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Assessment of Adequacy of Hemodialysis and Nutritional Status in Patients on Maintenance Hemodialysis at Dialysis Centre Sheikh Zayed Hospital Rahim Yar Khan

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ABSTRACT

Background: In patients suffering from ESRD quality of life can be maintained by hemodialysis, CAPD or renal transplant. Adequate dose of hemodialysis is necessary for good quality of life. The hemodialysis adequacy is one of the most important issues influencing the survival of patients on maintenance hemodialysis.

Aim: To compare Kt/V measurement by online clearance module with conventional enzymatic urea analysis method and to compare the nutritional status of patients who are adequately dialyzed with those who are inadequately dialyzed.

Design: Cross sectional observational study.

Setting: Department of Hemodialysis and Nephrology, Sheikh Zayed Hospital, Rahim Yar Khan

Duration of Study with Dates: Six months (1st August 2014 to 28th February 2015).

Methods: We studied 90 regular HD patients using Fresenius 4008S&H dialysis machines and B-Braun dialogue+, equipped with online clearance modules (OCM) to measure Kt/V. OCM-based Kt/V was noted at the end of each dialysis session as well as pre and post dialysis sample were collected to measure urea clearance by using Daugirdaus equation to measure single pool Kt/V (conventional blood sampling method).

Results: The Kt/V measured by OCM highly correlated with the one derived from conventional blood sampling method (r=0.80; p<0.01). The OCM-based method underestimated urea clearance by the mean of 7.3% and it varied greatly within individual patients with a mean of 1.39±0.24.

Conclusion: The OCM-based method seems to be an easily obtained measure of the delivered dialysis dose, correlating well with standard equation based method of urea clearance. Substantial interdialysis session variations imply that repeated measures are necessary to obtain a real answer to the mean treatment dose being delivered to the patients.

Keywords: Hemodialysis, Adequacy, Online clearance monitoring, End stage renal disease

INTRODUCTION

The kidneys are bean shaped paired organs, which remove the waste materials from the blood that are incompatible with life. They control blood pressure, prevent development of anemia, help in the formation of bones and play important role in the regulation of body fluids and electrolytes balance. When the kidneys fail due to any disease process, these functions are disturbed, resulting in various manifestations. Some of the diseases of the kidneys are treatable like recurrent urinary tract infections and obstructive nephropathy, while in some of the diseases, the effect on kidneys can be reduced by adequate control of the present disease like diabetes and hypertension[1].

When the kidneys lose their function completely and there is no reversible element then the term applied is end stage renal disease (ESRD). It is estimated that there are 100-150 new patients /

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million population/year in Pakistan who suffer from such a condition. With the passage of time the incidence of this condition is increasing because of more awareness as well as increase in incidence of certain diseases like diabetic nephropathy[2].

In many patients who are candidates for kidneys transplantation, will need dialysis before they actually undergo transplantation[3].

Dialysis is of two types i.e., hemodialysis and peritoneal dialysis. Both of these treatment modalities have advantages and disadvantages. Most commonly used modality is hemodialysis. In this procedure, the blood comes out of the patient, passes through a dialyzer, in hollow fibers around which dialysis fluid is circulating. Urea, creatinine and other waste material passes through semi permeable membrane from blood to dialysate side, which is then discarded[4].

Hemodialysis is a life-sustaining procedure for the treatment of patients with end-stage renal disease .With adequate amount of dialysis it results in a dramatic reversal of uremic symptoms and helps

to improve the patient's nutritional as well as functional status and increases patient's survival. Numerous studies have shown a correlation between the delivered dose of hemodialysis and patient morbidity and mortality. Therefore, the delivered dose should be measured and monitored routinely to ensure that the patient receives an adequate amount of dialysis. There are different parameters to assess the adequacy but the important ones are calculation of Kt/V, URR (urea reduction ratio), TAC$_{urea}$ (time averaged concentration of urea) and assessment of nutritional status[5,6].

Kt/V is an index of dialysis adequacy and is best described as the fractional clearance of urea as a function of its distributional volume. According to different studies the target Kt/Vsp should be 1.4 per session while weekly Kt/V should be 4.2 for thrice weekly patients to maintain the adequacy of hemodialysis. In past Kt/V had widely been calculated with the help of enzymatic urea analysis using Daurgidas 2nd generation natural logarithmic formula by measuring pre and post dialysis BUN.[7,8] But these days it can be calculated by Online clearance Monitoring (OCM). Online Clearance Monitoring is an optional module, which is integrated in most of the latest hemodialysis machines. It provides automatic intradialytic measurement of the delivered dialysis dose Kt/V, the in-vivo urea clearance. In addition, the OCM is capable of detecting adjustments to blood flow or dialysate flow rates within one minute and immediately recalculates the corresponding new clearance values. This means the effect of any alteration to treatment parameter on actual clearance can be continuously monitored during an on-going session[9,10,11,12].

However OCM is greatly dependent on some other factors, errors of which can cause wrong calculation of Kt/V. These are hematocrit level, dry weight/volume of distribution of urea (V), blood flow and dialysate flow rate and equipment related problems (dialyzer and blood lines). So OCM might be a preferred way of Kt/V measurement if the influence of above mentioned factors is studied along with proper intervention during hemodialysis treatment[13]. With OCM it could be possible to do alteration in dialysis prescription like change in blood flow diasylate flow or time duration, when desire Kt/V is not achieved and OCM adjusts actual clearance according to new parameters[14].

In addition, dialysis adequacy must not be assessed by solute clearance alone. A global review of the patient including clinical and other laboratory data is necessary to make a judgment on patient well-being and treatment adequacy. There are several strong independent predictors of patient outcome, which must be considered at least as important as solute clearance. These are blood pressure control, nutritional status, inflammatory markers, cardiovascular diseases, serum phosphate levels, metabolic acidosis etc. Assessment of nutritional status and uremic symptoms are important indirect parameters of hemodialysis inadequacy and strongly correlates with patient's outcome and survival so their regular assessment is strongly recommended[15,16].

This study was conducted to compare these two methods of Kt/V measurement and how adequacy correlates with nutritional status of patients on regular hemodialysis.

OBJECTIVES
1. To compare Kt/V measurement by online clearance module with enzymatic urea analysis method as a parameter of hemodialysis adequacy.
2. To compare the nutritional status of patients who are adequately dialyzed with those who are inadequately dialyzed.

MATERIAL AND METHODS

It is a single center, cross sectional observational study of patients who are on regular hemodialysis conducted at Hemodialysis unit of Shaikh Zayed Hospital, Rahim Yar Khan. Non-probability convenient sampling was used. Total 90 patients were included in the study. Duration of study was six months (1st August 2014 to 28th February 2015)

All patients with end stage renal disease due to any cause who are on regular hemodialysis twice or thrice weekly for at least three months were included in the study.

Exclusion Criteria
- Patients who are critically ill due to multiple co-morbid conditions like malignancies, advance cirrhosis and septicemia.
- The patients who do not follow thrice weekly regimen or undergo irregular dialysis.

Data will be analyzed by using statistical software SPSS version 12. Frequencies were calculated for variables like sex and frequency of dialysis. Mean ± standard deviation was calculated for numerical variables like age, lab values and anthropometric parameters etc. Two tail paired t-test was applied to compare Kt/V values by both methods while unpaired t-test will be applied to compare the lab and anthropometric parameters of both groups those who are adequately dialyzed and those who are inadequately dialyzed. Correlation between uremic symptoms and adequacy of hemodialysis was studied by using chi square test. For all analysis p value ≤ 0.05 was taken as significant.

RESULTS

A total of 90 chronic hemodialysis patients were dialyzed with OCM-option equipped dialysis machines. Among them 40 were female and 50 were male (Fig. 1). Sixty patients were on 2 x weekly hemodialysis schedule while 30 patients were on 3xweekly schedule (Fig. 2). Mean age was 45.3±6.4 years, minimum age 15 years and maximum age 72 years while mean duration on dialysis 38.5±34.4 months. OCM-based Kt/V was compared with Daugirdas second generation single pool Kt/V (spKt/V). 44% patients (39) showed low Kt/V (<1.4) as compared to 56% patients (51) with Kt/V >1.4 (Fig. 3).
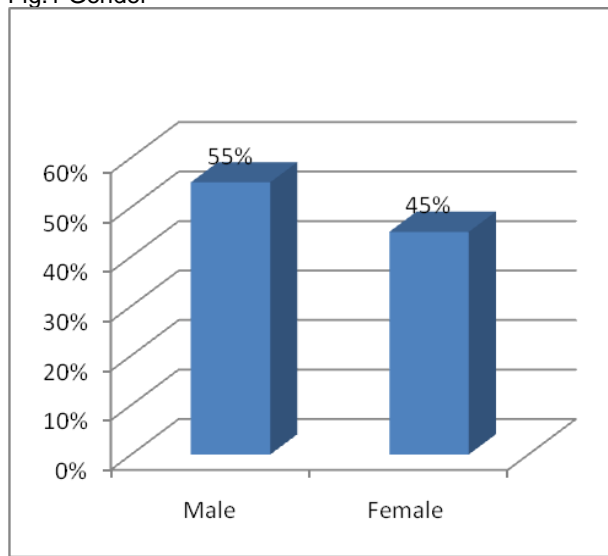
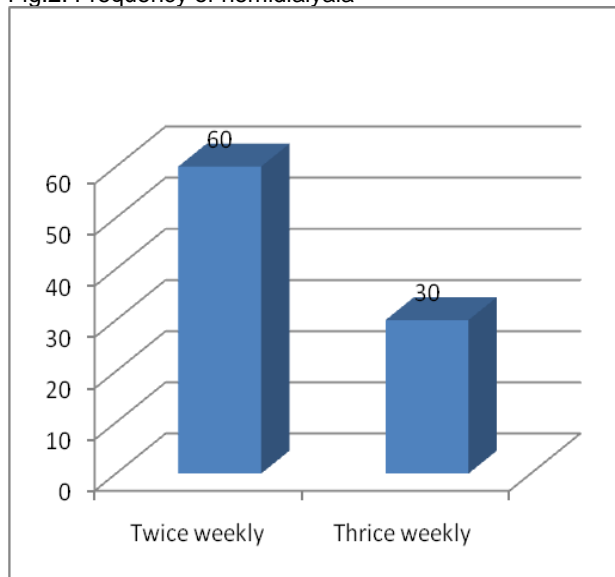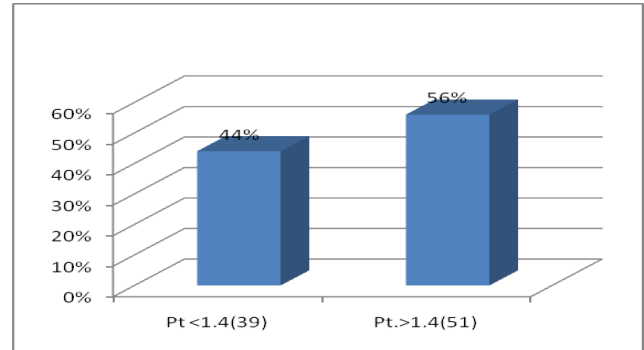Fig.1 Gender

Fig.2: Frequency of hemidialyaia

Fig.3: Comparison of achieved Kt/V by OCM and conventional method

Mean values for OCM-based Kt/V was 1.37±.24 and with spKt/V it was 1.49±.34. OCM-based Kt/V was 712% lower than the conventional blood sampling method thus showing significant correlations with spKt/V [r = 0.79; p<0.01] (Table 1). Mean weekly Kt/V (OCM) was 3.35±0.87 as compared to conventional method that showing a little bit higher i.e. 3.59±1.03 [p-value 0.00] (Table 2).

According to frequency of dialysis, those patients who were on twice weekly dialysis, 50% had Kt/V < 3.6 as compared to the 30% patients who were on thrice weekly dialysis schedule having weekly Kt/V < 3.6 thus indicating significant difference [p-value 0.00] (Table 3).

Other parameters like hemoglobin (mean 9.50±1.68) and s/albumin (mean 3.31±.48) were also low in most of the patients. Mean nPCR was 1.13±.28 and there was linear correlation(r: 0.57 and p: 0.002) between low nPCR and low Kt/V i.e. 72% patients with low Kt/V (<1.4) also had low nPCR (<1.2 g/Kg/day). There was no significant difference in the hematological and biochemical parameters of two groups. When these parameters were analyzed according to frequency of hemodialysis, again no significant difference was noted between the two groups except HDL. Same results were found when these parameters were compared according to weekly Kt/V (Table 4).

Anthropometric parameters of nutritional status assessment like body mass index (BMI), tricep skin fold thickness, mid arm muscle circumference and mid arm circumference have been shown in table 6 with their mean±SD. All showed significant p-value and well correlated with Kt/V value. When these parameters were compared according to frequency of dialysis and weekly Kt/V, most of the parameters again showed significant P-value as shown in table (Table 5). Uremic symptoms of both groups were compared as shown in table 9 and they did not show significant correlation with Kt/V i.e., all showed p-value > 0.05 (Table 6).

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Table 1: Comparison of Kt/V measurement by both methods

Variable	OCM-based	Conventional method based	p-value	Percentage difference
Kt/V	1.37±0.24	1.49±0.34	0.01	7.1%*

*OCM based Kt/V value is 7.2% lower than conventional blood sampling method

Table 2: Comparison between mean weekly Kt/V by OCM and conventional method

Variable	OCM-based	Conventional method based	p-value
Kt/V	3.35±0.87	3.59±1.03	0.00

Table 3: Effect of frequency of hemodialysis on achieved Kt/V

Variable	Twice Weekly Hemodialysis	Thrice Weekly Hemodialysis	p-value
Kt/V<3.6	50%	30%	0.00

Table 4: Laboratory and nutritional parameters according to weekly Kt/V

Parameters	Weekly Kt/V≥3.6	Weekly Kt/V<3.6	P-value
Age(years)	44.81±17.35	45.73±15.88	0.83
Hemoglobin(g/dl)	9.76±1.70	9.30±1.67	0.29
Hematocrit(%)	29.30±6.20	28.62±5.56	0.67
S/Albumin(mg/dl	3.36±0.47	3.35±0.50	0.95
T/Protein(mg/dl)	7.50±0.83	7.56±1.08	0.84
S/Cholesterol(mg/dl)	158.93±40.67	156.52±37.30	0.81
HDL(mg/dl)	29.93±7.49	34.82±9.44	0.03
LDL(mg/dl)	93.04±32.62	91.39±27.43	0.83
Triglycerides(mg/dl)	204.15±89.81	161.64±94.62	0.08
BMI(%)	24.17±3.80	2.36±4.30	0.09
TSF(mm)	12.15±2.68	10.82±2.51	0.05
MAC(cm)	24.75±3.80	23.52±3.90	0.22
MAMC(cm)	21.24±3.33	19.74±3.30	0.09
nPCR (g/Kg/day)	1.17±0.25	1.10±0.31	0.40

Table 5: Parameters of nutritional status assessment

Parametres	Group-1	Group-2	p-value
Body Mass Index(%)	20.73±2.77	25.04±4.07	0.001
TSF thickness(mm)	9.46±2.03	12.91±2.03	0.000
MAC(cm)	21.04±2.40	26.39±3.11	0.000
MAMC(cm)	18.30±2.81	22.03±2.85	0.002
nPCR(g/kg/day)	0.96± 0.24	1.24± 0.25	0.002

Table 6: Statistical analysis of uremic symptoms

Symptoms	Group-1 (Kt/V <1.4)	Group-2 (Kt/V≥1.4)	p-value
Anorexia,nausea & vomiting			0.19(NS*)
Nil	17	15	
Mild	7	17	
Moderate	2	2	
Severe	nil	nil	
Body aches and pains			0.24(NS*)
Nil	8	13	
Mild	15	11	
Moderate	2	8	
Severe	1	1	
PND			0.58(NS*)
Nil	18	25	
Mild	8	8	
Moderate	nil	1	
Severe	nil	nil	
Pulmonary edema			0.67(NS*)
Nil	20	25	
Mild	6	8	
Moderate	nil	1	
Severe	nil	nil	
Generalised weakness			0.32(NS*)
Nil	4	10	
Mild	14	12	
Moderate	6	11	
Severe	2	1	

(NS*): Not Significant

DISCUSSION

To maintain chain of life in patients suffering from ESRD hemodialysis is mandatory and to have good quality of life adequate and up to mark those of dialysis and good nutrition must be provided, hemodialysis dosage has been shown to have a significant impact on morbidity and mortality rate in patients on hemodialysis. Different methods for quantification have been suggested. Some authors signified a single pool model to be sufficient for calculating dialysis dosage while others suggested the two-pool model which takes the urea rebound into account. However, the practibility of two-pool model is limited because the final measurement of urea has to be done with a 30 minutes delay to equilibrate the second pool. Therefore, Daugirdas suggested an empirical formula to estimate equilibrated Kt/V without waiting for the rebound which is still a matter of debate. Direct quantification by a urea monitor is claimed to be the gold standard but it necessitates a special device and is up to now limited to special centers and is being used in scientific studies. Hence the disadvantages like inconvenience for the patients and the indispensable sampling of blood and dialysate prevents the regular assessment of Kt/V at each dialysis[17,18,19].

Conductivity cells are ideal sensors for the continuous measurement of the conductivity of the dialysate. As sodium and urea diffusion coefficient are almost equal, electrolytic clearance monitoring should give exact figure for the effective total urea clearance. Furthermore, conductivity based clearance measurement several times monitoring separately the efficiency of each hemodialysis with consideration of real blood and dialysate flow, dialysis time recirculation and ultra filtration without additional burden to the patients and dialysis staff[20].

With improvement of the Online Monitoring" method, Goldau et al[21] a further analytical series in 2002 an improved level of precision below 5% error limit. Thomson D. in 2004 also showed a linear correlation between OCM based and conventional blood sampling method of Kt/V measurement.

Literature gives explanation for this difference in Kt/V measurement because calculation of OCM-based Kt/V measurement depends upon multiple factors for example machine overestimates the urea distribution volume i.e.' V ' by using Watson formula (already installed software in machine). As a result Kxt determined by OCM is then divided by incorrectly high value of V thus leading to low value of urea clearance. Secondly OCM based urea clearance also depends upon hematocrit. For every 10% higher or lower change in hematocrit results in 2-3% change in clearance. If no hematocrit value is entered before dialysis, machine automatically assumes hypothetical value of 35%. Third factor is blood flow rate. Blood side method uses pre-set value of blood flow rate that is usually 10% higher than effective blood flow while OCM calculates clearance by using effective blood flow rate[22].

Several studies have clearly shown that the dose of dialysis is a major factor which determines the outcome of patients on dialysis. The optimal dose of dialysis above which no further improvement in morbidity and mortality can be expected has not yet been determined, although several studies suggest that Kt/V >1.4 is the optimum dose of dialysis when patient is on thrice weekly dialysis. In this study 43.3% patients were getting low Kt/V (<1.4) as compared to 56.7% patients with Kt/V >1.4. In our society where most of people are living with low socioeconomic status, the financial constrain is the major factor for low dose of dialysis. When hematological as well as biochemical parameters were compared between these two groups, no significant difference was noted perhaps again on the basis of residual renal functions of twice weekly dialysis group patients. The other possible explanations for these results might be other factors e.g. use of erythropoietin, iron therapy, good diet etc. That is why where frequency of dialysis is different, single session value of Kt/V is not reliable to assess adequacy and weekly Kt/V is more reliable along with frequent measurement of Kt/V as well as measurement of residual renal function to give final opinion about adequacy of dialysis.

Inadequate dialysis leads to symptoms of azotemia and increased morbidity and mortality thus clinically adequacy can be assessed to some extent without checking laboratory parameters. Contrary to this our clinical parameters did not correlate with Kt/V values possibly due to above mentioned factors. Same results were found in a local study in 2000. Literature review showed that apart from increasing symptoms, Ahmad and Cole retrospectively compared the patient hospitalization rate with the dose of dialysis and found that patients with mean hospitalization rate of 1.93 days/year had Kt/V 0.98±0.04 whereas those with no hospitalization had a Kt/V of 1.29±0.12[23].

Malnutrition is an important problem in patients on chronic hemodialysis or peritoneal dialysis. It occurs in 20 to 70 percent of patients (depending upon the method used to measure nutritional status), with an increasing length of time on dialysis correlating with an increasing decline in nutritional parameters. There may be significant differences between countries with respect to some measures of nutritional status, such as serum albumin concentration. Based upon the Dialysis Outcomes

and Practice Patterns Study (DOPPS), for example, the following mean serum albumin levels were reported in France (3.87mg/dL), Germany (4.17mg/dL), Italy (3.98mg/dL), Spain (3.98mg/dL), United States (3.6mg/dL), and the United Kingdom (3.72 mg/dL). In a local study in 2000, mean serum albumin was 3.77mg/dl but in this study the mean serum albumin was found to be 3.36mg/dl which is comparable to above mentioned values. In our study, mean serum albumin was 3.35 mg/dl while contrary to hematological and biochemical parameters, the anthropometric parameters correlated well with the Kt/V value. However, since differences in measurement methods cause differences in results, the method used from laboratory to laboratory and country to country must be known to assess any true differences in serum albumin in an individual patient or groups of patients[24].

Another important parameter of nutritional assessment is the estimation of the normalized protein equivalence of nitrogen appearance (nPNA), as index of protein intake in dialysis patients. This is also known as the normalized protein catabolic rate (nPCR). As the Kt/V rose from 0.82 to 1.32 over a three month period, there was a concurrent elevation in PCR from 0.81 to 1.02g/kg per day. The rise in PCR was indicative of increased protein intake (and better nutrition) due, presumably, to improved appetite. A second group in which the dialysis regimen was unchanged had no increase in either Kt/V or PCR. In this study although the mean PCR was 0.96 g/kg/day that was lower than the standard value (1.2g/kg/day) but it was positively correlated with Kt/V[25,26].

CONCLUSION

In end stage renal disease hemodialysis is a good option in patients who can not undergo renal transplant. To maintain good health adequate dose of hemodialysis should be offered which is reflected by Kt/V ≥1.2. The OCM-based method seems to be feasible and an easily obtained measure of the delivered dialysis dose, correlating well with standard equation based method of urea clearance and its use might be more practical and beneficial for dialysis patients. Moreover when frequency of dialysis is different, single dialysis session value of Kt/V would not be sufficient parameter to assess dialysis adequacy as well as measurement of residual renal function must be done at the same time. It is recommended that clinical and biochemical assessment should be made to provide adequate dialysis to reduce the morbidity and mortality of these patients and dialysis adequacy must be repeated reviewed.

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