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Adequacy of Hemodialysis and Laboratory Parameters in Patients at Shaikh Zayed Medical Complex Hemodialysis Center, Lahore

Salman T. Shafi, Rizwan ul Haq and Tahir Shafi
Department of Nephrology, Shaikh Zayed Hospital, Lahore.

SUMMARY

Hemodialysis is an established mode of treatment for end stage renal disease (ESRD) patients. Various studies have shown increased morbidity and mortality among ESRD patients who receive inadequate dialysis. We conducted a study to determine adequacy of hemodialysis in terms of urea reduction ratio and Kt/V in our hemodialysis unit. We also calculated and analyzed various clinical and laboratory parameters in these patients to determine frequency of patients who have these values in target range or in range associated with lower mortality. We selected 94 ESRD patients who were on maintenance hemodialysis for at least 3months. To calculate adequacy of dialysis, pre dialysis BUN, pre dialysis weight, post dialysis BUN, post dialysis weight and duration of dialysis were determined. Urea reduction ratio and Kt/V were calculated by using mathematical formulae. Mean Kt/V was found to be 1.12±0.4 and mean URR was 59.7±13.7%. Only 40% and 39.7% of all patients had Kt/V above 1.2 and URR above 65% respectively. Mean arterial blood pressure was adequate in 62.8% patients. Calcium, alkaline phosphatase, phosphate and potassium were found in recommended range in 45.7%, 46.8%, 77.7% and 83% of all patients respectively. Only 19.1% and 72.3% patients had hemoglobin and albumin in adequate range. We recommend that adequacy of hemodialysis should be assessed regularly in ESRD patients and further studies should be conducted to determine various factors responsible for inadequate hemodialysis. We also recommend more intensive management of hypertension, anemia and calcium-phosphate balance in these patients.

INTRODUCTION

A central issue in management of hemodialysis patients is the adequacy of dose of hemo-dialysis. Patient's clinical improvement is poor predictor of adequacy as it can be secondary to combination of erythropoetin use or blood transfusions and dialysis, though patient may be under dialyzed. Similarly blood urea nitrogen (BUN) level is not a good indicator as it may reflect protein malnutrition rather than adequate urea removal. Numerous studies have demonstrated increased mortality among ESRD patients who receive inadequate hemodialysis[1-4]. Solute removal during hemodialysis focuses on urea. Adequacy of hemodialysis is assessed in terms of removal of urea from body. The standard index of urea removal is Kt/V, which is defined as dialyzer clearance of urea multiplied by duration of dialysis divided by volume of distribution of urea. Another popular but least recommended index is urea reduction ratio URR[5]. According to NKF/DOQI guidelines, Kt/V should be measured by using formal urea kinetic modeling employing single pool, variable volume model. Recognizing that computational software to support calculations using urea kinetic modeling may not be available to all hemodialysis providers, second generation natural logarithm formula to calculate Kt/V is also recommended and acceptable[6]. There is no universally accepted target value for Kt/V, but large cross sectional studies have shown increased

mortality with Kt/V values of less than 1.2 and urea reduction ratio of less than 65%[7,8].

Different studies have shown the predictive value of commonly measured laboratory parameters on long term mortality of hemodialysis patients[9,10]. Pre dialysis BUN values of greater than 110 mg/dl or less than 60 mg/dl are associated with increased mortality. Similarly target values for potassium, calcium and phosphate are 3.5-5.5, 9-12 and 3.5-5.5 mg/dl, respectively. Target values for hematocrit or hemoglobin are at least 33% or 11grams/dl respectively[11-13]. Mortality doubles for alkaline phosphatase values of greater than 150 units/liter.

We conducted a retrospective study on 94 ESRD patients who were on maintenance hemodialysis for at least 3 months in Shaikh Zayed Hospital Hemodialysis center. Objective of this study was to evaluate adequacy of hemodialysis in our patient population by calculating urea reduction ratio and Kt/V (using second generation natural logarithmic formula) and to suggest possible causes of inadequate dialysis. Various pre dialysis laboratory parameters of these patients were also analyzed to determine percentage of patients who have these values in target range or in range associated with lower mortality.

PATIENTS AND METHODS

We selected 94 patients, 53 (56.4%) men and 41 (43.6%) women, who were on maintenance hemodialysis in our hemodialysis unit for at least 3 months. Mean age of these patients was 48.3±15.5 years.

To evaluate adequacy of hemodialysis, both urea reduction ratio and Kt/V were calculated. For this purpose, pre dialysis BUN, pre dialysis weight, post dialysis BUN, post dialysis weight and duration of dialysis in hours were recorded. BUN sampling was done in accordance to NKF/DOQI guidelines as follows[14]: -

- For pre dialysis sampling, blood was obtained from arterial needle before connecting to arterial blood tubing or flushing the needle with normal saline.
- For post dialysis sampling, at the completion of hemodialysis, dialysate flow was reduced to minimum. Blood flow was reduced to 50-100 ml/min for 15 seconds and blood sample was drawn from arterial sampling port closest to the patient.

Urea reduction ratio URR was calculated as follows[15]:

URR = 100 x (Pre dialysis BUN – Post dialysis BUN)/ Pre dialysis BUN

Kt/V was calculated as follows (16): -

$$Kt/V = -\ln(R-0.008 \times t) + (4-3.5 \times R) \times UF/W$$

Where R is ratio of post dialysis BUN to pre dialysis BUN, t is duration of dialysis in hours, UF is ultra filtration volume and W is post dialysis weight.

RESULTS

Mean urea reduction ratio in our patients was found to be 59.7±13.7%. Only 39.7% of all patients had urea reduction ratio of 65% or greater. Mean Kt/V was found to be 1.12±0.4 and only 40% had Kt/V greater than 1.2. These results are shown in Figure 1.

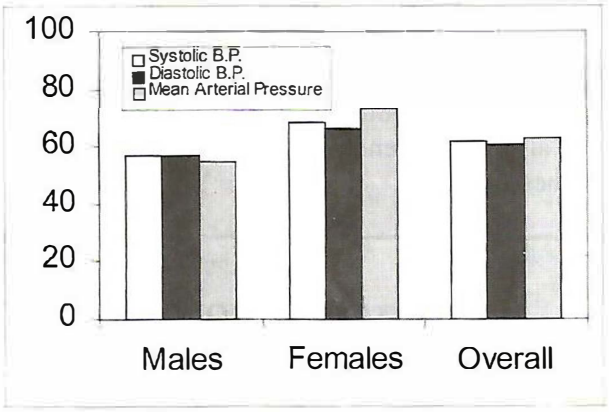

Fig. 1: Percentage of patients meeting target Blood Pressure

Various pre dialysis laboratory parameters and pre dialysis blood pressure of these patients were also measured. Target range for different variables along with mean values in our patients are shown in Table 1.

Above table shows that mean value of hemoglobin (9.43±1.8 g/dl) in our patients was lower than target hemoglobin (>11g/dl). Mean value of alkaline phosphatase was (208±211 U/L) also higher than recommended value (<150 U/L).

Table 1: Target and mean values of blood pressure and laboratory parameters.

Clinical and Laboratory Parameters	Target values	Mean value in males	Mean value in females	Overall mean value
Systolic blood pressure (mmHg)	<140	140.5±22	133.9±26	137±24
Diastolic blood pressure (mmHg)	< 85	84.7±12	82±13	83.5±13
Mean arterial Pressure (mmHg)	<106	103.4±15	99.2±16	101.6±16
Pre dialysis BUN (mg/dl)	60-110	59.1±18	58.6±21	58.9±20
Potassium (mg/dl)	3.5-5.8	5±1	4.9±1	4.9±1
Calcium (mg/dl)	9-12	8.9±1	9.1±1	9±1
Phosphate (mg/dl)	3.5-5.5	5.6±2	5.8±2	5.7±2
Alkaline phosphatase (U/L)	<150	185±112	237±294	208±211
Hemoglobin (g/dl)	>11	9.5±2	9.3±2	9.4±2
Albumin (g/dl)	> 3.8	4.1±0.5	4.1±0.5	4.1±0.5

Figures 2, 3 & 4 show frequency of patients having various laboratory and clinical parameters in target range or range associated with lower mortality.

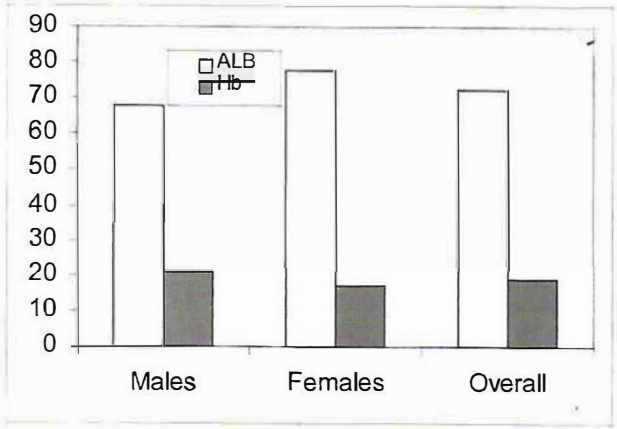

Fig. 2: Percentage of Patients meeting target or lower mortality range of albumin and hemoglobin

Results show that target hemoglobin (>11g/dl) was found in only 19% of patients. Mean arterial pressure was adequate in only 62.8% of all patients. Blood pressure control was better in females (73%) as compared to males (54.7%). Target serum calcium, phosphate and alkaline phosphatase were found in 45.7%, 77.7% and 46.8% of all patients respectively. Serum potassium and albumin were found in recommended range in 83% and 72.3% of all patients respectively.

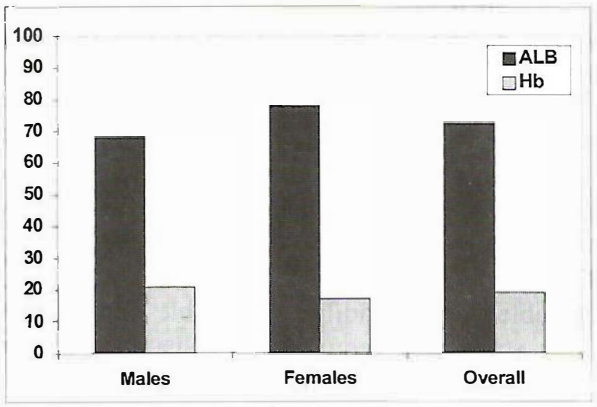

Fig. 3. Percentage of patients meeting target albumin and hemoglobin.

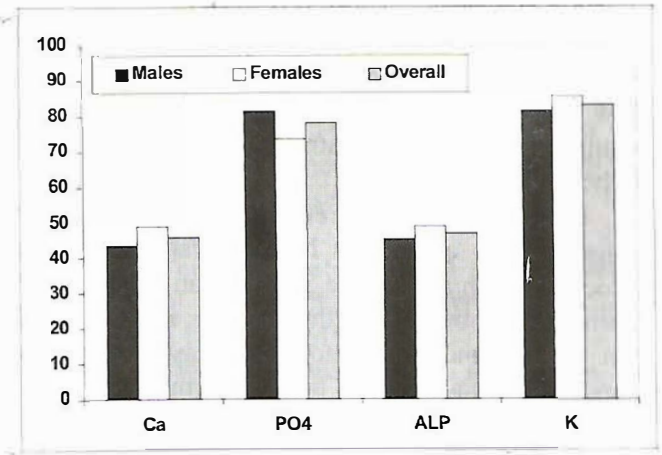

Fig. 4. Percentage of patients meeting target Ca, PO^4, K and ALP.

DISCUSSION

Kt/V and Urea reduction ratio are principal measures of adequacy of dialysis. Lower values of these parameters are associated with increased mortality. We found that mean Kt/V in our dialysis unit is only 1.12±0.4. Only 40% of all patients had Kt/V greater than 1.2. In contrast Kt/V values of 1.3 to 1.6 are now the norm in the United States. As an example, in the year 2001 annual report, the mean delivered Kt/V of adult in-center dialysis patients in the United States was 1.49. The percentage of patients receiving a benchmark URR $\geq$ 65 percent increased from 43 percent in 1993 to 72 percent in 1997 in USA[17,18]. One center in France reported improved survival of hemodialysis patients. This was attributed to an average Kt/V of 1.67, longer duration of dialysis and adequate control of blood pressure[19].

Recommended frequency for measurement of Kt/V or urea reduction ratio is once per month[20]. We recommend routine measurement of these indices of urea removal in our patients. Though application of formal urea kinetic modeling to calculate Kt/V may not be feasible, but mathematical calculation is an acceptable and readily applicable alternative. Further studies are required to evaluate the impact of less than target Kt/V on outcome of our hemodialysis patient population. Research is also required to determine prevalence of various factors responsible for inadequate dialysis in our setting. Possible suggested factors are inadequate vascular access, technical error in sampling methods for BUN, inadequate machine calibration, low blood flow rates, episodes of hypotension or cramps requiring changes in treatment, overestimation of dialyzer clearance etc[21].

Cross-sectional and retrospective studies have suggested that anemia in hemodialysis patients is associated with a decrease in life span, particularly when hemoglobin is less than 11g/dl. A substantial part of this increased mortality may depend on increased cardiac disease due to anemia, including higher incidence of left ventricular hypertrophy and dilatation as well as frank congestive heart failure[22]. Mortality, hospitalization rate and hospitalization days continue to decrease as hematocrit increased to 33-36%. (23). Only19% of our patients had hemoglobin >=11 g/dl, which suggests that our patients need regular recombinant erythropoetin therapy. Full work up of anemia is also required in our patients to determine other causes of anemia which can co-exist with erythropoetin deficiency.

Hypertension is the main risk factor for left ventricular hypertrophy in dialysis patients followed by age and anemia[24]. There is clear evidence that hypertension control has beneficial effect on left ventricular hypertrophy[25]. Rise in mean arterial pressure is associated with increased likelihood of developing left ventricular hypertrophy, dilatation, cardiac failure and ischemic heart disease[26]. About 60% of our patients had mean arterial pressure less than 106 mm Hg. Blood pressure control was more adequate in females (73%) as compared to males (54%). These results suggest that blood pressure of all dialysis patients should be checked routinely and blood pressure should be adequately controlled through maintenance of dry weight by dialysis and drug treatment.

Hypocalcemia and hyperphosphatemia predispose to secondary hyperparathyroidism which results in renal osteodystrophy. Prevention of uremic osteodystrophy hinges on minimizing secondary hyperparathyroidism through maintenance of serum calcium and phosphate levels in adequate range. Serum calcium and phosphate levels were found in recommended range in 45.7% and 77.7% of our patients respectively. More attention is needed towards proper use of calcium supplementation, phosphate binders and vitamin D analogs in these patients.

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The Authors:

Salman T. Shafi,
Medical Officer
Department of Nephrology,
Shaikh Zayed Hospital, Lahore.

Rizwan ul Haq
Trainee Registrar
Department of Nephrology,
Shaikh Zayed Hospital,
Lahore.

Tahir Shafi
Professor & Head of Division of Medicine,
Department of Nephrology,
Shaikh Zayed Hospital,
Lahore.