Evaluation of dialysis adequacy in patients under hemodialysis and effectiveness of dialysers reuses

DN Manandhar, PK Chhetri, R Tiwari and S Lamichhane

Hemodialysis unit, Department of Medicine, Nepal Medical College and Teaching Hospital, Jorpati, Kathmandu, Nepal

Corresponding author: Dr. Dhiraj Narayan Manandhar, Lecturer, Department of Medicine, Nepal Medical College and Teaching Hospital, Jorpati, Kathmandu, Nepal; e-mail: dhiraj783@gmail.com

ABSTRACT

Reuse of dialysers is being practiced since the start of hemodialysis (HD) service in Nepal, which is cost effective as well as safe. A retrospective study was done in Nepal Medical College and Teaching Hospital. We reviewed case records of the year 2008 and retrieved required data such as pre and post urea, post dialysis weight and ultrafiltration volume from 186 sessions of dialysis of 60 patients. Dialysis sessions were divided into nine groups according to the number of use of dialyser. Out of 60 patients, 40 were male. Mean age of the study population was 45.82±15.42 yrs (range 18-78). Dialysers were reprocessed manually up to 9 times. Adequacy of dialysis was assessed using single pool Kt/v (spKt/v) and urea reduction rate (URR). Mean pre urea, post urea and spKt/v were 160± 51.2 mg/dL, 71.8±28.5 mg/dL and 0.95±0.28 respectively. Mean URR was 54.82±11.24%. Out of total 186 sessions, spKt/v was ≥ 1.2 in only 31 sessions (17.0%). There was no significant difference in mean spKt/v between the groups (p=0.87). When compared between the individual groups e.g. 1st vs. 7th, 1st vs. 8th and 1st vs. 9th, there was no significant difference in spKt/v. Dialysis is inadequate in most of our patients undergoing HD twice a week. Reuse of dialyser is effective in urea clearance and the practice of reuse is cost effective and safe.

Keywords: spKt/v, reuse of dialyser, hemodialysis, end stage kidney disease.

INTRODUCTION

The burden of end stage kidney disease (ESKD) patients requiring renal replacement therapy (RRT) is increasing day by day in Nepal. Hemodialysis (HD) is one form of RRT which is very popular in Nepal amongst nephrologists and patients as well. The cost of RRT is very high and HD is no exception. The average cost of each session of HD varies between 1,500-3,000 NRs. (US$ 19-38; 1 US$ = 80 NRs May 2009) (personal communications) depending upon the centers. Due to economic constrains, almost all of ESKD patients of Nepal are undergoing HD twice a week each of four hours duration. To further decrease the cost of therapy, all HD centers are reusing dialysers which are reprocessed manually in most of the centers. The cost of HD in Nepal is very important because of very low per capita income (US$ 418; 2007 1 US$ = 80 NRs May 2009) and unavailability of insurance/ re-imbursement policies.

Different studies done in the past have shown that reuse of cellulose or cellular acetate based dialysers were beneficial as it rendered the membrane more biocompatible with blood.[1] For reprocessing, different chemicals are used e.g. Renalin (made up of peroxyacetic acid, acetic acid and hydrogen peroxide), formaldehyde and glutaraldehyde.[2] Reuse of dialysers is associated with low cost. Reuse of dialyser is safe if the reprocessing procedure is done as per the protocol.[3] Reuse of the dialyser may affect its performance as a result of deposition of blood elements inside the lumen of the blood compartment and on to the dialyser membrane. Reprocessing procedure may also damage the membrane thus affecting the performance.[2]

An index of dialysis dose is the fractional clearance of urea which is expressed as Kt/v.[4] Kt/v and urea reduction rate (URR) are the indicators of dialysis adequacy. The K-DOQI guidelines recommend a minimum spKt/v of 1.2 which corresponds to URR of 65.0% for HD thrice a week.[5] This study was carried out to assess the dialysis adequacy of patients under HD in Nepal Medical College and Teaching Hospital (NMCTH) and evaluate the effectiveness of reuse of dialysers as to the best of our knowledge this kind of study has not been done in Nepal.

MATERIALS AND METHODS

This was a retrospective study carried out in HD unit of NMCTH. The study period was carried out in the year 2008. Patients who were dialysed for four hours using CAHP 1.3 (cellulose acetate; Baxter company) dialysers and having data of pre and post blood urea level were included in the study. We used Nikkisso DBB 26 and 27 (Japan) hemodialysis machines for HD. Blood flow ranged from 200-250 ml/min and dialysate rate was fixed at 500 ml/min. We used bicarbonate as a buffering agent.

Table-1: Blood Pre urea, Post urea and spKt/v of individual groups

No. of use	Pre urea (mg/dL) (mean±SD)	Post urea (mg/dL) (mean±SD)	SpKt/v (mean±SD)
1st (n=64)	162.30±60.30	72.50±31.80	0.96±.28
2nd (n=17)	153.30±44.80	64.30±22.50	1.0±0.25
3rd (n=6)	153.0±30.40	64.50±13.0	0.99±0.26
4th (n=6)	161.30±48.60	72.0±16.60	0.92±0.36
5th (n=7)	139.10±35.80	62.0±16.60	0.93±0.20
6th (n=22)	179.54±55.65	83.22±33.34	0.90±0.24
7th (n= 33)	147.63±37.80	68.87±23.70	0.90±0.30
8th (n= 18)	166.83±55.13	70.0±27.0	1.02±0.20
9th (n=13)	161.54±39.84	77.23±34.85	0.92±0.42

At the end of each dialysis session, dialyser and tubing were immediately cleaned manually with hydrogen peroxide and reverse osmosis treated water. After thorough cleaning, the dialyser and tubing were filled with 4.0% formalin and stored with proper labeling.

We reviewed case records of patients on HD and retrieved the required data from 186 sessions of HD of 60 patients. All the data required such as age, sex, ultrafiltration volume, post dialysis weight, pre and post blood urea were entered in a data sheet of Microsoft office XP Excel Worksheet. Adequacy of dialysis was assessed using single pool Kt/v (spKt/v) and URR. Data were analyzed using the software SPSS ver. 11.5. spKt/v was calculated using the formula:[6]

Sp(Kt/v)= -ln(R-0.008xt)+(4-3.5xR)xUF/W; where, R=post Blood urea nitrogen (BUN)/pre BUN; t= duration of hemodialysis in hours; UF= Ultrafiltrate volume in liters; W= post dialysis weight in Kg.

URR was calculated with the formula:[7]

100X(1-Post BUN/Pre BUN)Mean and standard deviations of age, pre urea, post urea, spKt/v and URR were calculated. Dialysis sessions were grouped into nine groups according to number of uses of dialyser. spKt/v of >1.2 and URR of >65.0% are considered to be adequate dialysis.[5] Anova test was used to compare the means between the groups. Independent't' test was used to compare the means between 1st and 7th, 1st and 8th, 1st and 9th use. p value of <0.05 was taken as significant.

RESULTS

There were total of 60 patients out of which 40 were males. Total of 186 sessions of dialysis sessions were included. Mean age of the study population was 45.82±15.24 years (range 18-78). We reused dialysers for maximum of 9 times. Mean pre urea and post urea were 160± 51.2 mg/dL and 71.8±28.5 mg/dL respectively. Likewise mean spKt/v and URR were 0.95±0.28 and 54.82±11.24% respectively. Only in 31 sessions (17.0%) of 186 sessions spKt/v was ≥ 1.2. Table-1 shows mean pre urea, mean post urea and mean spKt/v of individual use of dialysers.

There was no significant difference in mean spKt/v between the groups (p=0.87). When compared between the individual groups e.g. 1st vs. 7th, 8th and 9th, there was no significant difference in mean spKt/v (Table-2).

There were no reported incidences of febrile reactions and other untoward side effects related to the reuse of dialysers.

DISCUSSION

Results showed the average spKt/v as 0.95±0.28 which is far less than the recommended spKt/v of ≥1.2. URR was noted 54.82±11.2% which is also less than the recommended value of 65.0%. In our study only 17.0% of the sessions had received adequate dialysis. Previous study from Nepal also showed that around 75.0% of the population had inadequate dialysis, where, URR was 57.3%.[8] Studies from neighboring countries like India and Pakistan also showed inadequate dialysis in their population. In India, Rao *et al* reported that only 50.0% of the dialysis delivered a spKt/v of ≥1.[9] In a study by Anees *et al*, URR of Pakistani patients was adequate in 31.0% only.[10] In studies from Malaysia[11] and Iran[12], spKt/v were 1.5 and 1.17 respectively which are quite comparable with the recommended Kt/v. Kt/v is related with URR. Inadequate HD can increase the risk of mortality and morbidity hence hospitalization. Inadequate HD can also result in malnutrition, functional impairment and anemia.[12] Owen *et al* in their retrospective study concluded that URR of <60.0% was associated with increased mortality.[13] In another retrospective study by Collins *et al*, spKt/v was shown to be independently associated with patient survival.[14] Japanese Patient Registration Committee has reported progressively decreasing risk of death with increasing spKt/v value of up to 1.8.[15] This shows that the dialysis of most of our patients who are undergoing HD twice a week is inadequate and our patients are at increased risk of mortality and morbidity. To achieve the recommended spKt/v, we have to increase the frequency of dialysis.Reuse of dialyser is practiced in many countries of the world especially in Asia and North America. Reuse of dialyser is desirable because it is cost effective and has benefit of elimination of 1st use syndrome and improved biocompatibility. Waste disposable is also

Table-2: Difference of means and significances between the individual groups

	Significance	95.0% CI of the difference of means
1st use vs. 7th use	0.40	-0.07-0.18
1st use vs. 8th use	0.27	-0.19-0.05
1st use vs. 9th use	0.80	-0.23-0.30

decreased with reuse of dialysers which decreases the environmental impact.[16,17] Reuse of dialysers is very common in India, Pakistan, China and Singapore where the incidence of reusing is practiced in >95.0% of HD centers. In Nepal as well as in neighboring countries, most of the centers are reprocessing dialysers manually. Reprocessing of dialyser is generally done with automated machines in developed and developing countries e.g. in Singapore, Australia, Saudi Arabia, South Korea, US and European countries. Countries like India, Pakistan, and Philippines are reprocessing dialysers manually.[18]

Reuse of dialyser is associated with decreased cost of HD. This is especially important in countries like Nepal. In the present study, we could not compare the cost between reuse and single use dialyser as in our study we did not have patients who were on single use dialyser. However, in Nepal cost of CAHP 1.3 dialyser is around 1400 NRs (US$ 17.5 1 US$ = 80 NRs May 2009). On an average we are reusing dialysers seven to nine times. So when dialyser is reused, one patient can save up to 8400-11200 NRs (US$ 105-140 1 US$ = 80 NRs May 2009). Cost of one session of HD in our center is 2000 NRs (US$ 25 1 US$ = 80 NRs May 2009) when dialysers are reused for 7-8 times. One session of HD in India cost between US$ 15 and 40.[19] Therefore, the cost one patient saves, is around 50.0% when dialysers are reused for 7 times. If we can reuse dialysers for more sessions, the saving can further increase. Frequency of reuse can vary with the facility available and averages 17 reuse per dialyser when automated reprocessor is used. Orlowski *et al* reported in their study that multiple uses of dialysers could save cost up to 70.0%.[16] Wittich *et al* have shown in their study that reprocessing of high flux dialyser can save up to 95.0% annually when the dialyser is reused for 20 times.[18] Other several studies have shown substantial savings with reuse.[17] However, Manns *et al* have shown that there is an increased hospitalization rate (but not mortality) of reuse group and cost saving was also small.[20]

There was no significant difference in Kt/v amongst the groups in our study. Other studies also show similar results. Orlowski *et al* showed in their study that decrease in elimination effectiveness was statistically irrelevant and had no clinical significance.[17] Cheung *et al* reported slight decrease in urea clearance of about 1.0-2.0% per 10 reuses regardless of the porosity of the membrane and reprocessing methods.[2] Collins *et al* did not find any significant difference in relative risk of death or in hospitalization risk among reuse as well as non reuse groups.[21] There was a trend for urea, creatinine and phosphate clearance to decrease with reuse for both the low and high flux dialysers but not satisfactorily significant. â2 microglobulin (â2MC) clearance decreased substantially with the reuse of high flux dialysers and the clearance of â2MC depended on both the membrane materials and the reprocessing technique.[2,22] Murthy *et al* observed in their study that the urea and creatinine clearance were better preserved in reprocessed cellulose based dialysers than with synthetic dialysers. They also observed that â2MC was not cleared with cellulose dialysers and new F80B (polysulphone) dialysers didn't behave as high flux dialysers but became one only after reprocessing with bleach and formaldehyde for 15-20 times to reach the â2MC clearance cut off level of 20ml/min.[23] In view of saving and insignificant difference in Kt/v with the number of reuse of dialysers, we can recommend reusing dialysers in a resource poor country like Nepal provided reprocessing procedure is performed according to described protocol. In a study by Drozdz *et al,* they found that reuse was safe if the reprocessing protocol was strictly observed and they also did not find any significant influence of reprocessing procedure on Kt/v.[3]

There was no difference between the overall rate of pyrogenic reaction between the reusers and non reusers. Gram negative bacterial infections have been reported in reprocessed dialysers but most of the infections have been attributed to use of contaminated water supply and dialysate. There has been conflicting reports on mortality. But it appeared that mortality was more likely to be affected by dialysis dose, nutrition and anemia correction.[18]

Dialysis is inadequate in our patients who are on HD twice a week. Reused dialyser is efficient as well safe and cost effective. Adequacy of dialysis can be increased by increasing the frequency of dialysis, introduction of insurance/re-imbursement policy and reusing dialyser for maximum times after being reprocessed as per the protocol. However, a prospective large scaled multicentered trial is required to confirm this finding.

REFERENCES

1. Lowrie EG, Hakim RM. The effect on patient health of using reprocessed artificial kidneys. *Proc Dial Transplant Forum* 1980; 10: 86-9.

2. Cheung AK, Agodoa LY, Daugirdas JT *et al* and the hemodialysis (Hemo) study group. Effects of hemodialyzer reuse on clearances of urea and ß$_2$-microglobulin. *J Amer Soc Nephrol* 1999; 10: 117-27.
3. Drozdz M, Su³owicz W, Drozdz D, Kopeæ J. Use of urea kinetic modeling for evaluating the efficacy of reusing capillary dialyzers. *Przegl Lek* 1996; 53: 406-11.
4. Locatelli F, Buoncristiani U, Canaud B, Köhler H, Petitclerc T, Zucchelli P. Dialysis dose and frequency. *Nephrol Dial Transplant* 2005; 20: 285-96.
5. NKF-K/DOQI Clinical practice guidelines for hemodialysis adeuqacy: update 2000. *Amer J Kidney Dis* 2001; 37: S7-S64.
6. Daugirdas JT. Simplified equations for monitoring Kt/v, PCRn, eKt/v and ePCRn. *Adv Ren Replace Ther* 1995; 2: 295-304.
7. Lowrie EG, Kew NK. The urea reduction ratio (URR), A simple method for evaluation hemodialysis treatment. *Contem Dial Nephrol* 1992; 12: 11-3.
8. Manandhar DN, Chhetri PK, Pahari LR, Tiwari R, Chowdhary SK. Nutritional assessment of patients under hemodialysis in Nepal Medical College Teaching Hospital. *Nepal Med Coll J* 2008; 10: 164-9.
9. Rao M, Juneja R, Shirly RB, Jacob CK. Haemodialysis for end-stage renal disease in southern India- a perspective from a tertiary referral care centre. *Nephrol Dial Transplant* 1998; 13: 2494-500.
10. Anees M, Ahmed AM, Rizwan SM. Evaluation of nutritional status of patients on haemodialysis. *J Coll Physicians Surg Pakistan* 2004; 14: 665-9.
11. Shaza AM, Rozina G, Izham MI, Azhar SS. Dialysis for end stage renal disease: a descriptive study in Penang Hospital. *Med J Malaysia* 2005; 60: 320-7.
12. Pourfarziani V, Ghanbarpour F, Nemati E, Taheri S, Einollahi B. Laboratory variables and treatment adequacy in hemodialysis patients in Iran. *Saudi J Kidney Dis Transplant* 2008; 19: 842-6.
13. Owen WF, Lew NL, Liu Y, Lowrie EG, Lazarus JM. The urea reduction ration and serum albumin concentration as predictors of mortality in patients undergoing hemodialysis. *New Engl J Med* 1993; 329: 1001-6.
14. Collins AJ, Ma JZ, Umen A, Keshaviah P. Urea index and other predictors of hemodialysis patient survival. *Amer J Kidney Dis* 1994; 23: 272-82.
15. Shinzato T, Nakai S Akiba T *et al*. Survival in long term haemodialysis patients: results from the annual survey of Japanese Society for Dialysis Therapy. *Nephol Dial Transplant* 1997; 12: 884-8.
16. Or³owski A, Szepietowski T. Repeated use of hemodialysis equipment in the same patient. *Polim Med* 1991; 21: 15-24.
17. Twardowski ZJ. Dialyzer reuse—part II: advantages and disadvantages. *Semin Dial* 2006; 19: 217-26.
18. Brown C. Current opinion and controversies of dialyser reuse. *Saudi J Kidney Dis Transpl* 2001; 12: 352-63.
19. Agarwal SK, Srivastava RK. Chronic kidney disease in India: challenges and solutions. *Nephron Clin Prac* 2009; 111: 197-203.
20. Manns BJ, Taub K, Richardson RM, Donaldson C. To reuse or not to reuse? An economic evaluation of hemodialyzer reuse versus conventional single-use hemodialysis for chronic hemodialysis patients. *Inter J Technol Assess Health Care* 2002; 18: 81-93.
21. Collins AJ, Liu J, Ebben JP. Dialyser reuse-associated mortality and hospitalization risk in incident Medicare haemodialysis patients. *Nephrol Dial Transplant* 2004; 19: 1245-51.
22. Leypoldt JK, Cheung AK, Deeter RB. Effect of hemodialyzer reuse: dissociation between clearances of small and large solutes. *Amer J Kidney Dis* 1998; 32: 295-301.
23. Murthy BVR, Sundaram S, Jaber BL *et al*. Effect of formaldehyde/bleach reprocessing on in vivo performances of high-efficiency cellulose and high-flux polysulphone dialysers. *J Amer Soc Nephrol* 1998; 9: 464-72.