Effect of Dialyzer Reuse on Dialyzer Performance

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SUMMARY

Background: Dialyzer reuse has been practiced for many years and since its beginning questions have been raised about safety of the practice and also its effect on dialyzer clearance of small solutes. The aim of this study was to determine the effect of reusing dialyzer on clearance of small solutes and adequacy of dialysis.

Materials and Methods: The in-vivo clearance of dialyzer that were manually reprocessed in 33 end stage renal disease patients were tested for clearance of urea and creatinine by collecting simultaneous arterial and venous blood samples one hour into dialysis at blood flow rate (QB) of 200ml/ minute and dialysate flow rate (QD) of 500ml/minute at negative pressure of 0mmHg. Urea reduction ration (URR) was used as adequacy of dialysis session. Seventeen patients used the nephorsytem cuprophand dialyzer while 16 used the fresenius F5 polysulfone dialyzers.

Results: Dialyzers were reused for four times. The clearance of urea and creatinine decreased significantly at the 4th use for the cuprophand nephrosystem dialyzers (139.5ml/minute at 1st use to 132.9±6.9ml/min at 4th use $p<0.05$) creatinine clearance dropped from 111.5ml/min to 107.6ml/min at 4th use $p<0.0.5$. the urea clearance for fresenius F5 dialyzers dropped significantly after 3rd use from 149.9±3.9ml/min to 144.5±3.8ml/min $p<0.05$. the mean URR declined with reuse for both F5 polysulfone dialyzer and NP08E dialyzers but this was not statisticant; for the nephrosystem cuprophan dialyzer URR dropped from 52.4±15.4 at 1st use to 46.6±11.6 at 4th use $P>0.05$ and for Fresenius F5 dialyzers from 52.4±7.8 at 1st use vs 48.5±5.5 at 4th use $p>0.5$.

Conclusion: manually reprocessed dialyzers can be used up to times without significantly affecting the solute clearance.

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KEYWORDS: **dialyzer reuse, urea clearance, dialysis adequacy**

INTRODUCTION

Haemodialysis is the most common type of treatment for end stage renal disease (ESRD)[1] Haemodialysis though readily available, is expensive and containment of cost is important for the institution that take care of the patients and those responsible for payment of cost. In order to reduce cost, the practice of using the same dialyzer several time has become widespread [2,3]. Reuse of dialyzers has become a common practice in the United States and currently ore than 65% of the units practice reuse[4]. In Nigeria, the practice of reusing dialyzers started in 1990 and mainly for economic reasons[5]. The way in which reuse is performed varies from unit to unit. Dialyzers can be cleansed either by machine or by hand, and different units choose different chemicals to use for the cleaning process.

Dialyzer reuse has been controversial since its beginning, and question have been raised about the safety of the practice. Several studies have demonstrated that when properly conducted dialyzer reused is safe and may be beneficial to the patient[6-8]. Among the beneficial effects are improved biocompatibility[6], reduced incidence of first use syndrome[7] and reduced dialyzer cost[5,8]. In general there is no evidence to suggest excess risk of complications or death attributable to reuse[9]. However, it is well known that reprocessing of dialyzers may reduce their solute clearance capabilities and certain complications could arise due to the type of sterilant and disinfectant used[10-11]. In his study, we report on the effect of dialyzer reuse on clearance of solutes and adequacy of dialysis in a out –patients dialysis unit.

METHODS

Thirty three patients with established end stage renal failure who were on regular maintenance dialysis in a public out-patient dialysis unit in Lagos were recruited. Patients dialysed 8 to 12 hours a week suing either the nephrosystem cuprophan NP08E dialyzer (membrane surface area. 0.8m^2) or fresenius polysulphone F6 dialyzers (surface area 1.0m^2). Excluded were patients who were hepatitis and human immunodeficiency virus positive because dialyzers used on the patients were not reused. Haemodialysis was carried out using single pass, individual proportioning dialysate delivery system with acetate as the base. Nine patients were dialyzed via arterio-venous fistula, while 24 via single lumen femoral catheters.

Performance of the dialyzer was assessed by in-vivo blood urea and creatinine clearance[12]. arterial and venous blood samples were collected simultaneously across the dialyzer one hour after commencing dialysis at blood flow rate (QB) of 200ml/minute and dialysate flow rate (QD) of 500ml/minutes at a Tran membrane pressure of 0mmHg[12]. Clearance was calculated using the formula[12].

$$K = \frac{CB_i - CB_0}{CB_i} \times QB$$

Where K = clearance

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CB_i = Concentration blood in (arterial)
CB_0 = Concentration blood out (venous)
QB = Blood flow rate

Dialyzers were manually reprocessed and reused for up to 4 times for administrative reason (standing order in the unit.). After each dialysis section, the blood compartment was rinse with reverse osmosis water, while the dialysate compartment was cleansed by reverse ultra filtration technique. Hydrogen peroxide was used as the chemical cleaning agent and 4% formaldehyde solution as the sterilizing agent. Before dialysis, the dialyzer arbitrarily after 4th use, for aesthetic reasons, technical problems like burst membranes or if efficiently fell markedly before 4th use.

Adequacy of each dialysis session was measured by urea reduction ratio (URR) expressed as a percentage[13].

$$URR = \frac{\text{Pre-dialysis urea} - \text{Post dialysis X } 100}{\text{Pre dialysis urea}}$$

Statistics

Results are reported as mean values + standard deviation (SD). Comparison of group means was by student t test for unpaired variables. The level of significance was set at $p<0.05$.

RESULTS

There were 33 patients on chronic haemodialysis, 24(72.7%) males and 9 (28.3%) females. The are range was 18 – 68 years with mean age of 45.8±15.6 years for male patients and 45.8±14.5 years for female $p>0.05$. The duration of dialysis ranged from one month to 3 years. Seventeen patients used the nephrosystem cuprophan dialyzers while 16 used the Fresenius F5 polysulphone dialyzes. Twenty three (69.7%) patients were bale to use their dialyzers for up to 4 times. The reasons for not completing four uses were death in 4 patients were transferred to the dialysis facilities, 2 patients lost to follow up and 1 dialyzer was discarded for ruptured membrane. Table 1 shows the in-vivo clearance of urea and creatinine. The clearance of urea and creatinine decreases significantly at the 4th use for clearance for the cuprophan nephrosystem dialyzers (139.5mlminute at 1st use to 132.9±6.9ml/min at 4th $p<0.05$) creatinine clearance for fresenius F5 dialyzer dropped significantly after 3rd use from 149.9±3.9ml/min to 144.5±3.8ml/min $p<0.05$. the mean URR declined with reuse for both F5 polysulfone dialyzers and NP08E dialyzers was 52.4±15.4 at 1st use vs 46.6±11.6% at 4th use $p>0.05$ and for Fresenius F5 dialyzers 52.4±7.8 at 1st use vs 48.5±5.5 at 4th use. The mean URR for both types of dialyzers for 1st and subsequent uses was below the recommended target of 65% indicating that most patients were under dialyzed.

DISCUSSION

The effect of dialyzer reuse on dialyzer performance was assessed by measuring the in-vivo clearance of small molecular weight solutes and adequacy of dialysis as assessed by URR. Our results showed significant drop in solute clearance after 3rd and 4th uses fro the polysulfone and cuprophan dialyzes respectively. This is similar to reports by other researchers[14,15] but differs form other studies that reported no significant drop in the clearance of small solutes and increased number of reuses[16,1 8]. Billiouw et al reported a drop in clearance from 4th to 7th use of dialyzers that were reprocessed using automated machines[14]. In contrast, Liao et al reported a decrease in cleanse after 20th use of filtryzer B dialyzers reprocessed manually using sodium hypochlorite as cleansing agent[16]. Gagnon et al have also reported increased usage with automated systems using sodium hypochlorite[17]. The decline in dialyzer performance can be attribute to the clogging of the fibres and reduction in blood compartment volume. Incomplete removal of blood residue is also a possible cause of reduction in dialytic effect. The difference in umber of time dialyzers were reused in our study

Table 1: In-vivo clearance for urea and creatinine

Dialyzer	Solute	Clearance (ml/minute) at different reuses. Means ± SD			
		1st use n = 17	2nd use n = 14	3rd use n = 13	4th use n = 13
Nephrosystem cuprophan	Urea	139.5 ± 6.6	135.3 ± 6.6	135.5 ± 7.7	132.9 ± 6.9
	Creatinine	111.5 ± 6.5 n = 16	110.7 ± 7.7 n = 15	109.3 ± 6.2 n = 11	**107.6 ± 7.0 n = 10
Fresenius F5 polysulfone	Urea	149.9 ± 3.9	145.1 ± 4.8	**144.5 ± 3.8	**141.3 ± 3.8
	Creatinine	117.8 ± 4.7	114.3 ± 6.8	**111.5 ± 5.2	**108.9 ± 5.8

**P<0.05

Table 2: Mean urea reduction ration at difference reuses

Dialyzer	Precent urea reduction ratio at different reuses. Means ± SD			
	1st use n = 17	2nd use n = 14	3rd use n = 13	4th use n = 13
Nephrosystem	52.4 ± 6.6 n = 16	51.7 ± 12.9 n = 15	49.8 ± 16.1 n = 11	46.6 ± 11.6 n = 10
Fresenius F5	52.4 ± 7.8	51.7 ± 7.6	49.7 ± 4.6	48.5 ± 5.5

and the other studies may be due to the technique of reprocessing, we used manual reprocessing technique and employed hydrogen peroxide as cleansing agent while they used sodium hypochlorite as cleansing agent and used automated reprocessing system. Sodium hypochlorite plays an important role in dissolving protein and fibrin thereby increasing number of reuses and reused dialyzer efficacy. However, sodium hypochlorite also has a disadvantage; it appears to cause a high incidence of blood leaks due to etching of cellulose based membranes leading to increased protein loss in the dialysate[19]. Sodium hypochlorite is also reported to restore the complement activating capability of cellulose based membrenes[19]. In addition to increased usage, the automated cleansing systems also have the added advantage of carrying out other test of dialyzer functions like measurement of residual fibre bundle volume, fibre integrity, and ultrafiltration capacity which recommends automated reprocessing above the manual technique. Studies have also shown that the membrane characteristic could determine reusability[15,20]. Kadiri et al reported that the cuporphan dialyzers were more reusable than the polysulfone dialyzers[15]. our finding is in keeping with this as clearance of solute dropped much earlier with the polysulfone dialyzers compared with cuprophan dialyzers.

In this study the dose of dialysis delivered as measured by URR was inadequate for most patients from the first session of dialysis and the dose declined further with reuse although not significantly probably because of the small number of patients and low reuse number. Sherman et al reported a decline in Kt/v with high reuse in 436 patients[21]. Several reasons could be adduced in dialyzer solute clearance. Second, all patients were under-dialyzed because dialysis prescription was not individualized as all patients used the same dialyzer and had same session length without putting into consideration for size of the patients and residual renal function. Third, interference form hospital administrators, who determine the type of consumables to be purchased without prior consultation with the Nephrologists; thus limiting dialysis treatment to the use of consumable provided by the hospital authorities at the expense of delivering adequate dialysis. Dialyzer efficiency is one of the important determinants of dialysis adequacy others being session length. And blood flow rate[22]. high performance and more biocompatible dialyzes should routinely be used and prescription aimed at delivering a urea reduction ratio 65% or more which correlates with a Kt/v of 1.2 of single use 13. given the significant fall in dialyzer efficiency for urea removal that can occur after repeated uses of a dialyzer, dialysis prescriptions in units practicing reuse should be designed to deliver at Kt/V or URR value that exceeds the dose used for patient treated with single use dialyzers to make allowance for any possible reuse induced reduction in clearance.

Frequent quantification of dialysis dose and prompt intervention for inadequate delivery will help patients treated with reused dialyzers. For this reason, the measurement of Kt/V for urea as recommended by the AAMI or the determination of the urea reduction ratio (URR) is strongly recommended as least monthly to assesses the adequacy of the dialysis therapy for patients on regular chronic dialysis programmes[23]. The national kidney foundation takes no position for or against dialyzer reuse24. in view of the uncertainties related to the safety and biological impact of reuse and its potential beneficial and detrimental effects be undertaken with each patient[24]. Most researches agree that reuse is not harmful if properly conducted and there is no conclusive evidence to substantiate the notion that either morbidity or mortality associated wit single use or reuse is different[9].

Although the number of reuse achieved in this study was low; the authors still propose that hits practice be encourages in most dialysis units in the country for economic reasons. Given the increasing number of patients presenting with ESRD, the rising cost of dialysis consumables compounded by the prevailing poor economic conditions in the country and the current situation where dialysis treatment is rendered on the basis of out of pocket service, reuse appears to be an attractive option for reducing cost. The international society of Nephrology is concerned about making dialysis affordable especially in the developing countries (proceedings from the 3rd World Congress of Nephrology) and dialyzer reuse is one of the cheaper options being considered. It must however be emphasized that he procedure be conducted properly according to AAMI standards[23], or the automated technique adopted for better results and increased uses. Technicians and other personnel responsible for the reprocessing of dialyzer should receive proper training. These health care provides should be certified in reprocessing technique by and examining body like the Nephrology Association of Nigeria so that professional competency can be assured and centred performing reuse should be accredited periodically by this body to ensure they meet up with required standards. If the above

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