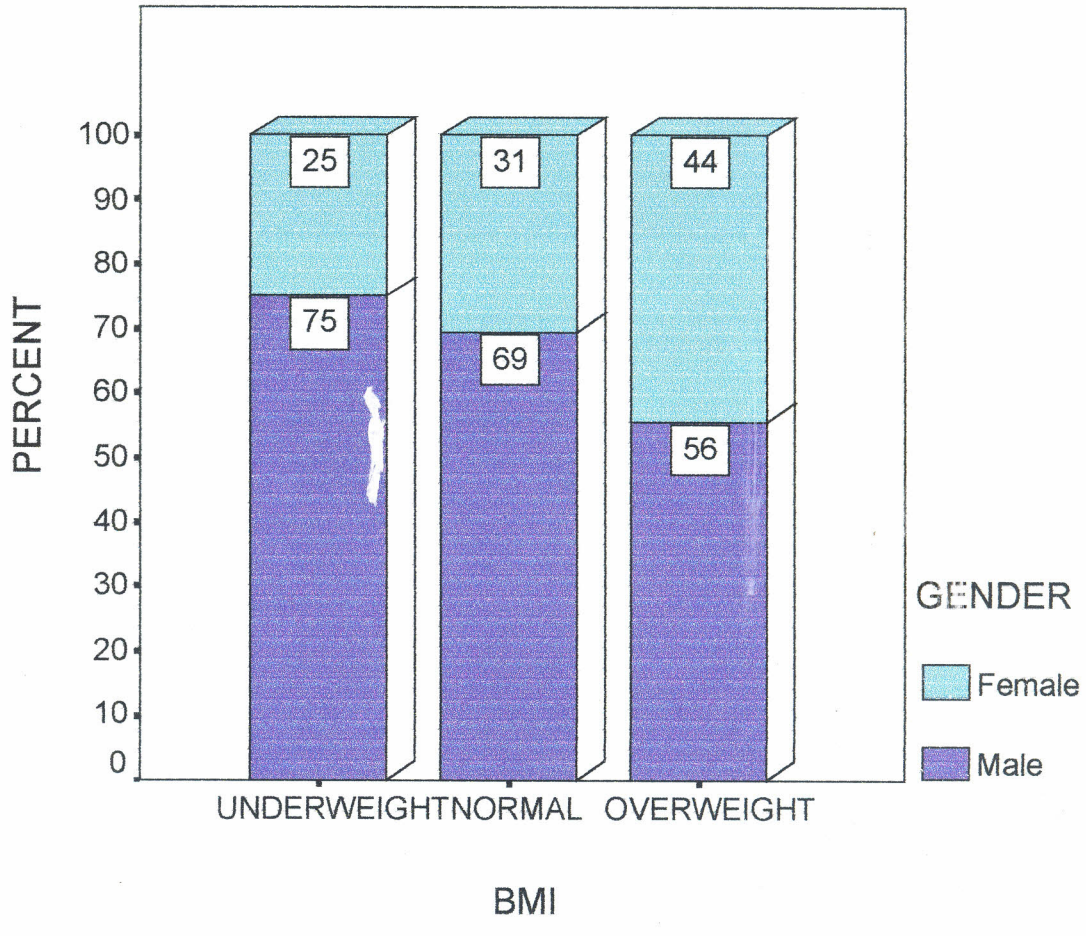
6.2.2. LEVEL OF EDUCATION

Seventy-four point three percent (74.3%) of the patients had secondary level of education while 24.2% and 1.5% had primary level and no formal education respectively.

6.2.3 BMI DISTRIBUTION

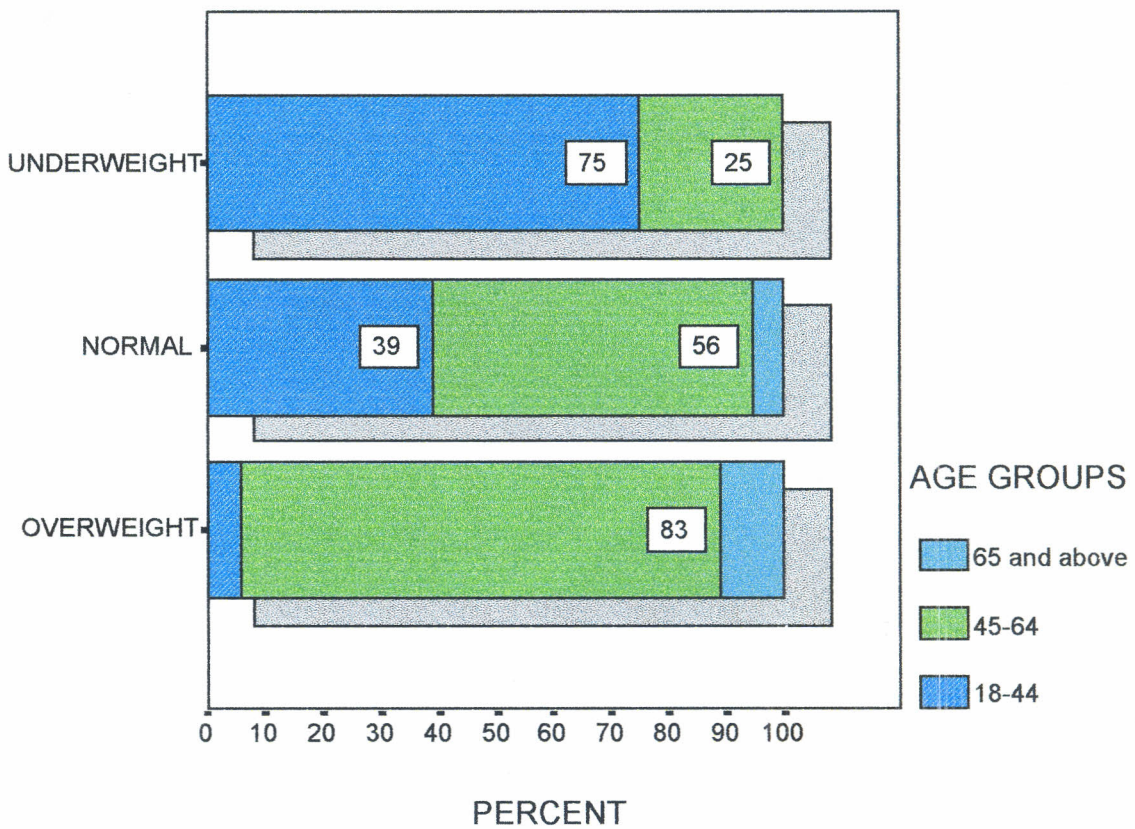
The mean body mass index was 23.1 ± 3.9 kg/m^2. Fifty four point five percent (n=36) of the study subjects had a normal BMI but 18.2% (n=12) and 27.3% (n=18) were classified as underweight and overweight respectively. The mean BMI for females was higher than for males, 24.1 ± 5.1 and 22.5± 3.2 respectively (p=0.134). Seventy-five percent (75%, n=9) of the underweight patients were males. (p=0.472)[Figure 3].

FIGURE 3. THE BMI DISTRIBUTION WITHIN GENDER.



Seventy five percent (n=9) of the underweight patients were younger, while 83.3% (n=15) of overweight patients were older (p=0.001, r=0.465). [Figure 4].

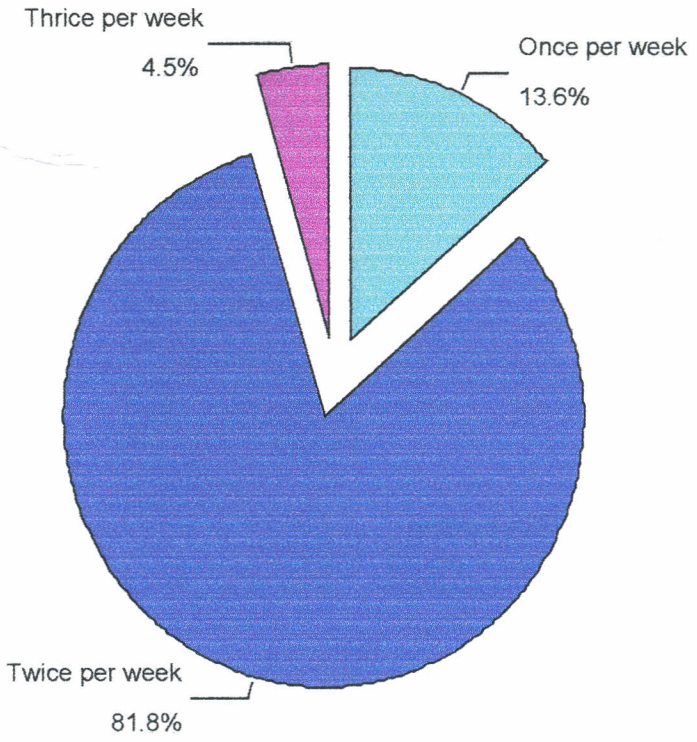
FIGURE 4. THE BMI DISTRIBUTION WITHIN THE AGE GROUP



6.3. SCHEDULE OF HAEMODIALYSIS

Most of the patients, 81.8% (n=54), underwent haemodialysis twice weekly. Figure 5. Dialysis time (t) for those patients who underwent once or twice weekly dialysis session was 5 hours, while for thrice weekly it was 4 hours.

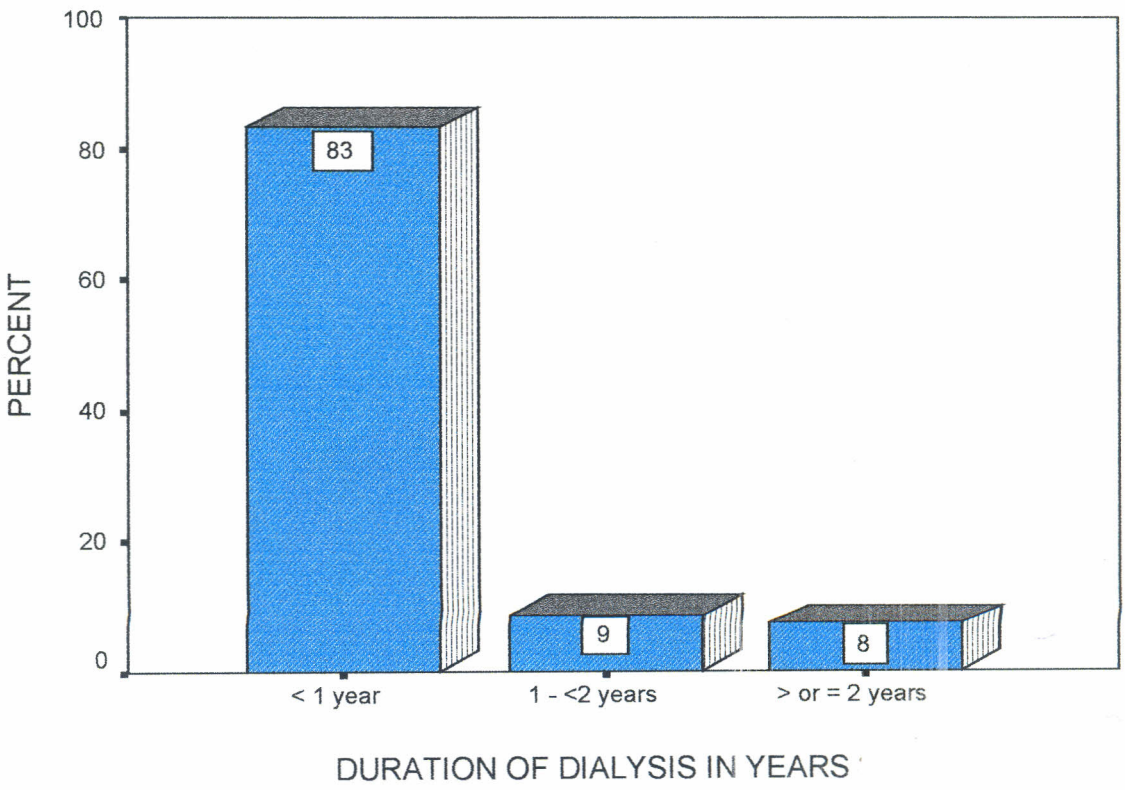
FIGURE 5. FREQUENCY OF HAEMODIALYSIS PER WEEK



6.4. DURATION OF HAEMODIALYSIS

Figure 6 shows the duration of dialysis prior to the study. Majority of the patients had been dialysed for less than one year (83.3%, n=55).

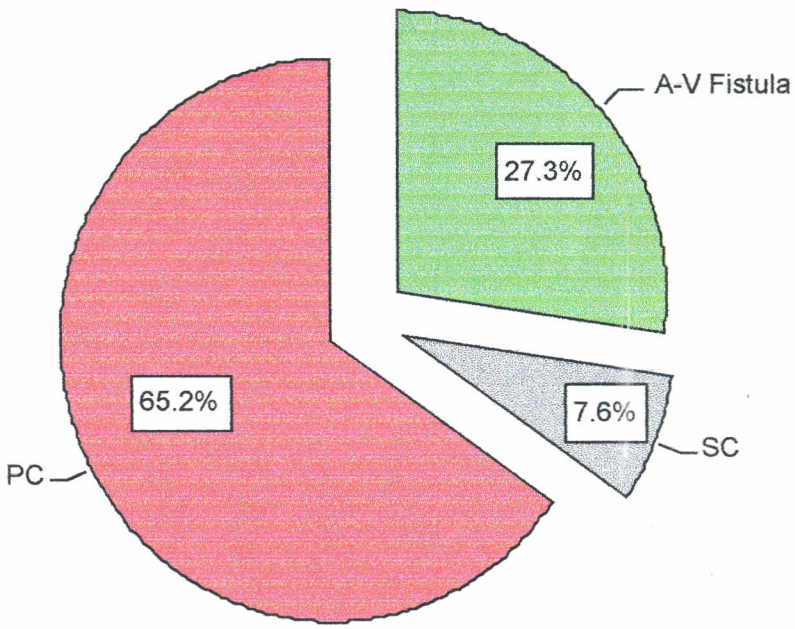
FIGURE 6. DURATION OF HAEMODIALYSIS IN YEARS



6.5. VASCULAR ACCESS OF HAEMODIALYSIS

Majority of our patients (70.3%) had temporary vascular access of haemodialysis [using permanent tunnelled cuffed catheter (PC) or subclavian double-lumen temporary catheter (SC)]. The commonest route used for vascular access was permanent tunnelled cuffed catheter (65.2%, n=43), inserted in the internal jugular vein, followed by Aterio-Venous fistulae (27.3%, n=18)). Only 5 patients had subclavian double-lumen temporary catheter inserted in the subclavian vein. [Figure 7].

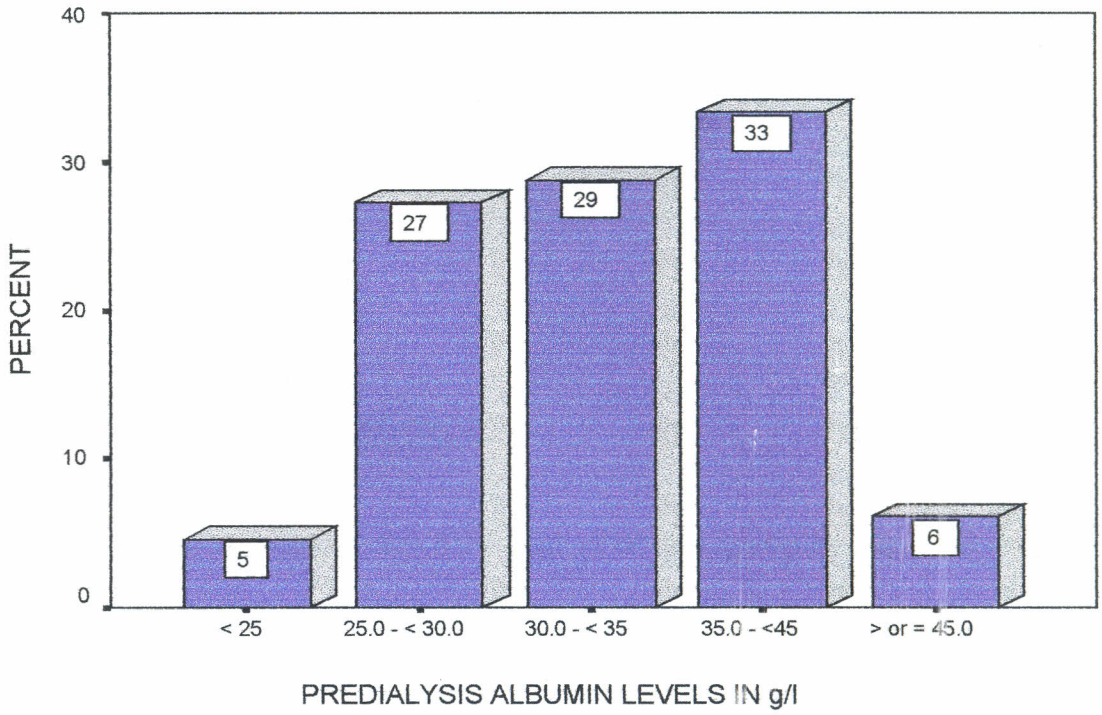
FIGURE 7. VASCULAR ACCESS OF HAEMODIALYSIS



6.6 PRE-DIALYSIS ALBUMIN

The mean pre-dialysis albumin levels were 33.67±6.03 g/l (ranges from 21.9 to 48.0g/l). Male patients had a higher albumin levels than females, 34.01± 5.7g/l and females 32.97±6.7g/l respectively (p=0.513). Sixty one percent (60.6%, n=40) of the patients had low pre-dialysis albumin (<35g/L). [Figure 8].

FIGURE 8. PRE-DIALYSIS ALBUMIN DISTRIBUTION



Seventeen patients (n=17, 25.8%) had a positive CRP while 74.2% were negative. In patients with low albumin level (<35g/l), 60% were negative for CRP. (p=0.189) .

6.7. Mean values of other parameters.

The means values of others variables studied are shown in table 3.

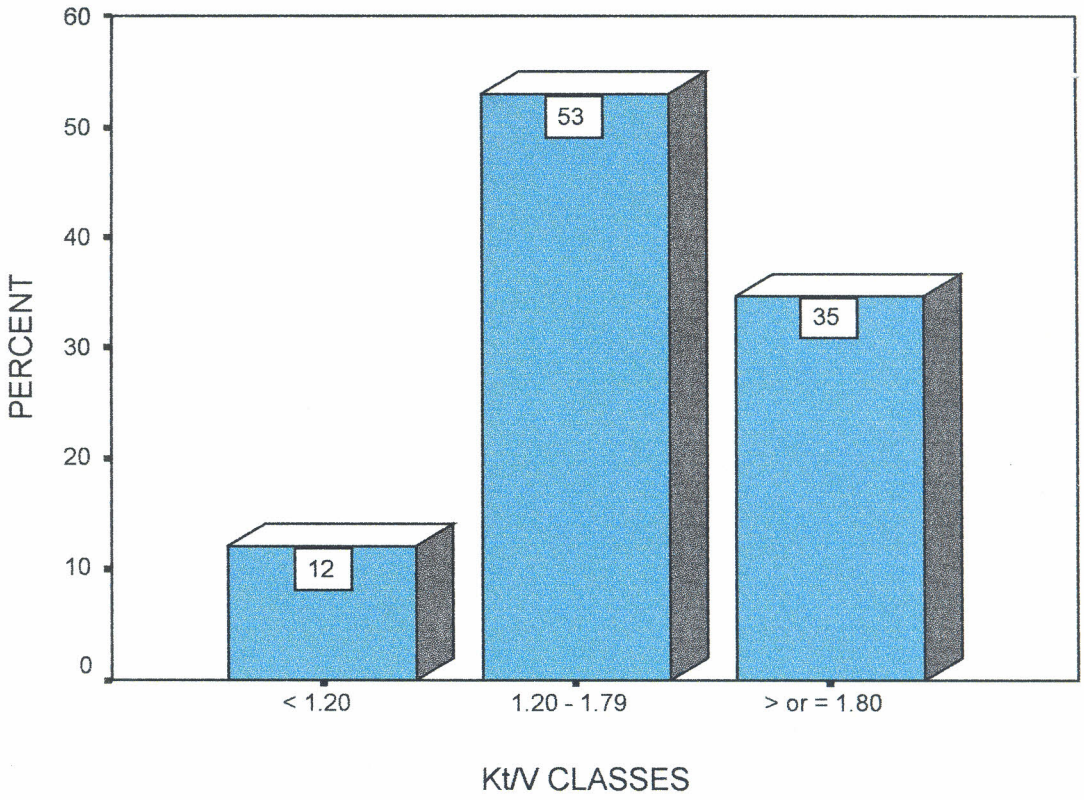
Table 2: Mean values of other parameters studied

Variable	N	Mean	S.D
Dialysate flow rate	66	483.4	51.4
Ultra filtration volume in litres	66	3.1	1.1
Ultra filtration rate in litres/hour	66	0.8	0.7
Pre-dialysis urea	66	30.9	11.4
Post-dialysis urea	66	8.7	4.7

6.8. Kt/V AND URR DISTRIBUTION

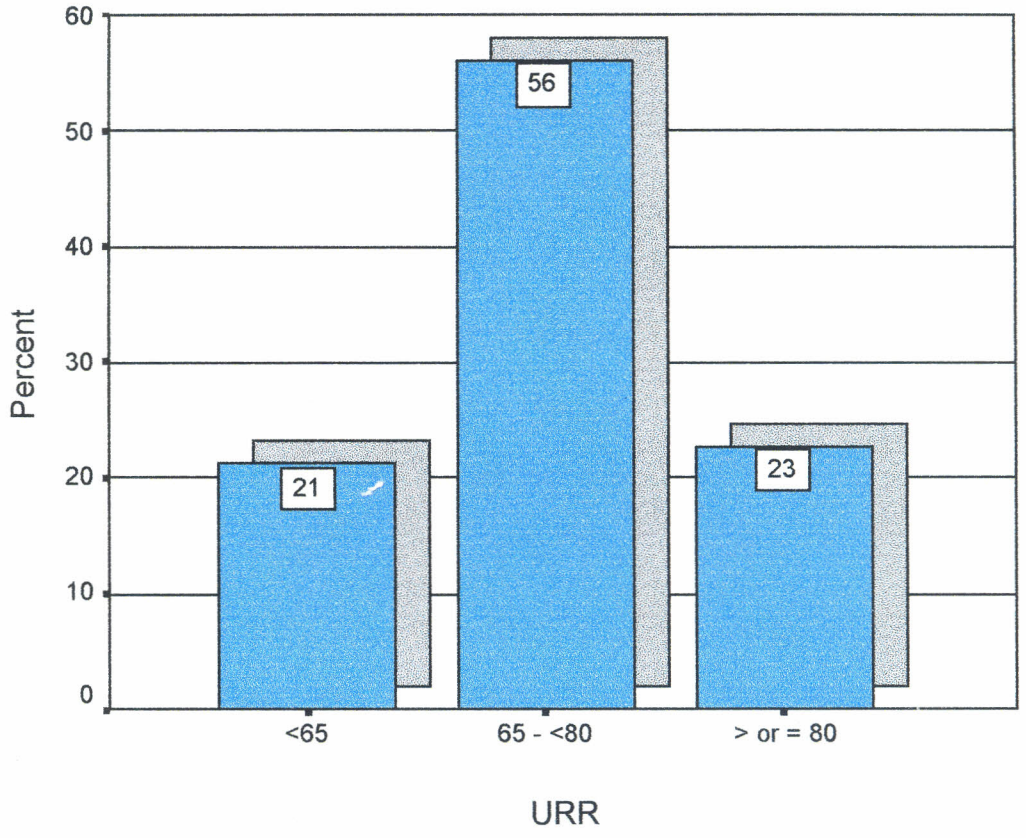
The frequency of distribution for Kt/V and URR are given in Figure 9 and 10 respectively. The overall mean Kt/V was 1.75 ± 0.72 while mean URR was 72.36 ± 11.8% (p=0.234). The mean values were higher in females (1.89 ±0.60) than in males (1.67± 0.76). This was also true when using URR; females had a mean of 76.58 ± 10.24% while males had a mean of 70.25 ± 12.05% (p=0.039). The majority of the patients 53% had a Kt/V of between 1.2 to less 1.8. Conversely, only 34.8% had a Kt/V ≥1.8.

FIGURE 9. Kt/V FREQUENCY DISTRIBUTION



The majority of the patients, 56% had a URR of between 65% to less 80%. Conversely, only 22.7%% had a URR of ≥ 80%.

FIGURE 10. URR FREQUENCY OF DISTRIBUTION



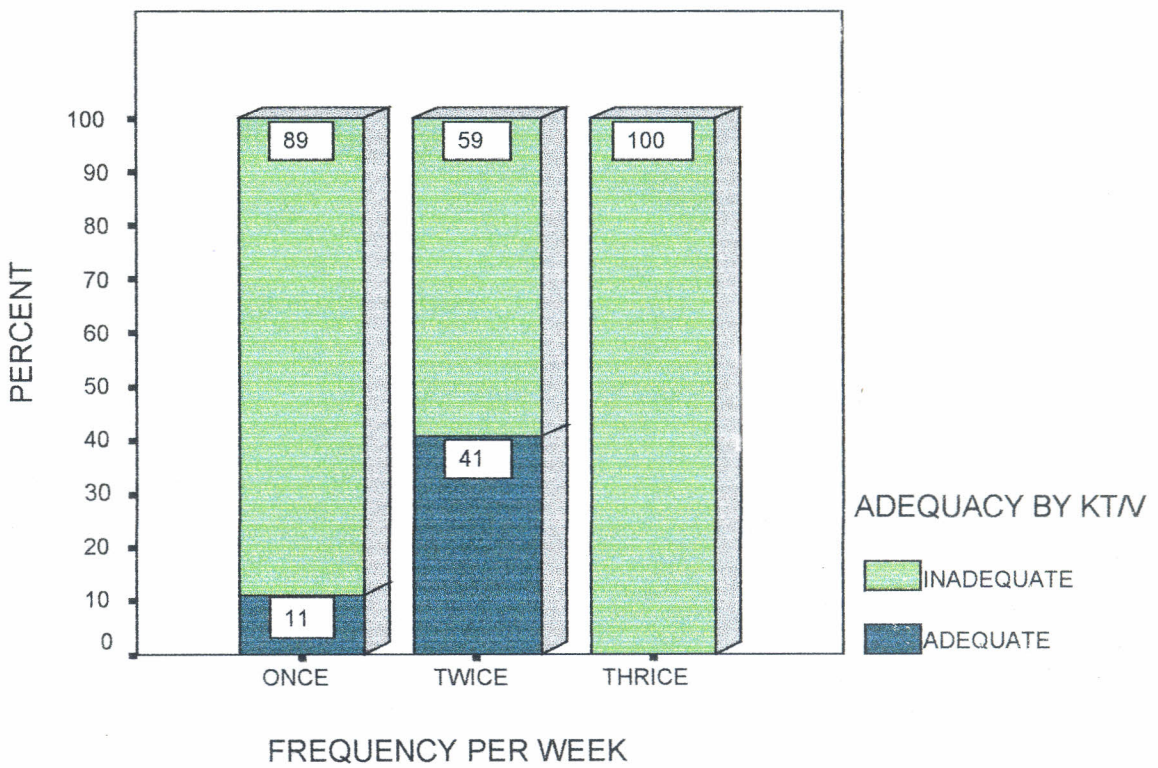
6.9. ADEQUACY OF HAEMODIALYSIS

The adequacy of haemodialysis, using Kt/V and URR, was analysed as per the following schedule: once or twice weekly schedule Kt/V of ≥ 1.8 and URR of ≥ 80%, while for thrice weekly Kt/V of ≥ 1.2 and URR of ≥ 65%.

6.9.1. ADEQUACY OF HAEMODIALYSIS BY SCHEDULE OF DIALYSIS

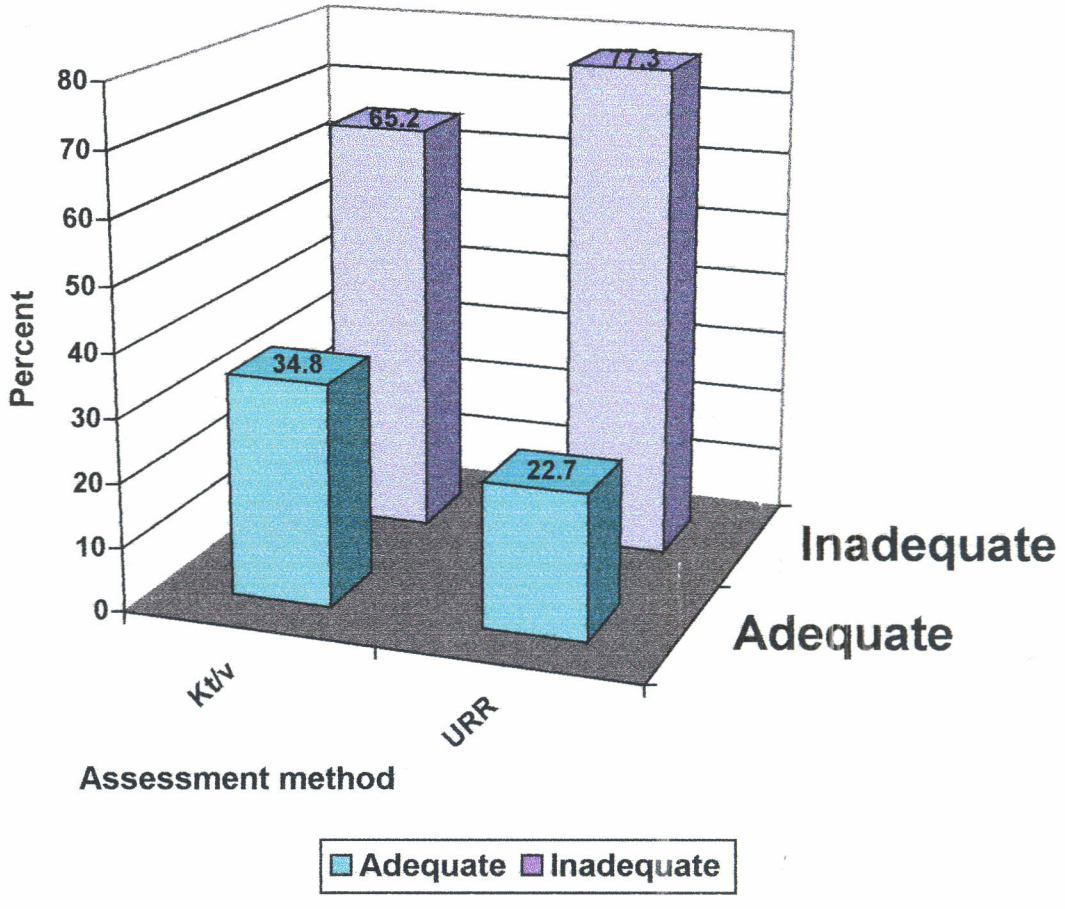
Patients who underwent a once weekly dialysis schedule, 88.9% were inadequate dialysed by either Kt/V or URR, with only 11.1% achieving adequate dialysis. (p=0.097 for Kt/V, p=0.389 for URR) All three patients who underwent a thrice-weekly dialysis schedule were inadequate dialysed, using either Kt/v or URR. The majority of twice weekly dialysis patients were inadequately dialysed using either method. Figure 11 shows the correlation of adequacy when using Kt/V.

FIGURE 11. ADEQUACY OF HAEMODIALYSIS BY SCHEDULE OF DIALYSIS



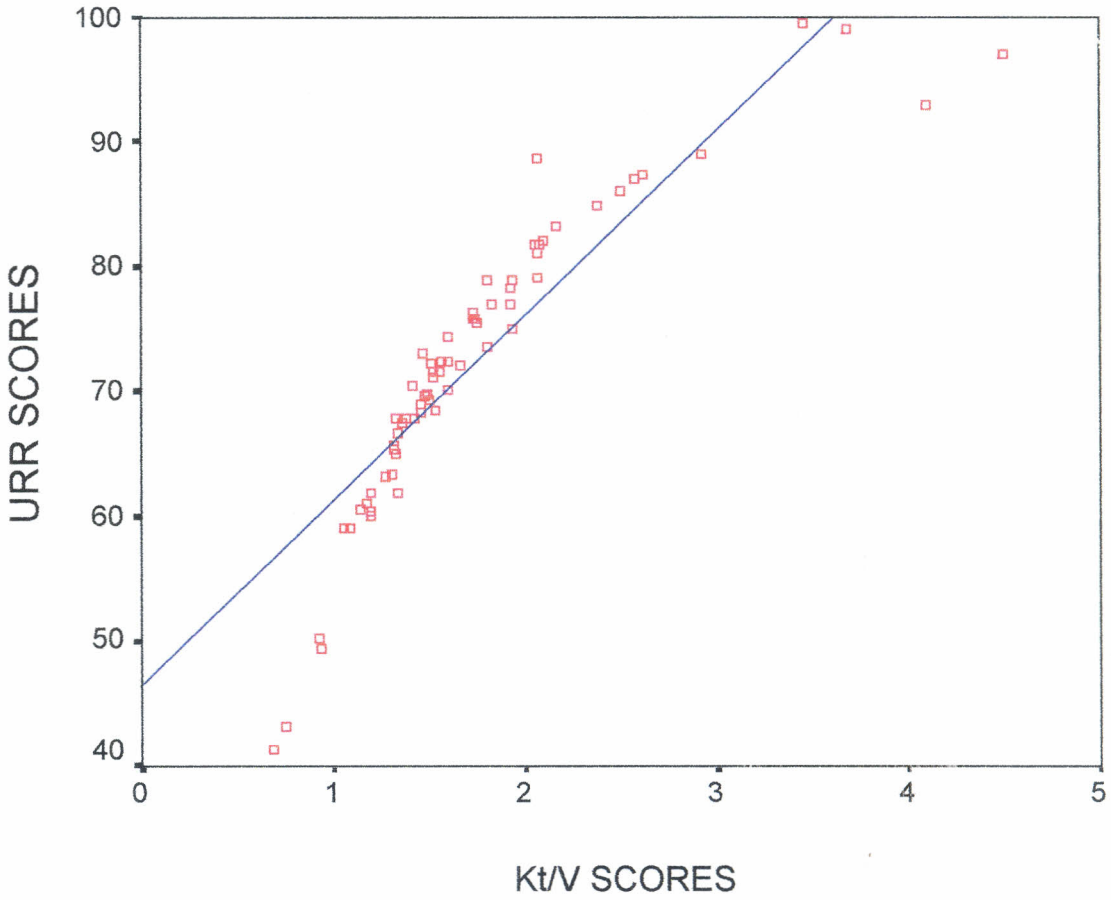
The overall adequacy of haemodialysis in this study, 34.8% (n=23) of the patients had adequate dialysis when using Kt/V while 22.7% (n=15) were adequately dialysed using URR. [Figure 12].

FIGURE 12. ADEQUACY OF HAEMODIALYSIS



A disparity between URR and Kt/V is expected as per DOQI guidelines. However we found a strong statistically significant correlation as shown below in figure 13. ($p=<0.001$, $r=0.742$)

FIGURE 13. CORRELATION BETWEEN Kt/V AND URR



The above graph shows a positive correlation between URR and Kt/V. This emphasize that URR is a function of Kt/V.

6.9.2. ADEQUACY OF DIALYSIS USING HAEMODIALYSIS PRODUCT.

All patients in this study had HDP of less than < 45 and thus were evaluated to be inadequately dialysed. The mean value was 18.6 ± 0.8 with a minimum value of 5 and maximum of 36. Majority of the patients (81.8%) had HDP of 20, while 13.6% and 4.5% had HDP of 5 and 36 respectively.

6.9.3. ADEQUACY OF HAEMODIALYSIS AND GENDER

Figure 14 and 15 shows adequacy of dialysis by gender. Using both Kt/V and URR readings, females were more adequately dialysed than males [59.1% vs. 22.7 % for Kt/V and 36.4% vs. 15.9% for URR]. The *p values* for Kt/V and URR were *0.003* and *0.062* respectively. (r=-0.46 for Kt/V).

FIGURE 14. THE RELATIONSHIP BETWEEN GENDER AND ADEQUACY OF HAEMODIALYSIS (BY Kt/V)

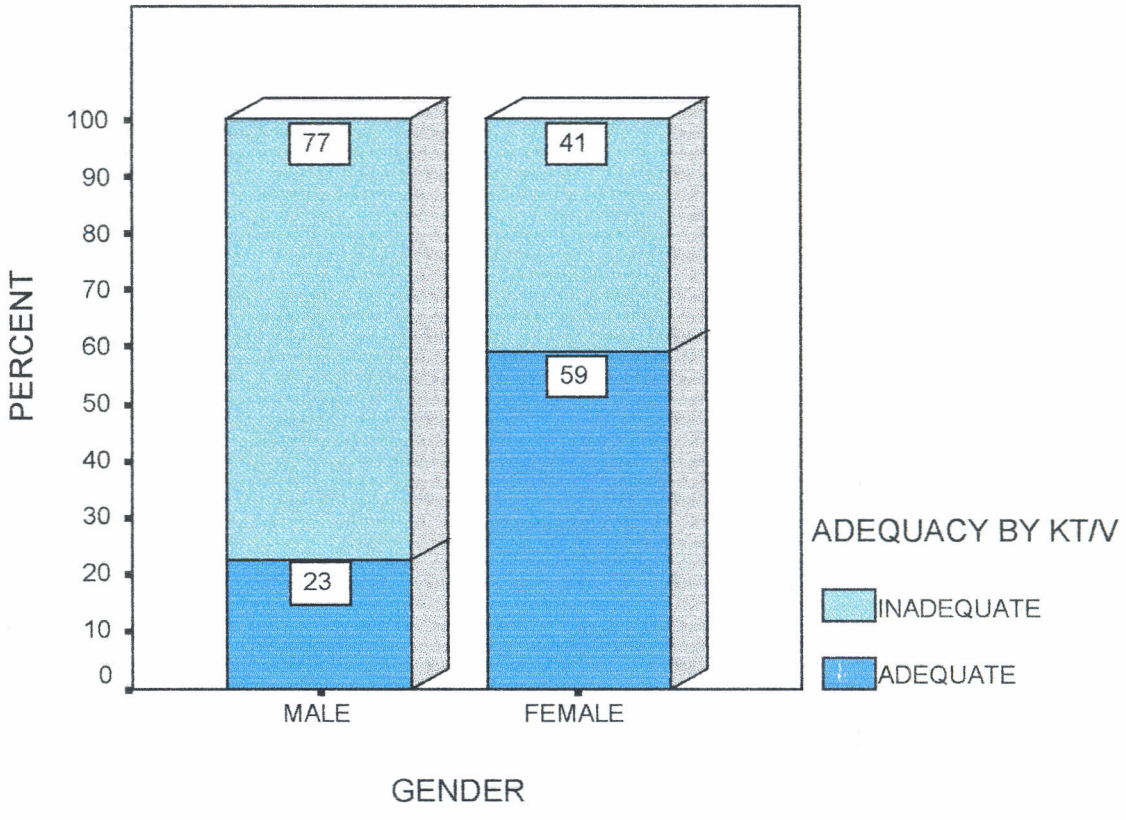
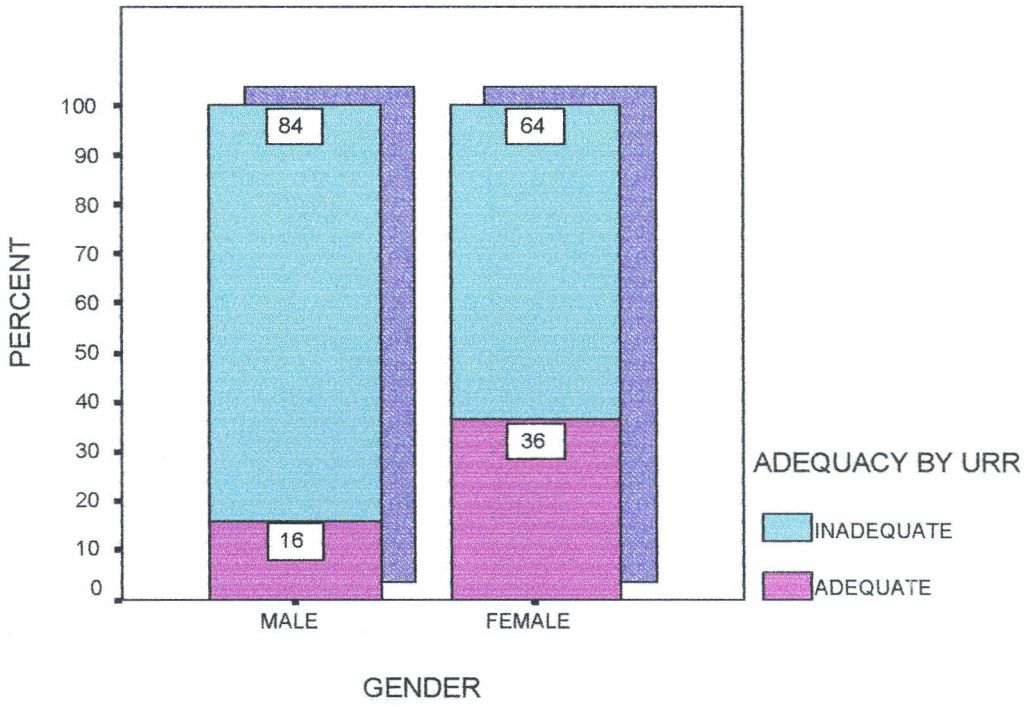


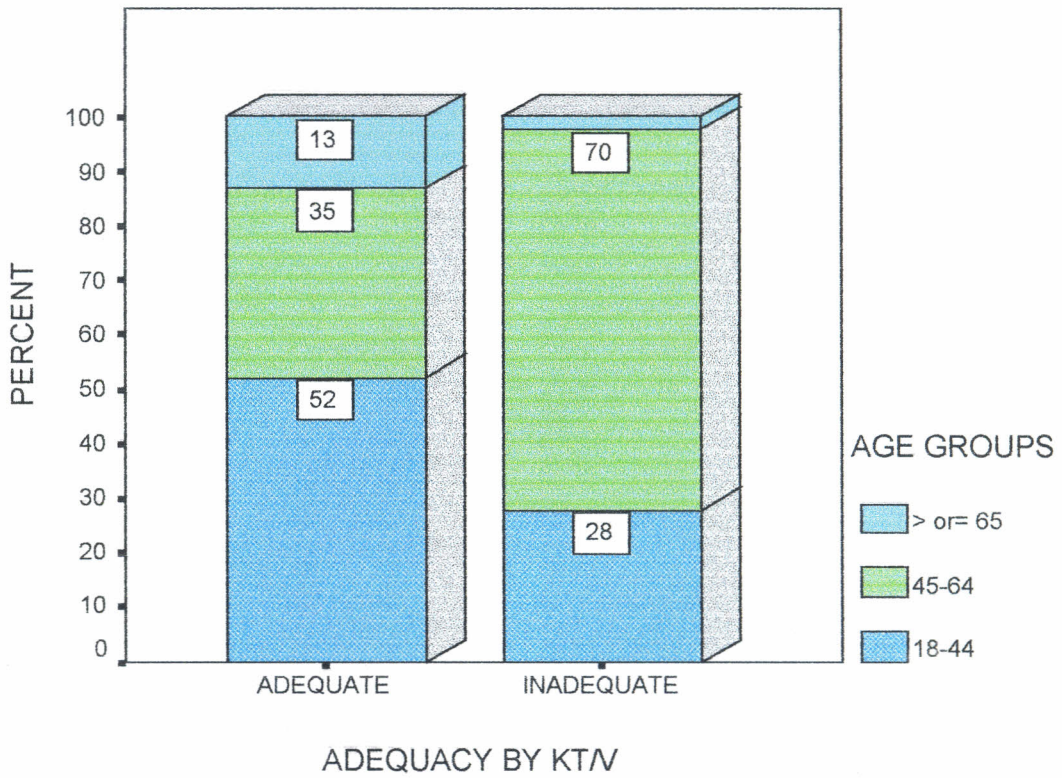
FIGURE 15. THE RELATIONSHIP BETWEEN GENDER AND ADEQUACY OF HAEMODIALYSIS (BY URR)



6.9.4. ADEQUACY OF HAEMODIALYSIS WITHIN THE AGE GROUP

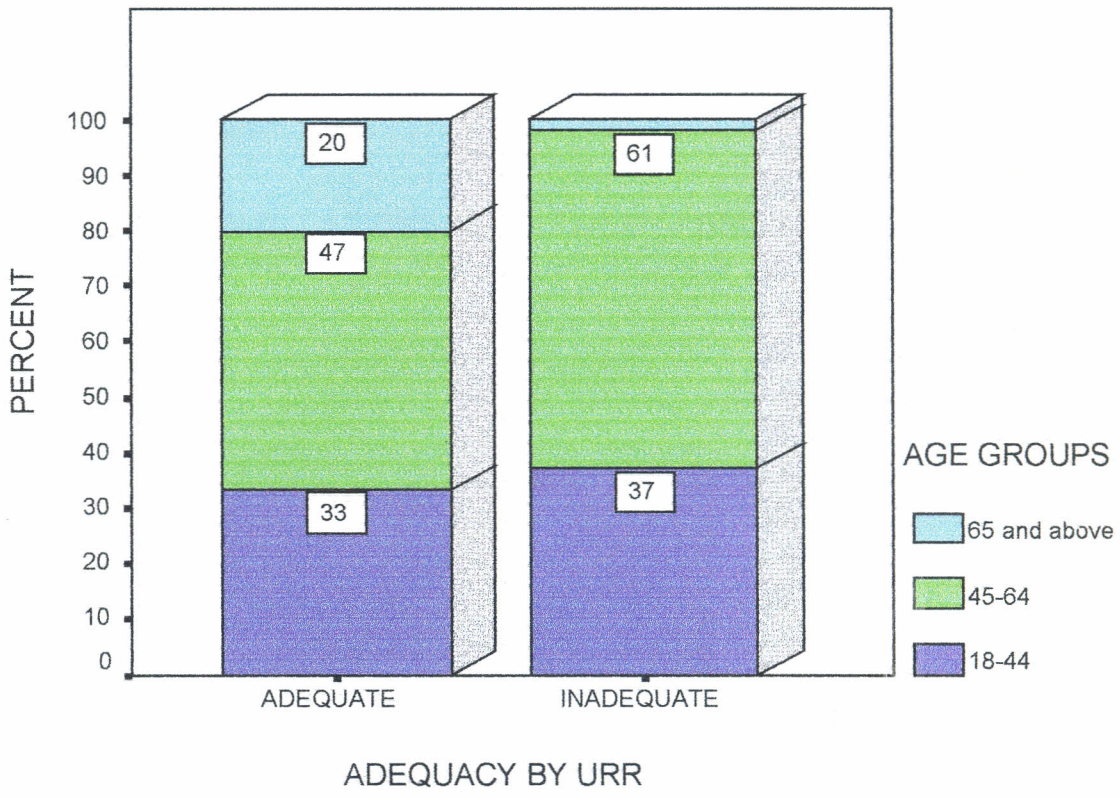
As shown in figure 16 (using Kt/V), younger patients (<45 years of age) were more likely to have an adequate dialysis compared to the older age groups (52.2 %, n=12,Vs 34.8%, n=8 *p=0.015)*.

FIGURE 16. THE RELATIONSHIP BETWEEN AGE AND ADEQUACY OF HAEMODIALSIS (BY Kt/V)



Using URR for the same analysis, the results were observed as in the figure 17 below. (p=0.068). Similar pattern was observed.

FIGURE 17. THE RELATIONSHIP BETWEEN AGE AND ADEQUACY OF HAEMODIALYSIS (BY URR)



6.9.5. ADEQUACY AND VASCULAR ACCESS OF HAEMODIALYSIS

Seventy eight percent of patients who were adequately dialysed had permanent-catheter *(p=0.034 Kt/V)*. Shown in figure 18. Similar observation was found with URR *(p=0.154)*. [Figure 19]

FIGURE 18. THE RELATIONSHIP BETWEEN ADEQUACY OF DIALYSIS (BY Kt/V) AND VASCULAR ACCESS

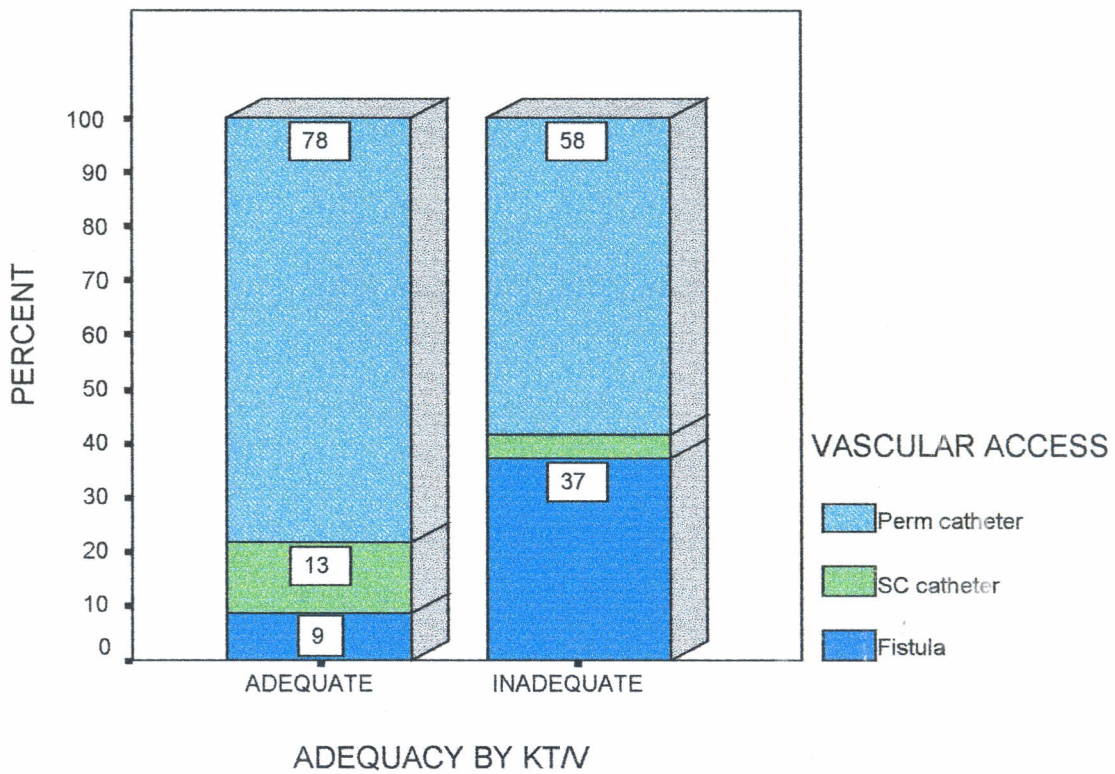
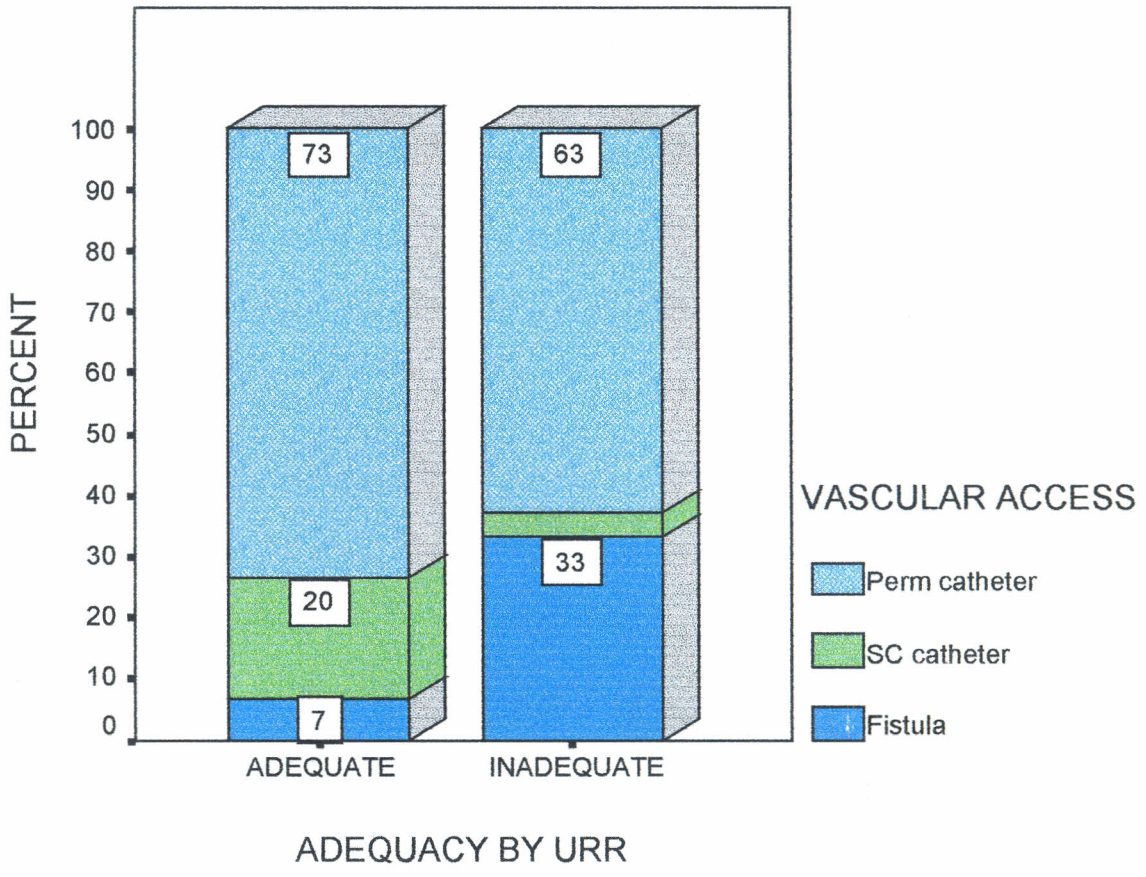


FIGURE 19. THE RELATIONSHIP BETWEEN ADEQUACY OF DIALYSIS (BY URR) AND VASCULAR ACCESS

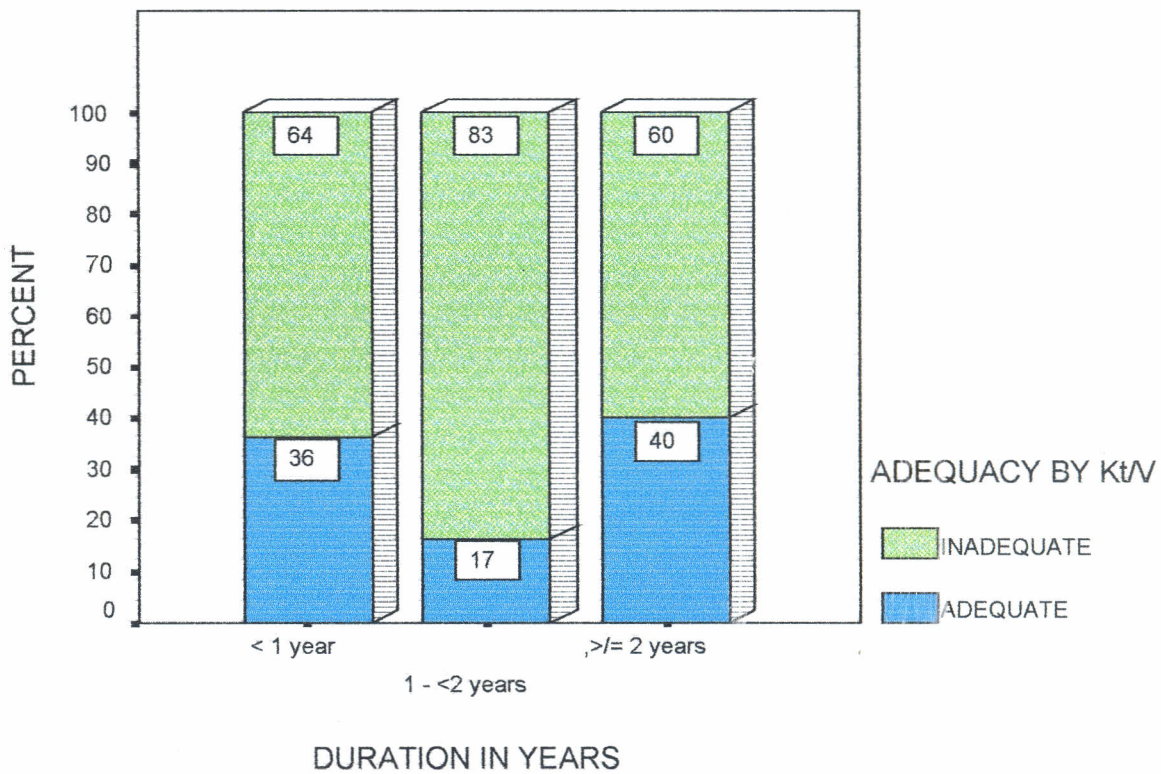


Interestingly, 89%(n=17) of patients on A-V fistula were inadequately dialysed (by Kt/V).

6.9.6. ADEQUACY AND DURATION OF HAEMODIALYSIS

The result showed that, patients who had dialysis for less than one year, 64% (n=35) were inadequately dialysed by Kt/V (p=0.61). 60% (n=3) of patients who were dialysed for more than two years were inadequately dialysed. There was no statistically significant. Figure 20. Similar observation was found with URR *(p=0. 41)*

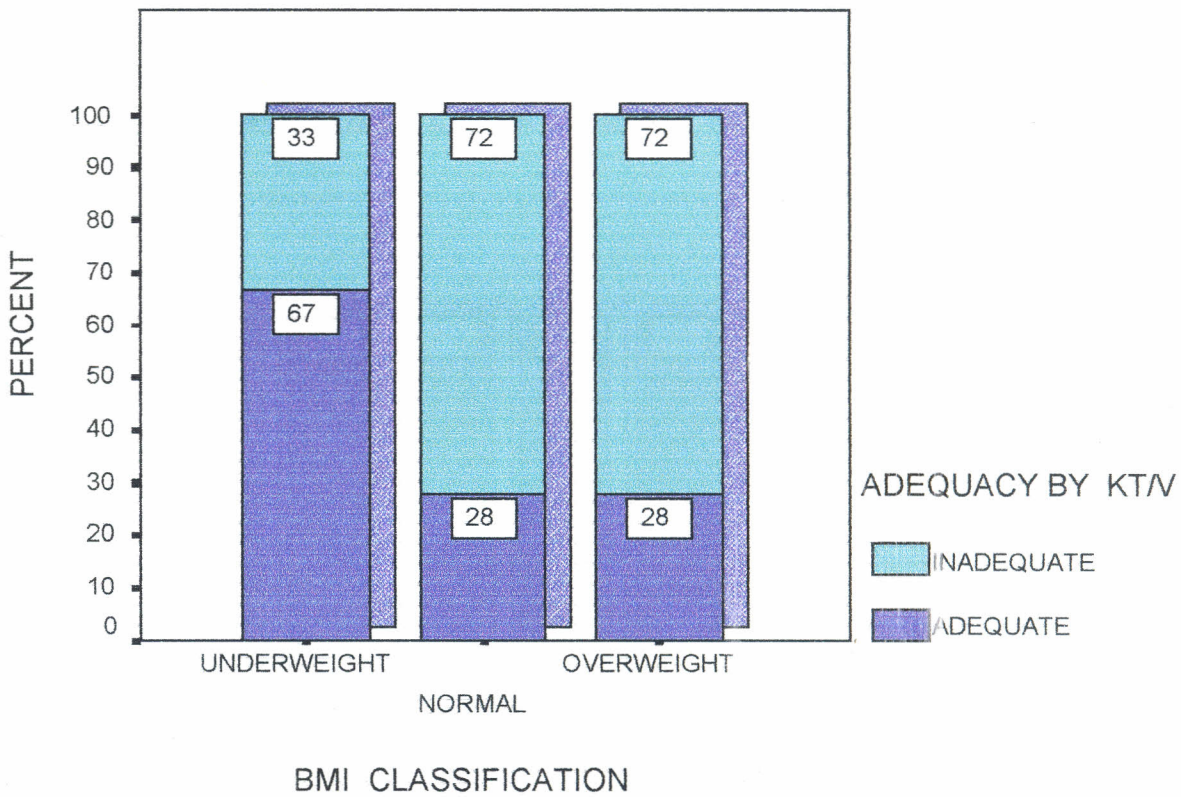
FIGURE 20. THE RELATIONSHIP BETWEEN DURATION AND ADEQUACY OF DIALYSIS (BY Kt/V)



6.9.7. THE ADEQUACY OF HAEMODIALYSIS AND BODY MASS INDEX

Sixty-six point seven percent (66.7%, n=12) of the underweight patients were adequately dialysed using Kt/V. Conversely, 72% of patients with a normal BMI and overweight were under dialysed. (p=0.038). [Figure 21]. Similar observation was found with URR *(p=0.74)*

FIGURE 21. THE RELATIONSHIP BETWEEN ADEQUACY OF DIALYSIS (BY Kt/V) AND BODY MASS INDEX

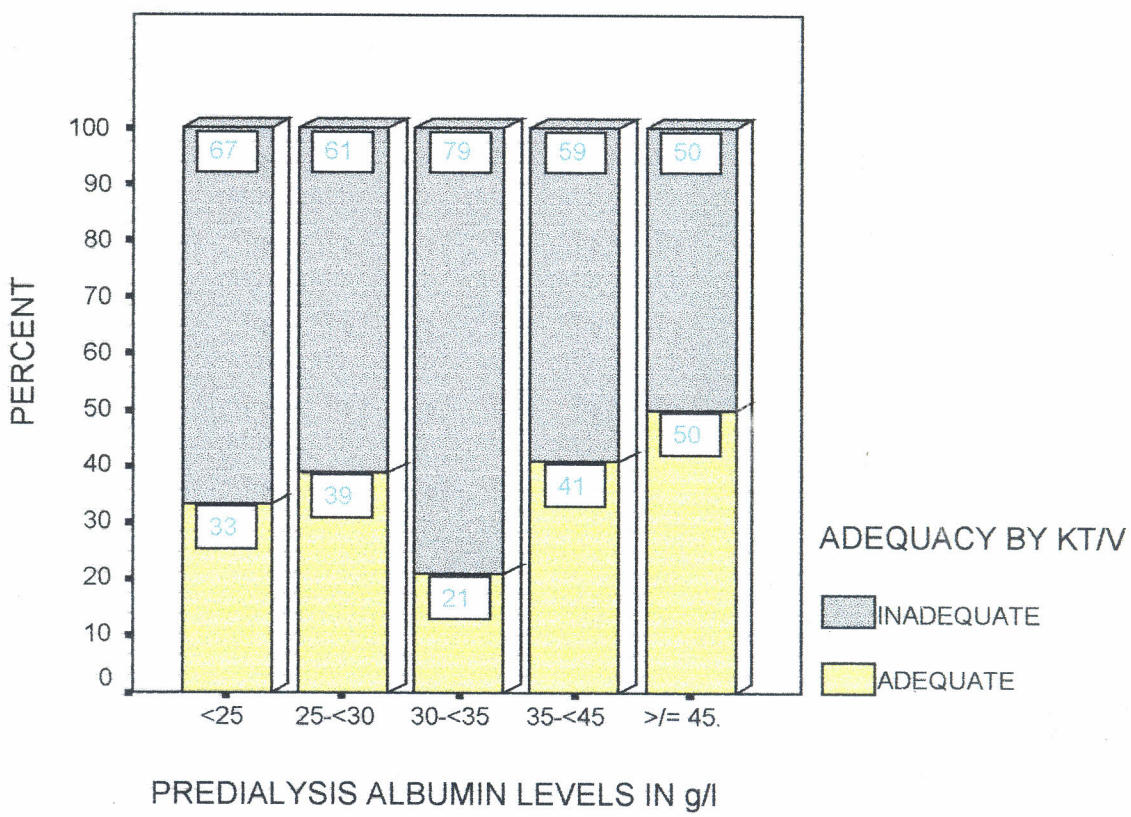


6.9.8. ADEQUACY OF HAEMODIALYSIS AND PREDIALYSIS SERUM ALBUMIN

The mean predialysis albumin level in patients who were adequately dialysed was 34.25 ±6.84g/l as compared to inadequately dialysed patients with mean value of 33.35±5.6g/l. Not statistically significant.

When correlating adequacy (using Kt/v) and Predialysis serum albumin the result is shown in figure 22. No statistically correlation (p=0.335). Similar finding was observed with URR.

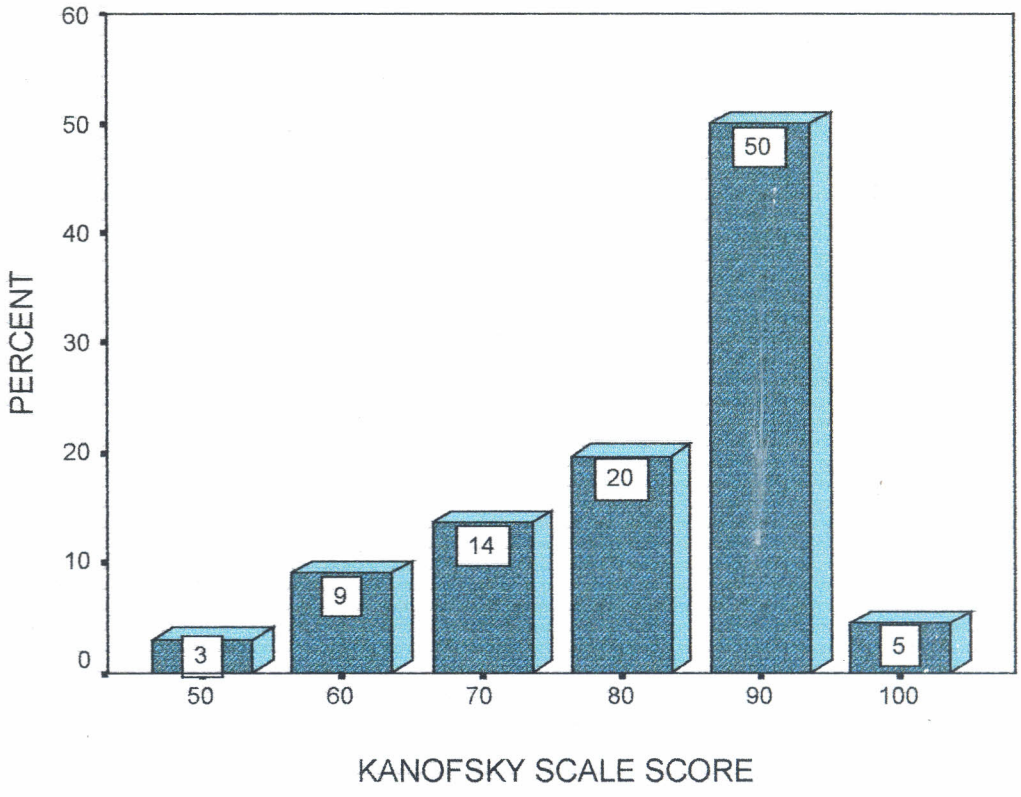
FIGURE 22. THE RELATIONSHIP BETWEEN PRE DIALYSIS ALBUMIN AND ADEQUACY OF DIALYSIS (BY Kt/V)



6.10. KARNOFSKY PERFORMANCE SCALE (KPS)

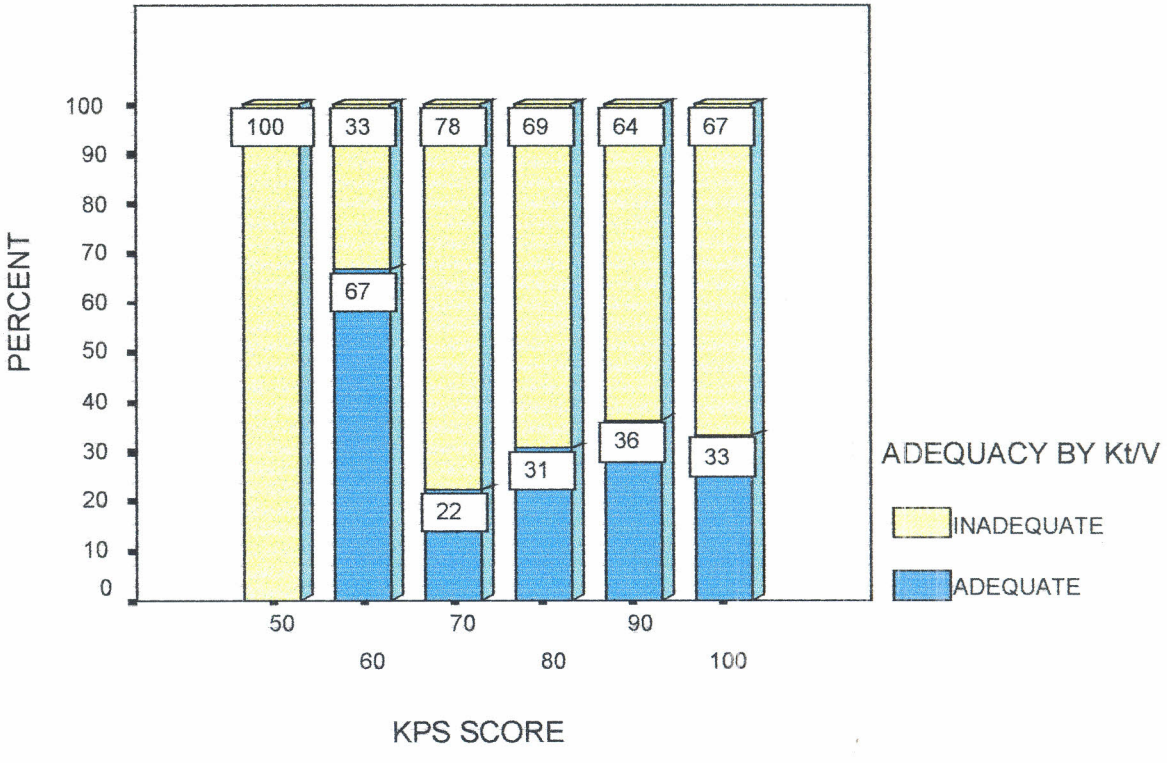
The frequency of distribution of KPS showed that 50% (n=33) of the patients had a score of 90. Figure 23.The mean KPS was 81.82 ± 12.0, with a median of 90. Male patients had a better KPS than females (p=>0.05). A KPS score of 80-100 reflects good functional status of life. Conversely a score of 50-70 reflects poor functional status of life. Therefore 75% of the study population had a good functional status of life

FIGURE 23. FREQUENCY DISTRIBUTION OF KPS SCORE



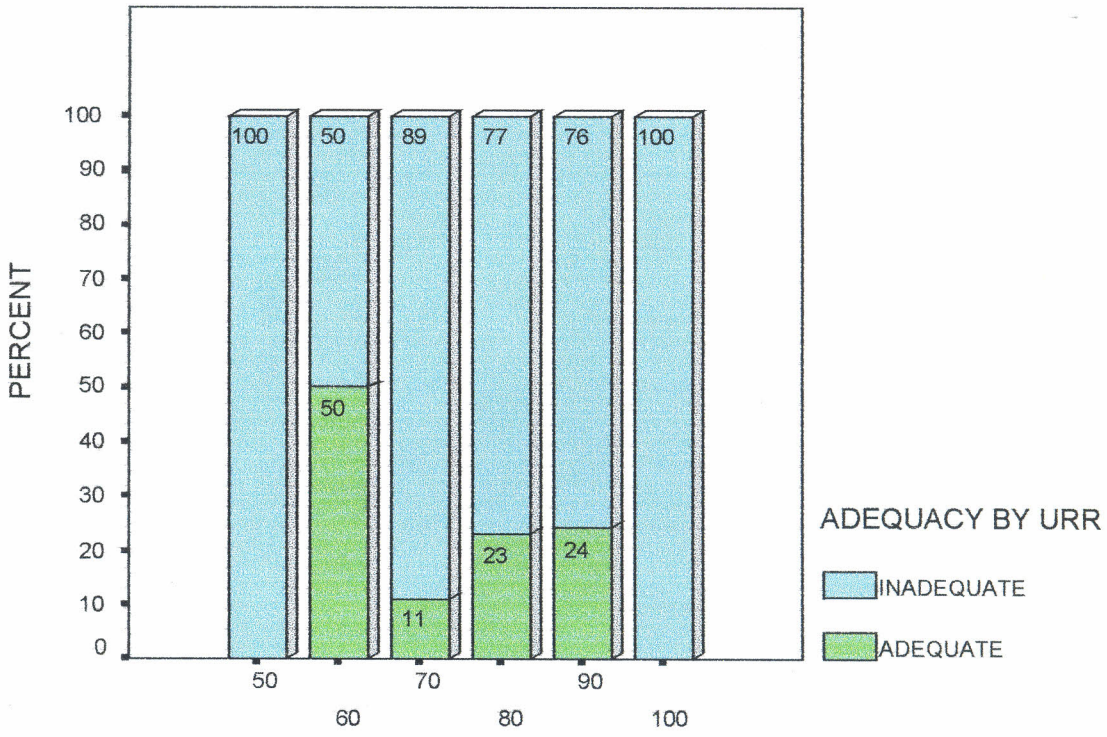
Sixty-six point seven percent of the patients with KPS of 100 were inadequately dialysed using Kt/V, while 100% of the patients with a KPS of 50 were inadequately dialysed (p=0.479). No statistical correlation between adequacy and KPS score. [Figure 24].

FIGURE 24. THE RELATIONSHIP BETWEEN KPS AND ADEQUACY OF HAEMODIALYSIS (BY Kt/V)



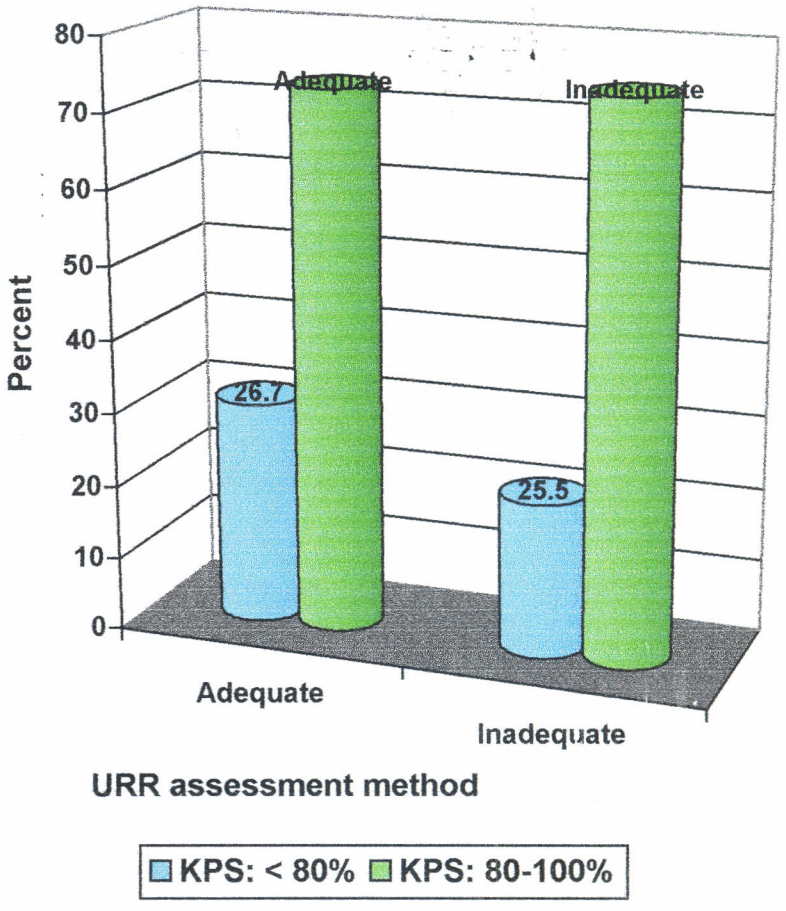
All three patients with a KPS score of100 were inadequately dialysed using URR (p=0.447) (Fig 25).

FIGURE 25. THE RELATIONSHIP BETWEEN KPS AND ADEQUACY OF HAEMODIALYSIS (BY URR)



When correlating patients who had a good KPS score with adequacy of haemodialysis (by URR), 73.3%(n=11) of those with adequate haemodialysis compared to 74.5%(n=38) of those with inadequate haemodialysis had a KPS of 80-100% as shown in Figure 26.

FIGURE 26. THE ASSOCIATION BETWEEN KPS (GOOD vs. POOR SCORE) AND ADEQUACY OF HAEMODIALYSIS (BY URR)

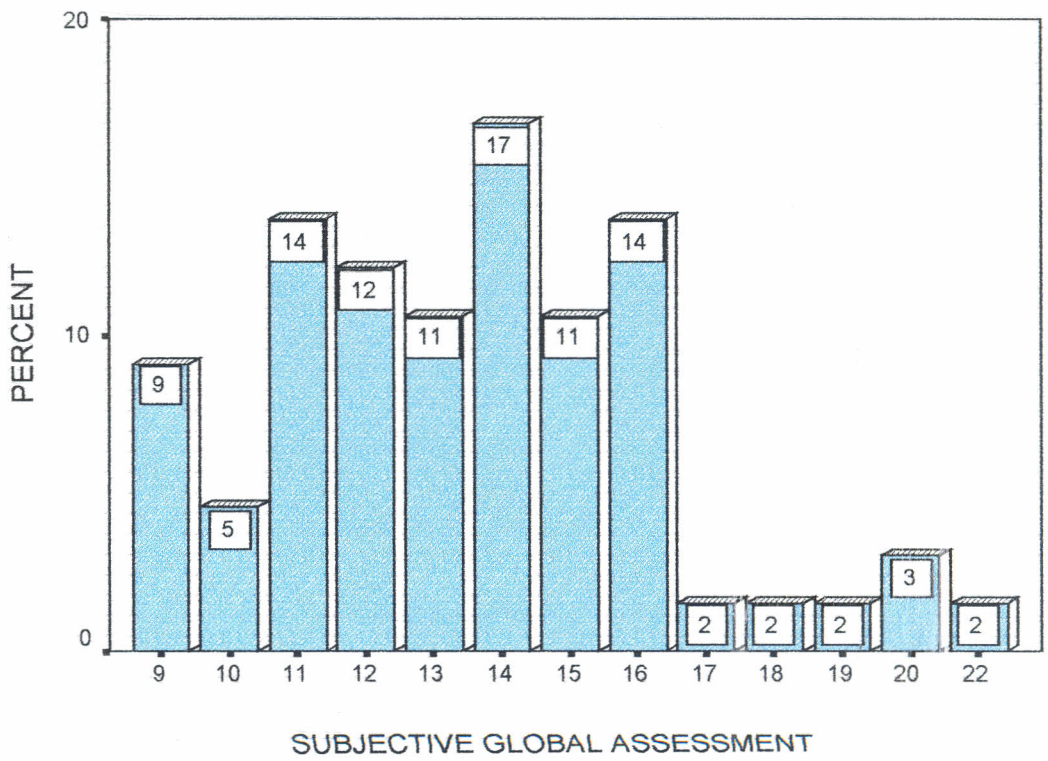


No significant difference in proportions of those with 80-100% KPS was found between the two groups (p = 0.447), indicating KPS is not associated with adequacy of haemodialysis .The Pearson's correlation coefficients (r), between KPS and Kt/v, URR and HDP were –0.039, -0.052 and –0.108 respectively. The coefficients are close to zero indicating lack of significant linear relationship between the variables.

6.11. MODIFIED SGA (mSGA)

The distribution of mSGA score in this study is shown in the Figure 27. The lower the score, the better the well-being and nutritional status of the patients and vice versa. A score of 7 - 8 is normal. Therefore most of the patients studied were malnourished. Fifty percent of the patients had a score of 12-15.

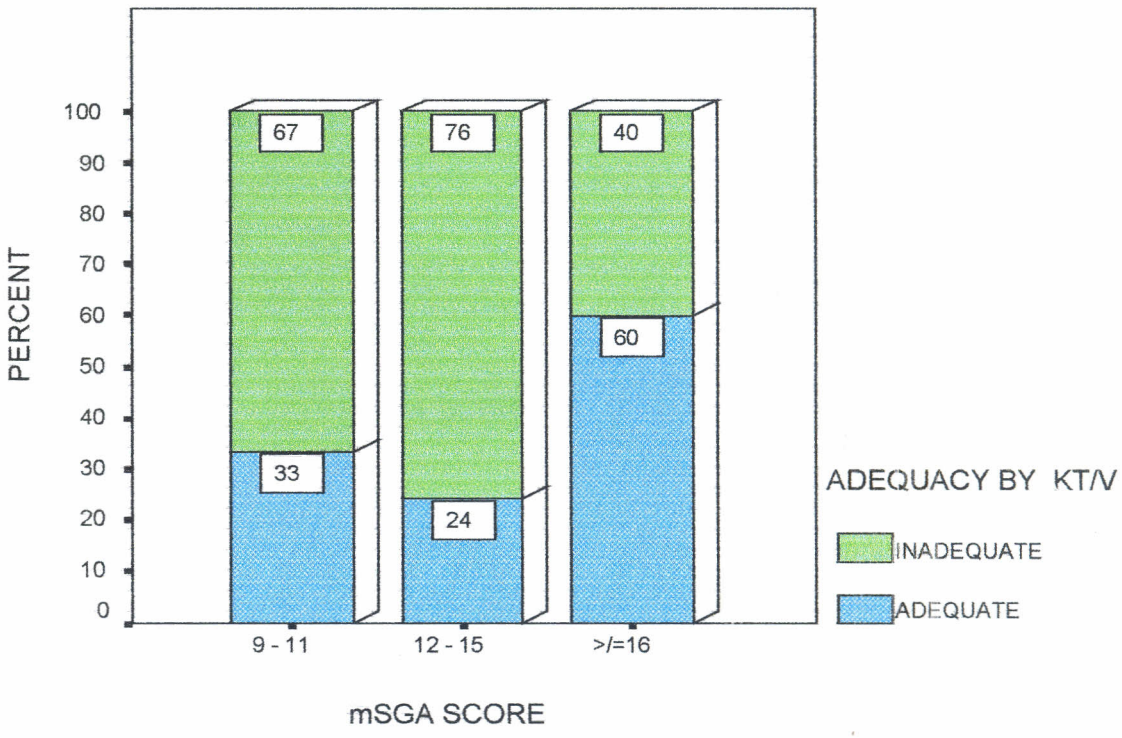
FIGURE 27. FREQUENCY DISTRIBUTION OF MODIFIED SGA SCORE



Thirty three point three percent (n=6) of the patients with an SGA score of 9-11 were adequately dialysed using Kt/v. (p=0.142). Sixty percent (n=9) of the

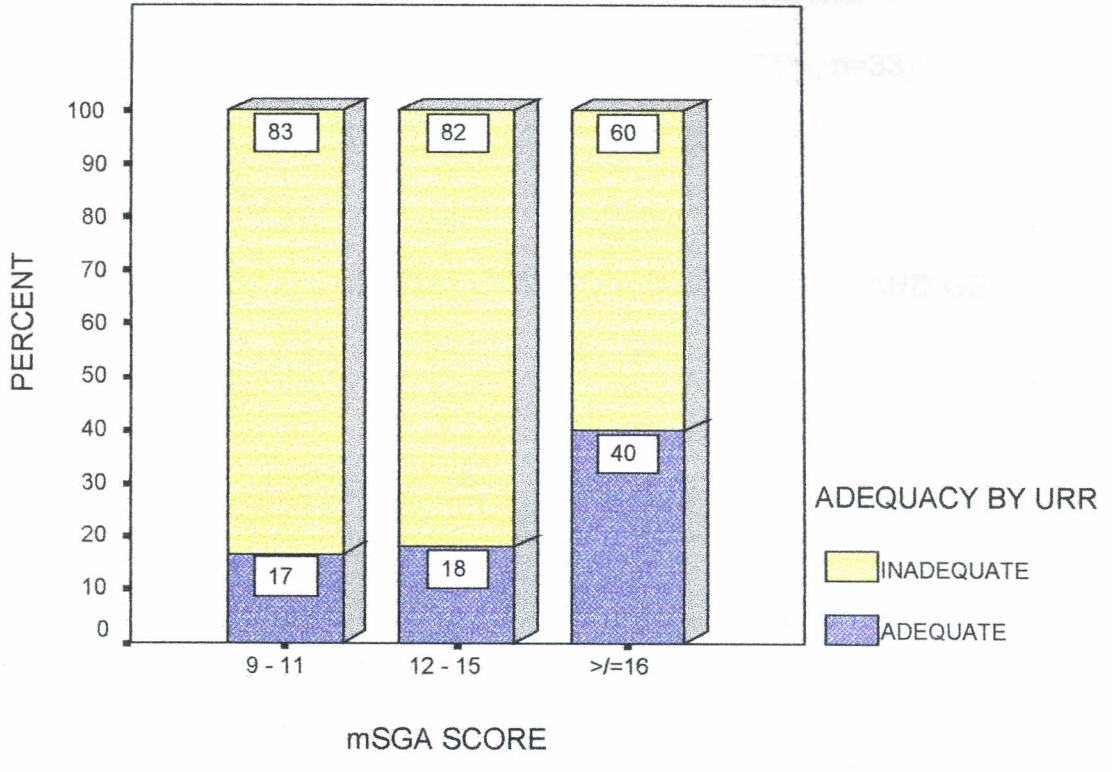
patients who had a score of greater than 16, were adequately dialysed. (Figure 28). The Pearson's correlation coefficients (r), between SGA and Kt/v, and URR were –0.182,and -0.189 respectively. The coefficients are close to zero indicating lack of significant linear relationship between the variables.

FIGURE 28. THE CORRELATION BETWEEN ADEQUACY (BY Kt/V) AND MODIFIED SGA SCORE



A similar distribution was seen with URR readings (p=0.191). [Figure 29]. Therefore, there is no evidence that modified SGA can be used as a surrogate marker for adequacy of dialysis.

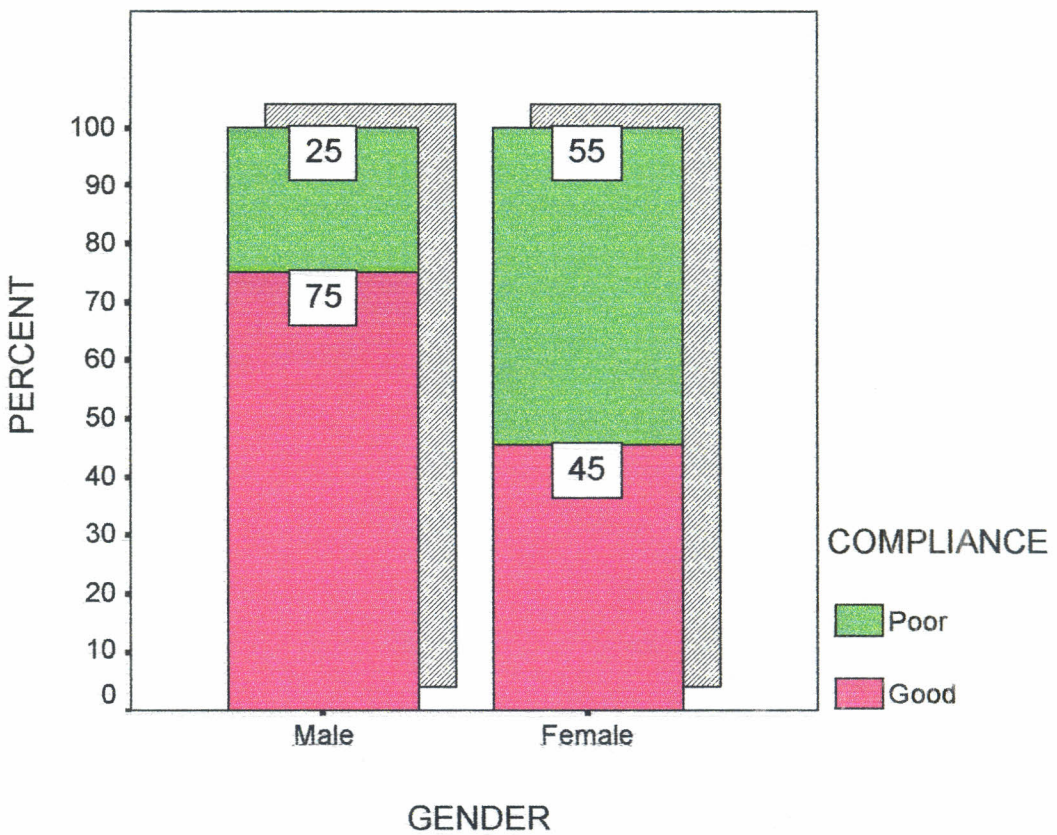
FIGURE 29. THE CORRELATION BETWEEN ADEQUACY (BY URR) AND MODIFIED SGA SCORE



6.12. COMPLIANCE

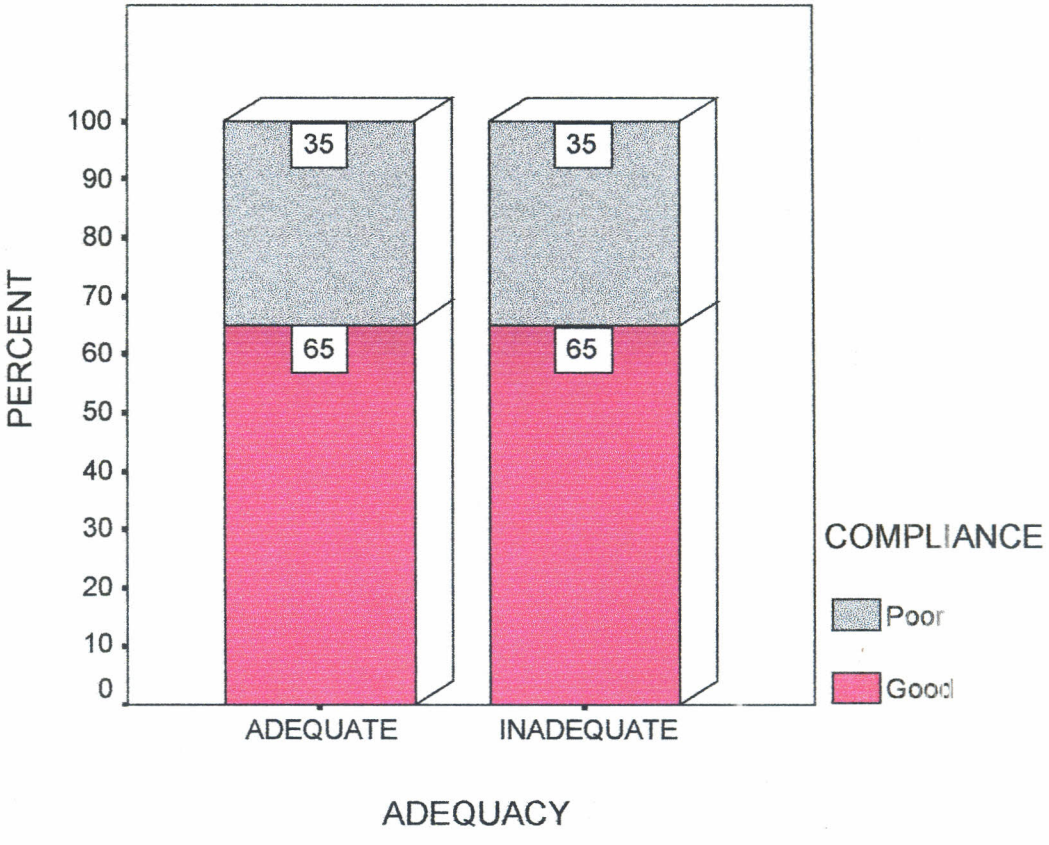
A majority of the patients (65.2%, n=43) had good compliance to their dialysis therapy. The reason for poor compliance was mainly financial (91.3%, n=21), others being distance and transportation. Male patients (75%, n=33) had a better compliance than females (45%, n=11). (p= 0.018).Figure 30.

FIGURE 30. THE RELATIONSHIP BETWEEN COMPLIANCE AND GENDER



Sixty two point five percent (62.5%, n=15) of the young patients were compliant to MHD therapy (p=0.174). Older patients were more compliant than younger patients (71% vs.63%). There was no statistical significant. Sixty five point two percent (65.2%, n=15) of patients who were adequately dialysed using kt/V were compliant to haemodialysis therapy, (P=0.99). Figure 31.

FIGURE 31. THE RELATIONSHIP BETWEEN ADEQUACY (BY Kt/V) AND COMPLIANCE



A similar trend was observed using URR.66.7% (n=10) of patients who were adequately dialysed were compliant (P=0.899).

7. DISCUSSION.

This was a prospective study and entailed evaluating the level of adequacy of haemodialysis in ESRD at KNH. The adequacy of dialysis is important in determining the survival and qualities of life in patients with ESRD.

The predominance of males in this study was a reflection of the sex distribution of patients attending the renal unit at KNH. The cause of this disparity is not apparent. This may reflect a gender difference in health seeking behaviour of the population under study. Other studies revealed a higher proportion of males (73). Data published in 1999 by the USRDS showed that majority of cases of ESRD occurred in men. (138). This disparity of the ratio is unlikely to affect interpretation of the result as the variable of interest i.e. URR and Kt/V and HDP do not have sex specific differences.

Majority of the subjects were older patients. This could be a reflection of an increase incidence of ESRD in older patients (2). Other possible explanation is that haemodialysis therapy could be more affordable to the older patients. The findings were similarly observed in a study done by Frankenfield et al (73).

The mean age of ESRD patients on haemodialysis at KNH is lower than that of Latin American countries (139) and much lower than that of USA (16). Our

younger mean age may be a reflection of Kenya's demographic pattern. Other possible explanations could be due to a higher life expectancy and a better health care system available in these countries. The younger the age of patients on renal replacement therapy, the more the social-economical problems, as these people are in the productive and creative period of age. This could partly contribute to poor compliance of this age group, consequently leading to inadequate dialysis.

Similar to Oduor study (28), we found that the level of adequacy of haemodialysis in KNH was much lower as compared to other countries like Egypt (81) and USA (41). In Oduor study, only 20% of the patients were adequately dialysed by using Kt/V (28). This low level of adequacy of haemodialysis in KNH reflects the level of adequacy of dialysis found in USA in the year 1993, where 36% of the patients achieved adequate dialysis (37,40). Presently the level of adequacy of dialysis in other haemodialysis centers (in USA) approaches 85% (140). This illustrate that, we need to improve the haemodialysis adequacy in our set-up, so as to achieve the present USA adequacy level.

The disparity in assessing adequacy of dialysis using Kt/V and URR is in keeping with the DOQi guidelines, which states that the efficacy of URR in individual patients is more limited (34,59). Although Kt/V is the gold standard method of assessing adequacy of dialysis, our study found that there was a strong statistical correlation between Kt/V and URR. They are mathematically linked, so

that they are directly derivable, one from another. There is no evidence that one is better than the other in terms of patient outcome (54,57,59). Since URR is the simpler method to execute, its sole use in assessing adequacy of dialysis is justified. The more likely standard of adequacy in the future is URR (76). In view of the fact that the current clinical practice guidelines from the RPA's and the National Kidney Foundation (NKF) recommends that the delivered dose of haemodialysis should be measured at least once a month in all adults (67). Thus it is worthwhile to use URR monthly in assessing adequacy of dialysis, so that we can individualise the haemodialysis prescription in our renal unit. Kt/V should be reserved less often because of its complexity in calculation.

Scribner et al (56), proposed HDP as a better way of assessing adequacy of dialysis as compared to Kt/V or URR. This new index incorporates dialysis frequency, which is the most important variable. The HDP takes into account the very positive results that have been obtained with more frequent dialysis by Bonomini et al (141) and Lockridge et al (142). Majority of our patients use a twice-weekly schedule. Interestingly all patients in this study had a HDP of less than 45 indicating inadequacy of haemodialysis. This may either indicate the need to increase the frequency of dialysis in our patient or the limitation of HDP as a marker of adequacy in our set up. However the latter is more likely, considering the low sensitivity and specificity of HDP. Also the frequency of dialysis is not the sole determinant of adequacy of haemodialysis and the lower values of HDP have not been validated especially for twice weekly dialysis

regime. There was no statistical correlation between HDP and URR or Kt/V. Therefore HDP is not a useful method in our set-up in assessing adequacy of haemodialysis.

Knowledge of patient related risk factors for inadequate delivery of haemodialysis would be helpful to select patient's subgroups for intensive control of dialysis adequacy. Our data suggest that male, older and overweight patients may require more intensive dialysis to achieve greater clearance.

Frankenfield et al (73) and Kuhlmann et al (143) found a similar result; that females were significantly better dialysed than males. The exact reasons for the above gender disparity are not well understood but could be due to the fact that, male patients have a greater body mass than females for a given weight, then they also have a large urea distribution volume. Another possible contributory factor could be due to a large muscle mass in males, thus a large urea distribution volume resulting in a low URR or Kt/V.

Contrary to the study by Frankenfield et al (73), who found that younger patients were more likely to be inadequately dialysed, our study revealed otherwise. They attributed the inadequate dialysis in younger patients to greater muscle mass and lower compliance. The apparent reason was not found in our study. However, it was noted that majority of the underweight patients were adequately dialysed and since two-thirds of the underweight patients were younger, this may tend to

partly contribute to the apparent higher adequacy of dialysis in the younger patients. Frankenfield et al (73) observed that heavy patients have lower Kt/V than needed to achieve the desired URR level. A strong statistical association was observed between body weight and URR. The weight of the patient with ESRD is a confounding variable for the delivery of an adequate haemodialysis dose. Heavier patients may have a larger urea distribution volume that result in a lower URR, if not balanced by sufficiently higher Kt. "Big body" patients were more likely to be inadequately dialysed and vice versa (143).

The high level of inadequacy associated with once and twice weekly dialysis schedule was expected as per DOQI guidelines (22,42). That's why we need to increase the frequency of dialysis per week in our set-up. Interestingly, contrary to the DOQI guidelines, the thrice-weekly session patients did not show an increase in the adequacy of dialysis. These patients on thrice weekly are so treated due to problems of malnutrition or other concurrent problems like infection. Sub-analysis of the patients who underwent thrice-weekly dialysis was not possible because of the small number (n=3).

Similar to findings in our study, Athenkul at el found a higher Kt/V in patients with permanent tunneled cuffed catheter inserted in the internal jugular (144). This could be explained by the fact that the subclavian dual lumen catheters have higher chances of thrombosis and stenosis leading to sub optimal angioaccess and compromised blood flow. Also other contributory factor includes some

limitation in maximum blood flow achievable through the double lumen catheter. Interestingly, majority of the patients with Arterio-Venous fistulae were inadequately dialysed. This is contrary to a report which showed that a higher percentage of patients dialysed with Arterio-Venous fistula had a higher mean delivered Kt/V compared to patient's dialysed with a catheter (140). Possible explanations are that fistulae are associated with a higher degree of recirculation and stenosis, which lead to haemodynamic interference, thus low level of adequacy of haemodialysis. However, sub-analysis could not be done, since the numbers of patients with Arterio-Venous fistulae were small.

Rocco et al (145) found that the adequacy increases with duration of haemodialysis. This is contrary to our study that found no correlation between duration and adequacy of haemodialysis due to fewer patients undergoing dialysis for more than a year. A possible explanation for this finding is that patients receiving haemodialysis for less than one year may have significant residual renal function. Alternatively, the higher adequacy levels observed for patient treated for two years or more may be a consequence of the decreased muscle mass observed as a patient's vintage on haemodialysis increases. This finding was not observed in our study due to fewer patients undergoing dialysis for more than a year.

Some investigators suggest that augmentation of urea clearance will improve a patient's nutritional status (146). We did not find this to be the case in our study,

and the correlation between the adequacy of dialysis and nutritional status (as measured by serum albumin concentration) was not significant. A similar finding was observed in Oduor study (28). Certainly, the persistence of a low serum albumin concentration despite an increased URR or Kt/V could have been due to many factors other than malnutrition, including hepatocellular dysfunction, hypovolaemia, and exposure to pyrogenic cytokines. 40% of hypoalbuminic patients in our study had a positive CRP. Owen et al revealed a weak correlation between adequacy of dialysis and predialysis serum albumin (30). .

Even though there was a lack of significant linear relationship between the *adequacy of haemodialysis and functional status of life as measured by KPS*, patients with a score less than 50 were more likely to be inadequately dialysed. The lack of correlation could be explained due to increased subjectivity in measurement of KPS. This scale depends, on patient perception of severity of the illness, age and other comobidity of the patients, and also the interviewer. Hutchinson et al found similar scientific problems in clinical scales, as demonstrated by the Karnofsky index of performance status (127). A single determinant of KPS score may have not reflected the long-term measures of functional status of life.

Like in our study, Kalantas et al showed that there was no correlation between the modified SGA score and adequacy of dialysis (112). This finding was also confirmed in Oduor study (28). A possible reason is that modified SGA is

subjective (depend on patient recall), and its sensitivity, precision, and reproducibility over time have not been extensively studied in maintenance haemodialysis patients. Therefore modified SGA cannot be used as a surrogate marker of adequacy of dialysis.

Compliance is undoubtedly an important issue in ESRD patients on haemodialysis. The majority of the patients in our study had good compliance to the haemodialysis prescription. The main reason for those with poor compliance was financial constraints. Others reasons being long distances between the patient's residence and the hospital and transportation to and from the hospital. Similar to our findings, Bame et al shows that older patients were more compliant than the younger ones (147). There was no statistical correlation between compliance and adequacy, but a pattern was observed showing presence of good compliance, was associated with higher level of adequacy of dialysis.

8. LIMITATION OF THE STUDY

1. Inspite of recruiting all patients on maintenance haemodialysis, the sample size was insufficient for sub-analysis. A prospective study with large sample size would obviate this.

2. Constraints on the data collection. Patient medical records from the file were usually incomplete. This could have been avoided if there was proper documentation and filing system in our renal unit.

3. Modified SGA and KPS are dependent on patient recall, which may have been inaccurate. In addition both KPS and modified SGA have not been validated in our set-up.

4. Haemodialysis is a continuous process. A single point determinant of adequacy (by of Kt/V or URR) may not reflect the overall dialysis status. The average of at least two values of Kt/V or URR measured within one month (at least one week apart) would have been a better reflection of adequacy of dialysis.

5. Modified SGA is affected by parameters such as albumin level and nutrition.

9. CONCLUSIONS

1. Total level of adequacy of haemodialysis patients are still very low compared to other Haemodialysis Centres in the world. Therefore there is an urgent need to address the issue of inadequacy of haemodialysis.

2. HDP was not useful in our set-up in assessing haemodialysis adequacy.

3. Gender, age, BMI and vascular access influenced the level of adequacy.

4. SGA cannot be used as a surrogate marker to assess haemodialysis adequacy.

10. RECOMMENDATION:

1. A larger prospective study should be carried out to assess the adequacy of haemodialysis with large number of patients undergoing twice and thrice-weekly sessions.

2. Larger prospective study should be carried out to assess the risk factors of inadequacy of haemodialysis in our renal unit.

3. The use of URR is a convenient and effective method of assessing adequacy of dialysis.

4. Larger prospective study should be carried out to assess adequacy of dialysis in patients with A-V fistulae in our set up.

5. Individualise the haemodialysis prescription dose in our renal unit

6. Regular measurement of adequacy of dialysis in our renal unit as per the DOQI guidelines.

7. The Government, with the collaboration of the hospital administration should work out modalities such that haemodialysis becomes more affordable to the patients.

8. Since our twice-weekly dialysis schedule is associated with high level of inadequacy, and our patients are financially constrained it should be thought of primarily as a transitional treatment strategy measure. (Resuscitation and stabilisation build up to early kidney transplantation).

11. APPENDICES

11.1 APPENDIX I

INFORMED CONSENT

This is to certify that my participation in this study of haemodialysis adequacy in ESRD is entirely voluntary; and I am free to refuse to take part or withdraw at any given time without affecting or jeopardizing my future medical care. The information obtained in this study will be considered confidential and used for research purpose. My identity will be kept confidential in so far as the law allows. If I agree to participate the following things will happen:

1. I will answer some question about my medical history.
2. I will have an ordinary physical examination.
3. I will have blood drawn with a needle from my arm for measuring BUN and other test. The needle often causes discomfort lasting less than a minute; occasionally a bruise or minor infection may occur, but these are very unlikely.

Patient signature.....

Date.....

Investigation Officer.

Signature.....

Date.....

11.2 APPENDIX II

METHOD FOR PERFORMING ANTHROPOMETRY

Anthropometry comprises a series of non-invasive, inexpensive, and easy-to-perform methods for estimating body composition. The Anthropometric measurements used will be BMI.

1. BMI

BMI is calculated by dividing weight (in kilograms) by height squared (in meters).

I.e. **$BMI = Wt/h^2$.**

Standing height will be measured once to the nearest 0.5 cm, without shoes, he back square against the wall tape, eyes looking straight ahead, with a set square resting on the scalp and against the wall. Weight will be measured once with a lever balance to the nearest 100 grams without shoes, in light garments.

BMI will be classified according to the WHO classification

The WHO grading of BMI (148):

BMI (Kg/m^2)	Grading
<20	Underweight
20 – 24.9	Normal
>25	Overweight

11.3 APPENDIX III

METHODS FOR MEASURING SERUM ALBUMIN

Most laboratories utilize a calorimetric method for the measurement of the serum albumin concentration and particularly the bromocresol green (BCG) assay. Nephelometry and the electrophoretic (149) method are very specific for the determinant of the serum albumin concentration. However, these methods are time consuming, expensive and not generally used in clinical laboratories. The BCG colorimetric method is rapid, reproducible and has been automated (150). The normal range for the serum albumin by the BCG method is **35-45g/l** Predialysis albumin level between 30-35 signifies mild malnutrition while less than 25 suggest severe malnutrition (99). The BCG method differs from the electrophoretic method by about 0.3g (149). The BCG method underestimates albumin in the high normal range and overestimates albumin below the range with an overall mean overestimated of approx 0.61g/dl (150). Some laboratories use the bromcresol purple (BCP) colorimetric method to measure the serum albumin concentration (149,150).

11.4 Appendix IV

A MODIFIED SGA

It consists of patient related medical history and physical examination.

There are seven items currently being used to assess nutritional status (105):

A. HISTORY

1.weight change over the past 6 months

Scores:

No weight change or gain	1
Minor weight loss <5% *(mild)*	*2*
Weight loss 5- <10% *(moderate)*	*3*
Weight loss 10 - <15% *(severe)*	*4*
Weight loss > 15% *(severest)*	5

2. Dietary intake

Dietary intake is evaluated and includes a comparison of the patient's usual and recommended intake to current intake.

Scores:

No change	1
Sub-optimal solid diet	2
Full liquid diet or moderate overall decrease	3
Hypo-caloric liquid	4
Starvation	5

3. Gastrointestinal symptoms:

Scores:

No symptoms	1
Nausea	2
Vomiting	3
Diarrhoea	4
Severe anorexia	5

4. Functional capacity (nutritionally related functional impairment)

Scores:

None (improved)	1
Difficult with ambulation	2
Difficult with normal activity	3
Light activity	4
Bed/chair-ridden with no a little activity	5

5. Co-morbidity

Scores:

Dialysis <12 months and healthy otherwise	1
Dialysis 1-2 years or mild commodity	2
Dialysis 2-4 year or age >75 or moderate co-morbidity	3
Dialysis > 4 years or severe co-morbidity	4
Very severe multiple co morbidity	5

B. EXAMINATION

Physical examination includes an evaluation of the patient's subcutaneous tissue (for fat and wasting and muscle mass).

1. Subcutaneous fat

It can be assessed by examining the fat pad directly below the eye and by gently pinching the skin above the triceps and biceps. The fat pads should appear as a slightly bulge in a normally nourished person but are "hollow" in a malnourished person. When the skin above the triceps and biceps is gently pinched, the thickness of the fold between the examiners finger is indicative of the nutritional status. The examiner then scores the observations on a five-point scale. Decreased fat store or loss of subcutaneous fat (below eye, triceps and biceps.

Scores:

No change	1
Mild	2
Moderate	3
Moderate – Severe	4
Severe	5

2. Muscle Fat

Muscle mass and wasting can be assessed by examining the temporalis muscle, the prominence of the clavicle, the contour of the shoulders (rounded indicates well nourished, square indicates malnutrition), visibility of the scapula, the visibility of the ribs and the interosseous muscle mass between the thumb and forefinger, and the quadriceps muscle mass. These are also scored on a 5-point scale. Signs of muscle wasting are examined in the temple, clavicle, scapula, ribs, quadriceps, interosseous and knee.

Scores:

No change	1
Mild	2
Moderate	3
Moderate – Severe	4
Severe	5

TOTAL SCORE:	7-11	NORMAL
	12-15	MILD MALNUTRITION
	16-25	MODERATE MALNUTRITION
	26-35	SEVERE MALNUTRITION

11.5 APPENDIX V

RECOMMENDED METHOD FOR PRE-DIALYSIS BUN

Recommended method when utilizing an arterio-venous fistula or graft (16):

1. *Blood specimen is obtained from the arterial needle prior to connecting the* arterial blood tubing or flushing the needle. There should be no saline and/or heparin in the arterial needle and tubing prior to drawing the sample for BUN measurement. This will prevent dilution of the blood sample.
2. Blood sample for use of predialysis measure of BUN should not be drawn if haemodialysis has been initiated or if saline or heparin is present in the line.
3. Blood sample for use of predialysis measure of BUN should not be drawn if haemodialysis has been initiated or if saline or heparin is present in the line.

Recommended method when utilizing a venous catheter

1. Withdraw any heparin and saline from the arterial port of the catheter. This prevents dilution of the sample.
2. Withdraw 10ml of blood from the arterial port of the catheter.
3. Connect a new syringe and draw the sample for BUN measurement.
4. Complete initiation of haemodialysis per dialysis unit protocol.

11.6 APPENDIX VI

POST DIALYSIS BUN SAMPLE: SLOW FLOW SAMPLING METHOD

The Recommended method of post dialysis blood sample is the slow flow. This method supports the use of formal UKM to quantitate the delivered dose of haemodialysis.

Method:

1. At the completion of haemodialysis, turn off the dialysate flow and decrease the ultra filtration rate (UFR) to 50ml/h, or to the lowest transmembrane pressure (TMP)/UFR settings, or off. If the dialysis machine does not allow for turning off the dialysate flow, or if doing so violates unit policy, decrease the dialysate flow to its minimum setting.
2. Decrease the blood flow to 50-100ml/h for 15 seconds. To prevent pump shut off, as the blood flow is reduced, it may be necessary to manually adjust the venous pressure limits downward.
3. With the blood pump still running at 50-100ml/min, draw the blood sample for
4. Post dialysis BUN measurement from the arterial sampling port closest to the patient.
5. Stop the blood pump and complete the patient disconnection procedure as per dialysis unit protocol.

11.7.Appendix VII

Karnofsky performance index (134)

	%	
Able to carry on normal activity. No special care is needed.	100	Normal. No complaints. No evidence of disease.
	90	Able to carry on normal activity. Minor signs or symptoms of disease.
	80	Normal activity with efforts. Some signs or symptoms of disease.
Unable to work. Able to live at home and care for most personal needs. A varying amount of assistance is needed.	70	Cares for self. Unable to carry on normal activity or to do active work.
	60	Requires occasional assistance but is able to care for most of his needs.
	50	Requires considerable assistance and frequent medical care.
Unable to care for self. Requires equivalent of institutional or hospital care. Disease may be progressing rapidly.	40	Disabled. Requires special care and assistance.
	30	Severely disabled. Hospitalisation is indicated, although death is not imminent.
	20	Very sick. Hospitalisation necessary.
	10	Moribund. Fatal processes progressing rapidly.
	0	Dead.

11.8.APPENDIX VIII

STUDY PROFORMA

1. SOCIO DEMOGRAPHIC DATA

Name..... Date.....

Code no..... Outpatient no .....

Age..... Residence.....

Gender ..... Race/Tribe.....

Educational level

Primary ..... Secondary..... Tertiary.....

Others, specify.....

Occupation .....

II NUTRITIONAL DATA:

A) HISTORY

1. **Weight change:**

- Current (weight).....
- Six month ago (weight).....
- Percentage weight change.....
- During the past 2 weeks weight has
  - Decreased
  - Not changed
  - Increased

2. Dietary intake:

As compared to patient's normal intake, the rate of food intake during the past month has been:

- ❑ Unchanged
- ❑ More than usual
- ❑ Less than usual
- ❑ Much less than usual

Patient is at present taking

- ❑ Little solid food
- ❑ Only liquids
- ❑ Only nutritional supplements
- ❑ Very little of anything (starvation)
- ❑ Normal food

3. Symptoms:

Gastrointestinal symptoms during the past 2 week the patient has been experiencing the following problem:

- ❑ No appetite
- ❑ Nausea
- ❑ Constipation
- ❑ Mouth sores (chellitis)
- ❑ Vomiting
- ❑ Diarrhoea
- ❑ Severe anorexia
- ❑ No symptoms

4. Functional capacity: (nutritionally related functional impairments over the past month, the patient activity can be rated as generally:

- ❑ Normal, with no limitations
- ❑ Not his/her normal self, but able to participate in fairly normal activities (difficult with ambulation activity).
- ❑ Patient's moral is very low and tends to spend <50% of his/her days in bed.
- ❑ Patient is able to do little activity and spend most of the day in bed or chair (light activity).
- ❑ Patient mostly bedridden, rarely out of bed.

5. Comorbidity:

- ❑ Dialysis less than 12 months and healthy otherwise.
- ❑ Dialysis 1-2 years or mild comorbidity.
- ❑ Dialysis 2-4 years or age> 75 or moderate comorbidity.
- ❑ Dialysis > 4 years or severe comorbidity.
- ❑ Very severe multiple comorbidity.

6. Stressors metabolism:

Patient has been experiencing a fever within the last 10 days that was:

- ❑ Higher than 37.2□ C but less than 38.0□ C
- ❑ Higher than 38.0□ C but less than 39.0□ C
- ❑ Higher than 39.0□ C

If patient had a fever, how long did it last?

- ❑ Less than 72 hours
- ❑ More than 72 hours

The patient is on steroid medication:

- ❑ Yes
- ❑ No

B) EXAMINATION

General condition. Good..... Fair..... Poor.....

Pallor Yes..... No.....

Jaundice Yes..... No.....

Oedema Yes..... No.....

Chellitis Yes..... No.....

Others specify, ...

Subcutaneous fat store or loss of subcutaneous fat (below eye, triceps, biceps, chest).

Yes..... No.....

If yes, specify: Mild..... Moderate..... Severe.....

Muscle wasting (sign of muscle wasting in temple, clavicle, scapula, knee, ribs, quadriceps, interosseous)

Yes..... No.....

If yes, specify as, Mild.....Moderate..... Severe.....

C) MODIFIED SGA (malnutrition score)

(A) Patients related medical history:				
1- Weight change (overall change in past 6 months)				
1	2	3	4	5
No weight change or gain	Minor Wt loss (<5%)	Wt loss 5 to 10 %	Wt loss 10 to 15%	Wt loss > 15% in
2- Dietary intake				
1	2	3	4	5
No change	Sub-optimal solid diet	Full liquid diet or moderate overall decrease	Hypo-caloric liquid	Starvation
3- Gastrointestinal symptoms				
1	2	3	4	5
No symptoms	Nausea	Vomiting or moderate GI symptoms	Diarrhoea	Severe anorexia

4- Functional capacity (nutritionally related functional impairment)

1	2	3	4	5
None (improved)	Difficulty with ambulation	Difficulty with normal activity	Light activity	Bed/chair-ridden with no or little activity

5-Co-morbidity

1	2	3	4	5
Dialysis<1 2 months and healthy otherwise	Dialysis 1-2 yrs or mild co morbidity	Dialysis 2-4 yrs or age>75 or moderate co-morbidity	Dialysis>4 yrs or severe co-morbidity	Very severe multiple co morbidity

(B) Physical Exam:

1- Decreased fat stores or loss of subcutaneous fat (below eyes, triceps, biceps, chest)

1	2	3	4	5
None (no change)		Moderate		Severe

2- Signs of muscle wasting (temple, clavicle, scapula, ribs, quadriceps, knee, interosseous)

1	2	3	4	5
None (no change)		Moderate		Severe

Malnutrition Score: (sum of all number)	

Normal	**7-11**
Mild malnutrition	**12-15**
Moderate malnutrition	**16-25**
Severe malnutrition	**26-35**

III) ANTHROPOMETRIC MEASUREMENTS:

- **Weight** – Pre dialysis weight (wt).....

  -Post dialysis weight (w).....

- **Height** .....

- **BMI** (weight/height^2).....

IV) DIALYSIS DATA:

1. **Cause of ESRD**

   - Hypertension
   - Diabetes
   - Glomerulopathy
   - Obstructive uropathy
   - Others, specify

2. **Duration of dialysis**.....

3. Vascular access

- ❑ Fistula
- ❑ Sc catheter
- ❑ Perm catheter
- ❑ Other, specify.....

4. Frequently (dialysis schedule)

- ❑ Once weekly
- ❑ Twice weekly
- ❑ Thrice weekly
- ❑ Daily
- ❑ Other, specify.....

5. Dialysate

Type.....

Flow Rate.....

Re use: Yes..... No.....

6.0 Membrane biocompatible

Yes..... No.....

If yes, specify.....

7. Type of Dialysis machine .....

8. Ultra filtration

Volume (UF) .....

Rate .....

9. Dialysis time (T).....

10. Blood Pressure (BP)

Predialysis BP .....

Postdialysis BP.....

11. Compliance

- ❑ Good .....
- ❑ Poor.....

If poor, is it:

- ❑ Missed schedule
- ❑ Premature termination
- ❑ Others specify.....

Causes of Poor Compliance:

- ❑ **Lack of education** Yes.....No.....

  If, yes specify.....

- ❑ **Medical reasons** Yes..... No.....

  If yes, specify.....

  - ○ Cramps
  - ○ Interdialytic hypotension
  - ○ Feeling sick
  - ○ Others, specify.....

- **Psychological problem** Yes.....No.....

If yes specify.....

- **Socio economical reason** Yes.....No.....

If yes, specify is it due to:

  - Financial Constraints
  - Transportation problems
  - Distance to the hospital
  - Availability of dialysis therapy
  - Others.....

- **Others** .....

V. Kanofsky performance scale (KPS); the patient will be question and examined for;

QUESTION: C0LUMN A	%	**ANSWER: COLUMN B**
1.Able to carry on normal activity. No special care is needed.	100	Normal. No complaints. No evidence of disease.
❑ Yes. .....Specify as (.Answer in column B)	90	Able to carry on normal activity. Minor signs or symptoms of disease.
❑ NO .....Then proceed to question 2).	80	Normal activity with efforts. Some signs or symptoms of disease.

2. Unable to work. Able to live at home and care for most personal needs. A varying amount of assistance is needed. ❑ Yes...Specify as (.Answer in column B) ❑ NO .....Then proceed to question 3).	70	Cares for self. Unable to carry on normal activity or to do active work.
	60	Requires occasional assistance but is able to care for most of his needs.
	50	Requires considerable assistance and frequent medical care.
3.Unable to care for self. Requires equivalent of institutional or hospital care. Disease may be progressing rapidly. ❑ Yes. .....Specify as (.Answer in column B)	40	Disabled. Requires special care and assistance.
	30	Severely disabled. Hospitalisation is indicated, although death is not imminent.
	20	Very sick. Hospitalisation necessary.
	10	Moribund. Fatal processes progressing rapidly.

VI) LABORATORY

Time Blood drawn .....

Pre dialysis urea (**Co**).....

Post dialysis urea (**C**t).....

Predialysis albumin.....

Predialysis creatinine .....

CRP .....

HIV.....

VII) CALCULATIONS

1. URR = 100 x (1 – R)

R *(Ct/Co)* = ...

∴ URR =.....

2. Kt/V = -ln (R – 0.008 x t) + (4 – 3.5 x R) x UF/W

R *(Ct/Co)* = ...

t =.....

UF =.....

W =

∴ **Calculated Kt\V =** .....

3. HDP= (hours/dialysis session) × (session/week) ²

Hours/session .....

Session/ week.....

∴ **HDP**=.....

12. REFERENCES:

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