EFFECT OF INCREASING DIALYSATE FLOW RATE ON ACHIEVED KT/V IN PATIENTS ON MAINTENANCE HEMODIALYSIS

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ABSTRACT

Background: In patients suffering from End Stage Renal Disease (ESRD) life can only be sustained by renal replacement therapy, including renal transplant or dialysis, which can be peritoneal dialysis or hemodialysis. Adequate dose of hemodialysis must be offered to patients for better quality of life. Hemodialysis adequacy, Kt/V, is one of the most important issues influencing the survival of patients on maintenance hemodialysis. Some patients do not achieve target Kt/V even with extended treatment time or by increasing blood flow rates. These patients have poor quality of life because of toxic effects of uremia, decreased appetite, metabolic complications of renal failure. These selected patients can be offered adequate dialysis by increasing dialysate flow rate, hence achieving adequate Kt/V, so quality of life can be improved. **Objective:** This study was conducted to determine the effect of increasing dialysate flow rate from 500 ml/min to 800 ml/min on achieved Kt/V, in under dialyzed patients who were on thrice weekly regular hemodialysis and were not achieving required Kt/V. **Patients and Methods:** This cross sectional study was conducted in hemodialysis unit, Sheikh Zayed Hospital, Rahim Yar Khan from 1st November 2011 to 30th April 2012. We included 100 regular under dialyzed patients using Fresenius 4008S dialysis machines, equipped with online clearance modules (OCM) to measure Kt/V. The patients were dialyzed for 4 hours, at dialysate flow rates 500ml/min and then 800ml/min each session. OCM-based single pool Kt/V was noted at the end of each dialysis session. The difference between two Kt/V was noted. **Results:** When 100 underdialyzed patients who were previously dialyzed at Qd 500ml/min, were offered 4 hour dialysis with Qd of 800ml/min, 87% patients achieved target Kt/V of >1.2. While 13% still did not achieved target Kt/V. So a significant number of patients were able to have adequate dialysis. **Conclusion:** Some patients did not achieved required target Kt/V>1.2 on conventional dialysate flow rate of 500ml/min despite of extended treatment time and optimized blood flow rates and hence were underdialyzed. But they achieved Kt/V >1.2 when dialyzed for 4 hours at Qd 800ml/min.So it is concluded that better dialysis can be offered to these selected patients by increasing dialysate flow rate from 500ml/min to 800ml/min, achieving better Kt/V and thus quality of life can be improved.

Key words: Hemodialysis, Adequacy, Online clearance monitoring, End stage renal disease, Dialysate flow rate.

INTRODUCTION

The kidneys are paired organs which have multiple functions and they remove the waste materials from the blood, 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 lost, resulting in many symptoms. Some of the diseases of the kidneys are treatable, while in other diseases, the effects on kidneys can be reduced by adequate control of comorbid disease like diabetes and hypertension. End stage renal disease (ESRD) is the term used when the kidneys lose their function completely and there is no reversible element. It is estimated that there are 100-150 new patients / million population / year in Pakistan who suffer from this condition.[1] 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] Once the patient develops ESRD, the treatment option left is either dialysis or renal transplantation. Although transplantation is a superior treatment option if donor is available and there is no contraindication to transplantation but it has certain limitations like unavailability of proper donor and some logistic problems. In many patients who are candidates for kidneys transplantation, will need dialysis before they actually undergo transplantation.[3] There are two types of dialysis i.e. hemodialysis and peritoneal dialysis. Most commonly used modality is hemodialysis. In this procedure, the blood comes out of the patient, passes through a dialyzer, in hollow fibres around which dialysis fluid is circulating (flow of direction is opposite to that of blood). Urea, Creatinine and other waste material passes through semi permeable

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membrane from blood to dialysate side, which is then discarded.[4]

Adeqauate hemodialysis depends upon some factors like treatment time, blood flow rate, size and type of dialyzer, volume of distribution and dialysate flow rate. The longer time duration of hemodialysis, good blood flow is directly related to adequate dialysis. Dialysate flow rate is very significant factor contributing to good hemodialysis. Adequate hemodialysis is directly related to dialysate flow rate as well. In many studies, it was observed that Kt/V improves as dialysate flow rate was increased. Numerous studies have shown a correlation between the delivered dose of hemodialysis and patient's 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 1.2 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), 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.[9-11]

Measurement of Kt/V by online clearance monitoring is a convenient, rapid and economical method and monitors Kt/V continuously during hemodialysis session. It is not dependent upon staff and laboratory investigations. With OCM it could be possible to do alterations in the dialysis prescription in the form of changes in blood flow rate, dialysate flow rate and time during an on-going session of hemodialysis when desired Kt/V is not being achieved and OCM adjusts actual clearance according to new parameters.[12] Ideally patients on maintenance hemodialysis must receive adequate dose of dialysis on conventional setting like treatment time, blood flow rate, size and type of dialyzer and dialysate flow rate. But few patients fail to achieve target Kt/V of 1.2 on routine setting.[13] These patients may need to increase dialysate flow rate to achieve target Kt/V.[14] This study was conducted to determine the effect of increasing dialysate flow rate from 500 ml/min to 800 ml/min on achieved Kt/V, in under dialyzed patients who were on thrice weekly regular hemodialysis and were not achieving required Kt/V.

PATIENTS AND METHODS

This cross-sectional study was conducted in hemodialysis unit, Sheikh Zayed Hospital, Rahim Yar Khan, from 1st November, 2011 to 30th April, 2012. It was a single centre, cross sectional study on patients who were on regular hemodialysis with non probability convenient sampling. We included 100 regular under dialyzed patients using Fresenius 4008S dialysis machines, having online clearance modules (OCM) to measure Kt/V. The patients were dialyzed for 4 hours at dialysate flow rates 500ml/min and then 800ml/min in each session. OCM-based single pool Kt/V was noted at the end of each dialysis session. The difference between two Kt/V was noted. The parameters of dialysis like treatment time, blood flow rate and type and size of dialyzer were kept same. While any evidence of accessory re-circulation was excluded. The data was entered in SPSS version 15 and analyzed.

RESULTS

In this study, a total of 100 patients were included who were on maintenance hemodialysis, thrice weekly and were underdialyzed at conventional Qd of 500ml/min, on machines equipped with OCM-option. Among them 45 were female and 55 were male. Mean age was 49.5.4 years, minimum age was 17 years, and maximum age was 90 years, while mean duration on dialysis was 30.5±34.4 months. Regarding aetiology of ESRD, 55 patients (55%) were diabetic, 25 patients (25%) were suffering from

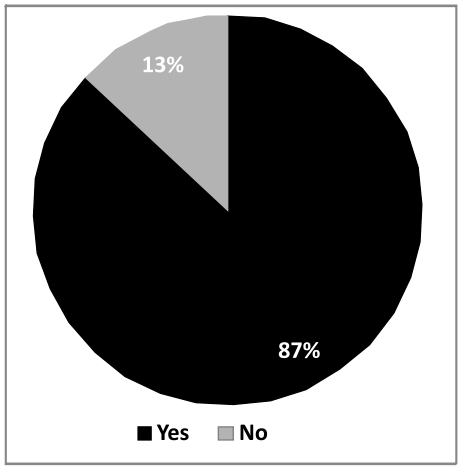
hypertension, 17 patients (17%) had chronic glomerulonephritis while 3 patients (3%) were having other diseases like polycystic kidney disease, nephrolithiasis, or renal cortical necrosis.(Table I).

Table I: Etiology of end stage renal disease

Aetiology of ESRD	Frequency	Percentage
Diabetes	55	55.0
HTN	25	25.0
Chronic Glomerulonephritis	17	17.0
Others	3	3.0
Total	100	100.0

Patients were divided in three groups according to age. Group 1 ranged from 16-30 years and 18% patients fall in this group. Group 2 having age 30-60 years has 51% patients, while group 3 having >61 years of age has 31% patients. When patients were dialyzed at Qd 800ml/min for 4 hours, 87 patients (87%) achieved target spKt/V of 1.2, while 13 patients (13%) still didn't achieved required Kt/V.

Figure I: Patients having achieved target Kt/V of >1.2 versus not achieved



Among those who achieved Kt/V at Qd 800ml/min, 38 were females and 49 were males, while 7 females and 6 males were unable to achieve required Kt/V. The mean Kt/V at Qd 800ml/min remained 1.218, and standard deviation was 0.0420. Maximum Kt/V was 1.29 while minimum was 1.08. The mean Kt/V at Qd 500/ml was 1.0893 with standard deviation of 0.05236 and minimum 0.88 and maximum 1.18. Aetiology of renal failure like diabetes mellitus, hypertension and chronic glomerulone-phritis had no impact on achievement of Kt/V.

Table II: Comparison of achieved Kt/V at both dialysate flow rates

Specification	Kt/V @ Qd 800	Kt/V @ Qd 500 ml
N	100	100
Mean	1.2183	1.0893
Median	1.2300	1.0900
Mode	1.24	1.12
Std. Deviation	0.04200	0.05236
Minimum	1.08	0.88
Maximum	1.29	1.18

DISCUSSION

To maintain chain of life in patients suffering from End Stage Renal Disease, hemodialysis is mandatory and to have good quality of life adequate and upto the mark dose of dialysis must be provided. Hemodialysis dosage(Kt/V) has been shown to have a significant impact on the morbidity and mortality rate in patients on regular hemodialysis. Therefore adequacy of each dialysis should be guaranteed. 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. 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 centres 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.[15]

Electrolytes and toxic material clearance is very important during hemodialysis. Conductivity cells are ideal sensors for the continuous measurement of the conductivity of the dialysate. The insertion of these cells into the dialyzer inlet and outlet lines allows a simple and safe continuous measurement of the actual electrolytic and toxins clearance. As

sodium and urea diffusion coefficient are almost equal, electrolytic clearance monitoring should give exact figure for the effective total urea clearance. This study was designed to evaluate the effect of increasing dialysate flow from 500ml/min to 800ml/min in thrice weekly regular under dialyzed patients and to observe changes in achieved spKT/V, while treatment time, blood flow rate, ultrafiltration volume, type and size of dialyzer were kept constant. The adequacy of hemodialysis can be measured by Kt/V. This adequacy of hemodialysis depends upon multiple factors. It is directly related to dialyzer urea clearance, total treatment time and inversely proportional to volume of distribution called V. The dialyzer urea clearance depends upon the size and number of hollow fibres utilized in dialysers. Second factor is blood flow rate which has minimal effect on Kt/V. Other important factor is dialysate flow rate(Qd) which when increased has direct effect on delivered dose of dialysis.[9,15] Hauk M et al[14] observed in their study on 23 patients that increase in dialysate flow rate improves achieved Kt/V. Hemodialysis was performed at Qds of 300ml/min,500ml/min and 800ml/min for at least 3 weeks each, whereas specific dialysis prescription like treatment time, blood flow rate, ultrafiltration volume and type and size of dialyzer, were kept constant. Delivered dose of dialysis, assessed by Kt/Vsp and Kt/Vdp was measured at least three times for each Qds. They observed mean Kt/V of 1.19±0.03 at Qd of 300ml/min,1.32±0.04 at 500ml/min and 1.45±0.04 at Qd of 800ml/min. The relative gains in Kt/V for increasing Qds from 300 to 500ml/min and 500 to 800ml/min were 11.7%-±8.7% and 9.9%± 5.1% respectively. Salahudeen AK et al noted in their study that 15% of the dialyzed patients failed to achieve Kt/V of 1.2 at dialysate flow rate 500ml/min, hence they were underdialyzed and increase in dialysate flow rate was associated with increase with in achieved Kt/V, hence better dialysis.[13]

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 >1.2 is the optimum dose of dialysis when patient is on thrice weekly dialysis. In this study, all patients were under dialyzed at dialysate flow rate of 500ml/min and getting low Kt/V (<1.2) even when thrice weekly dialyzed. When dialysate flow rate was increased to 800ml/min from 500ml/min, while patients were dialyzed thrice weekly, 87 patients (87%) achieved Kt/V >1.2, hence got good hemodialysis dose. While 13 patients (13%) still were unable to achieve the required Kt/V of 1.2, hence were underdialyzed.

In our society, where most of people are living with low socioeconomic status, the financial constraint is the major factor for low dose of dialysis. Apart from economical reasons, most of patients are not in favour of thrice weekly dialysis due to multiple factors like nonavailibility of conveyance or accompanying person. In a study, the main factors for inadequate dialysis were inadequate dialysis time due to multiple factors, presence of arteriovenous recirculation and low dialyzer clearance.[14] Inadequate dialysis leads to symptoms of azotemia and increased morbidity and mortality. This clinical adequacy can be assessed to some extent by OCM without checking laboratory parameters. So it is concluded that better dialysis can be offered to selected patients by increasing dialysate flow rate, who are not achieving adequate hemodialysis despite of extended treatment times and optimized blood flow rates.

CONCLUSION

In end stage renal disease, hemodialysis is a good option in patients who cannot undergo renal transplant. To maintain good health, adequate dose of hemodialysis should be offered, which is reflected by Kt/V > 1.2. To provide adequate Kt/V all factors who can effect Kt/V should be addressed like total treatment time, type and size of dialyzer, blood flow rate and accessory recirculation. So it is concluded that the patients who do not achieve target Kt/V on conventional dialysate flow rate of 500ml/min despite of extended treatment time and optimized blood flow rates, better dialysis can be offered by increasing dialysate flow rate from 500ml/min to 800ml/min, providing better Kt/V, so that quality of life can be improved and morbidity, mortality can be reduced.

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