Dialysis adequacy in ESRD patients on maintenance hemodialysis in a tertiary care center

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Abstract

Introduction: Assessment of the hemodialysis adequacy is one of the key factors for measurement of quality of life in end stage renal disease since it can predict the outcome of this disease. In this study, we aimed to evaluate hemodialysis adequacy in Institute of Medicine, Kathmandu. This would provide a good background for effective future planning by healthcare authorities.

Methods: This is a cross-section observational study done in Hemodialysis Unit, Tribhuvan university teaching hospital, Kathmandu, a tertiary level referral hospital in Nepal. Hemodialysis sessions of 50 patients on maintenance hemodialysis were evaluated after written consent. Demographic data along with length of hemodialysis, reuse of hemodialyzer, hemodialysis sessions per week and hemodialyzer membrane type were recorded for each patient. Urea reduction ratio (URR) and single pool KT/v (spKt/v) were calculated to determine hemodialysis adequacy.

Results: Bicarbonate-based solutions and low-flux membranes was used in all patients. Length of each hemodialysis sessions was 240 minutes. Thirty-nine (78%) patients were male and eleven (22%) patients were female. The mean spKt/v and URR were found to be (1.15 ± 0.3) and (60.35 ± 9.26 %) respectively. A spKt/v more than 1.2 and urea reduction rate more than 65% were found in 42% and 34% of the end stage renal disease patients respectively.

Conclusions: This study showed hemodialysis inadequacy in more than half of the patients. Adequacy of hemodialysis can be obtained by increasing its frequency, avoiding multiple use of dialyzer and increasing blood flow rate.

Keywords: End stage renal disease; Urea Reduction Ratio; Single-pool Kt/V

Introduction

The term “end-stage renal disease” (ESRD) refers to chronic kidney disease treated with either dialysis or transplantation. Hemodialysis (HD) constitutes the most common form of renal replacement therapy. Hemodialysis contributes, the better physical condition of the patient by preventing further problems and complications due to uremia. Minimum single pool Kt/v (spKt/v) and urea reduction rate (URR) are the indicators of dialysis adequacy.1 According to the Kidney disease outcomes quality initiative (KDOQI) guidelines for hemodialysis patients, the minimally adequate dose of dialysis should be a single-pool Kt/V of 1.2 or URR of 65%.2 The spKt/v is a numerical value obtained by formula using variables like pre and postdialysis blood urea nitrogen, post-dialysis weight and ultrafiltrate volume. The delivered dose of HD for patients with end stage renal failure has increased over the last decade. In developed countries, usually hemodialysis is done thrice
a week.' However, in Nepal most patients are given HD twice a week. Although it is understood that increasing the frequency of dialysis improves the quality of life, it is not feasible due to limited HD centers and increasing number of patients requiring dialysis.

This study was carried out to assess the dialysis adequacy of patients under HD unit in TUTH. This study aims to determine the extent to which patients undergoing HD treatment for established renal failure in the Institute of Medicine received the dose of HD. This dose of HD, measured by means of URR and spKt/v, will be compared with the recommended dose in the current clinical practice guidelines.

**Methods**

This is a cross-sectional observational study done in Hemodialysis Unit, Tribhuvan University Teaching Hospital, Maharajgunj, Kathmandu, Nepal from May 2011 to October 2012. Fifty session of maintenance hemodialysis were included in this study after written consent. Blood sample was collected from peripheral vein from each patient before HD and immediately after HD. PreHD sample was used for measuring hemoglobin. Blood samples were processed for biochemical analysis within half an hour of phlebotomy. Patients with reversible kidney injury; heart failure, liver cirrhosis and sepsis were excluded from the study. Fresenius low flux polysulfone dialyzer which were the only available dialyzer, were used for each dialysis sessions with the dialysate rate fixed at 500 ml/min. Dialyzers were reprocessed manually using hydrogen peroxides and reverse osmosis water while the circuits were reprocessed using bleach and reverse osmosis water.

spKt/v was calculated using the following formula:  

\[ \text{Sp(Kt/v)} = -\ln(R-0.008x)t+(4.3xR)\frac{xUF}{W}; \text{ where,} \]

\[ R = \text{post Blood urea nitrogen (BUN)/pre-BUN}; \]

\[ t = \text{duration of hemodialysis in hours}; \]

\[ UF = \text{Ultrafiltrate volume in liters}; \]

\[ W = \text{post dialysis weight in Kg}. \]

URR was calculated with the following formula:  

\[ 100 \times \left(1 - \frac{\text{BUN}_{\text{Post}}}{\text{BUN}_{\text{Pre}}} \right) \]

We compared the spKt/v between reuse of dialyzer. For this, dialysis sessions were divided into three groups according to the number of use of dialyzer. As in IOM maximum time of dialyzer reuse is four, so we compared mean of Kt/V between “first” (1), “second” (2) and third or fourth (≥3) use of dialyzer. Mean and standard deviations of variables like age, hemoglobin, serum albumin, corrected calcium, serum phosphorus, serum calcium and phosphorus product, urea reduction ratio, single pool Kt/V, post dialysis weight of patient and ultrafiltrate volume were calculated. The data were analyzed with the Statistical Package for the Social Sciences (SPSS) version 16 software.

**Result**

Mean age was 46.98 ± 17.51 years (Range: 21 to 79 years). Among 50 patients 39 patients (78%) were male and 11 patients (22%) were female. Vascular access of patient was radio-cephalic (82%) and brachio-cephalic (18%) anastomosis. Mean value along with standard deviation (SD) of various parameters obtained in this study is shown in the table below. (Table 1) Only 9 patients (18%) had hemoglobin level ≥ 10 gm/dl. Nine patients (18%) had calcium and phosphorus product more than 55. Among 50 hemodialysis sessions only 17 sessions (34%) had URR ≥ 65% as shown in Fig 1.

**Table 1: Mean ± SD of various parameters**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Mean Value (Unit)</th>
</tr>
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<tbody>
<tr>
<td>Hemoglobin (Hb)</td>
<td>8.78 ± 1.04 (gm/dl)</td>
</tr>
<tr>
<td>Serum albumin</td>
<td>33.46 ± 4.70 (gm/lit)</td>
</tr>
<tr>
<td>Corrected calcium</td>
<td>8.28 ± 0.81 (mg/dl)</td>
</tr>
<tr>
<td>Serum phosphorus</td>
<td>5.45 ± 2.36 (mg/dl)</td>
</tr>
<tr>
<td>Calcium and phosphorus product</td>
<td>44.99 ± 2.07 (mg²/dl²)</td>
</tr>
<tr>
<td>Urea reduction ratio</td>
<td>60.35 ± 9.26 %</td>
</tr>
<tr>
<td>single-pool Kt/V</td>
<td>1.15 ± 0.30</td>
</tr>
<tr>
<td>Ultrafiltrate volume (UF)</td>
<td>2.04 ± 1.03 (liters)</td>
</tr>
</tbody>
</table>

**Figure 1: Frequency of adequate HD based on URR**

![Diagram showing frequency of adequate HD based on URR](image_url)
Dialysis adequacy in ESRD ...

Figure 2: Frequency of adequate HD based on spKt/v

Among 50 hemodialysis sessions only 21 sessions (42%) had sp Kt/V ≥ 1.2 as shown in Fig 2.

Total number of patients in this study using hemodialyzer for the first time were nineteen, for the second time were eighteen and for the third or fourth time were only thirteen. The mean sp Kt/V for first use of hemodialyzer was 1.23±0.32, while for second, third or fourth were 1.13±0.21 and 1.03±0.36 respectively. The Error Bar diagram comparing each group showed 95% confidence interval overlapping that indicated no significant differences between group. However, mean of Kt/V linearly decreased with reuses. (Fig 3)

Figure 3: Error Bar Diagram of Kt/V versus number of times dialyzer used

Discussion

Survival of dialysis patients is strongly associated with delivered dialysis dose. According to KDOQI guidelines for hemodialysis patients, the minimally adequate dose of dialysis should be a single-pool Kt/V of 1.2 or URR of 65%. Hemodialysis Adequacy Clinical Practice Guidelines 2006 recommends spKt/V of 2/week (minimum spKt/V corresponding to a standardized Kt/V of approximate 2.0/week). Previous study from Nepal showed that around 75.0% of the HD patients had inadequate dialysis, where, URR was less than 57%. Inadequate HD is independently associated with increased hospitalizations, hospital days and inpatient expenditures thus has its direct impact on morbidity and health care costs.

Owen et al in their retrospective study concluded that URR of < 60% was associated with increased mortality. Single pool Kt/V is independently associated with patient survival. Our study showed that majority of patients had hemodialysis adequacy below recommended. Among 50 hemodialysis sessions only 21 sessions (42%) had sp Kt/V ≥ 1.2. This is not a surprising finding as we are performing only twice a week HD in deficient resources and excessive patients per dialysis machine. Furthermore, the findings of our study are better than reported from other centers in Nepal. A study done DN Manandhar et al in 2009 in Nepal Medical College, about dialysis adequacy, showed the average spKt/V as 0.95±0.28 and URR was 54.82±11.2%. They also studied the effectiveness of dialyzer reuse and found that reuse of dialyzer is effective in urea clearance and its practice is safe and cost effective. The lack of adequate hemodialysis might be due to factors like reuse of dialyzer and low blood flow rate. The better result of our study than that of DN Manandhar et al may be due to less time duration per session of HD in their case.

In our study, mean Hb of patient was 8.78 gm/dl. Only 9 patients (18%) had hemoglobin level ≥ 10 gm/dl. Lower Hb levels; seen in our study can be due to lower nutritional status, twice a week dialysis, and poor compliance with drugs. As study done in India by Chauhan R et al in 2015 also reported similar finding. Similarly, mean albumin is also lower, which is due to poor nutritional status and renal loss. Lower value of serum albumin is also related to chronic inflammation in patients with ESRD. According to KDOQI guidelines, serum levels of corrected total calcium should be maintained within the normal range preferably toward the lower end (8.4
to 9.5 mg/dL and calcium-phosphorus product should be maintained at &lt;55 mg²/dL.² In this study, calcium-phosphorus product of all patient was within the acceptable limit as per KDOQI. Majority of patients were receiving phosphate binder drugs at the time of study, thus maintaining calcium-phosphorus product in acceptable limits. Kim GH et al in 2014 reported the similar finding where majority of patients had serum calcium, serum phosphorus and calcium-phosphorus product within the recommended guideline.²²

Full 240 minutes dialysis time should be provided 3 times a week to achieve targets in accordance with KDOQI guidelines which will improve long-term outcomes in patients on chronic HD. However convincing patients to increase their frequency is not easier in our context due to limited HD centers and huge financial requirement. One of the recent study to know the socioeconomic status of ESRD patients in Nepal revealed that on an average patient spent Rs.2,40,000 per year in dialysis. Similarly, medication cost was Rs.1,80,000 and transplantation cost was Rs.5,00,000 to 10,00,000.¹³ Patient education and financial support is crucial for better quality of life of patients with end stage renal disease.

Further there is not a considerable uniformity between healthcare centers providing hemodialysis service in terms of dialysis adequacy. We recommend prescribing hemodialysis based on regular interval assessment of single-pool Kt/V of each centers. Lower spKt/V can be improved by taking into consideration the confounding factors like nutrition, filter type, reuse of dialyzer, dialysis duration and underlying comorbidities. There are some limitations in our study. We assessed hemodialysis adequacy for each patient just once instead of measuring Kt/V and URR in several occasions and all patient were receiving twice per week therapy of HD which is not recommended by KDOQI guideline.

Conclusion

Despite the current clinical guidelines, hemodialysis seems to be inadequate in majority of patients. Adequacy of hemodialysis can be obtained by increasing its frequency, avoiding multiple use of dialyzer and increasing blood flow rate.

Conflicts of interest: None declared

References