RESEARCH ARTICLE

COMPARISON OF OUTCOMES OF HEMODIALYSIS ADEQUACY WITH DIALYSATE FLOW RATE OF 500 ML/MINUTE AND 650 ML/MINUTE

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ABSTRACT

Background: The average achievement of hemodialysis adequacy which was carried out twice a week for 4 hours at Fatmawati Hospital was 1.49. As many as 82% had not reached adequate dialysis (Kt/V<1.8). Based on the calculation of the dialysate proportioning system, hemodialysis for 4 hours with a Quick Dialysate Flow (QD) of 500 ml/minute will leave dialysate. In1month observation, there were 1.755.6 liters residual dialysate parts Acid (A) and 6,283.2 liters parts Bicarbonate (B). On the other hand, QD affects the achievement of HD compliance. This study wants to know the difference in hemodialysis adequacy with QD 500 ml/minute and 650 ml/minute.

Methods: This study used a case-control analysis for the control group (QD 500 ml/minute) and the intervention group (QD 650 ml/minute) with a Quasy Experiment design through a comparative analysis approach with matching/ cross over techniques. The study was conducted on 115 respondents with a total of 230 HD sessions. Hemodialysis adequacy (Kt/V) is measured 2 times using the QX calculate application (Daugirdas formula), namely at QD 500 ml/minute and QD 650 ml/minute for further analysis using the Wilcoxon Signed-Rank test.

Results: The mean Kt/V in the intervention group was 1.69 and in the control group 1.49 (p-value=0.006) and it was seen that there was a shift in the achievement of HD adequacy to a better category.

Conclusion: Hemodialysis with QD 650 ml/minute resulted in better hemodialysis adequacy than QD 500 ml/minute.

Keywords: adequacy of hemodialysis, dialysate, hemodialysis, QD.

INTRODUCTION

Adequacy of dialysis is an important factor in reducing the morbidity and mortality of hemodialysis patients. The most commonly used marker of dialysis adequacy is Kt/V. Kt/V is influenced by various factors, namely dialyzer efficiency, duration of hemodialysis, blood flow rate, and dialysate flow rate. The faster the dialysate flow will increase the efficiency of diffusion of urea from the blood to the dialysate. The optimal dialysate flow rate is 1.5-2 times the speed of blood flow (Daugirdas, 2015). In daily practice, the dialysate flow rate is often set at 500 ml/minute. Using this figure, there is often some remaining dialysate at the end of a hemodialysis session. One of the reasons for the remaining dialysate is the duration of HD which lasts 3 or 4 hours. Data from the Indonesian Renal Registry (IRR) in 2017 shows that 41% of hemodialysis in Indonesia is still carried out with a duration of 3-4 hours.

The observation at Fatmawati Hospital showed that hemodialysis (HD) which was carried out with a duration of 4 hours and QD 500 ml/minute left dialysate part Acid (A) and part Bicarbonate (B). The average remaining part A and part B dialysate was 1.9 liters and 3.4 liters. If in 1 day there are 77 sessions of HD, then in 1 week (6 working days), part A and part B, respectively, will be the remaining 438.9 liters and 1.570.8 liters and a month will be 1.755.6 liters and 6.283.2 liters, and with a longer period of time the number will increase. The remaining unused dialysate will become liquid waste and become a burden for the hospital in managing the liquid waste.

The description of the remaining dialysate above is following the calculation of the proportioning system of dialysate acetate, bicarbonate and pure water (reverse osmosis water/RO). In the Dialysis Unit of Fatmawati Hospital with HD duration for 4 hours and QD 500 ml/minute, the need for dialysate (acid, bicarbonate and RO

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water) is 120 liters per 1 patient per 1 HD session, with the ratio stated on the acid label (part A) and RO water is 1: 35.83 and the ratio of part B to RO water is 1: 19.13. Meanwhile, with QD 650 ml/minute, for 4 hours using the ratio of part A and part B dialysate, the need for dialysate is 156 liters. Part A can still be used in 2 HD sessions, with the total consumption of part A is 8.48 liters. Part A will still have 1.52 liters left and Part B in 1 HD session will still have 2.25 liters left.

The use of a dialysate with a higher flow rate can increase the volume of clean blood that enters the dialyser. Sonikian's research, 2019 which found that after increasing dialysate flow rate from 500 to 700 ml/min we observed pre-dialysis reductions in serum concentrations of urea (154,8641,4 to 140,3630,3 mg/dlp=0,013), creatinine (9,762,2 to 8,962,2 mg/dl-p=0,001). This study showed that the achievement of adequate hemodialysis would be better with a greater QD.

Hemodialysis with high QD is safe for routine hemodialysis patients. Research by Krahn RE, et al (2019) showed that hemodialysis with high QD was not associated with the incidence of ventricular arrhythmias in Holter monitoring and had no effect on hemodynamics, changes in total serum calcium and blood potassium levels.

Based on the various studies above, the researchers wanted to improve the achievement of hemodialysis adequacy by utilizing the residual dialysate waste by looking at the difference in the mean Kt/V on hemodialysis with dialysate flow rates (QD) of 500 ml/minute and 650 ml/minute.

Knowing the difference in the achievement of hemodialysis adequacy performed with QD 500 ml/minute and 650 ml/minute.

METHODS

This research is a case-control study with a Quasy Experiment design through a comparative analysis approach with a matching/cross-over technique. The study was conducted on 115 respondents with a total of 230 HD sessions. The intervention group underwent hemodialysis with QD 650 ml / minute, while the control group with QD 500 ml/minute. The research subjects were routine hemodialysis patients at Fatmawati Hospital. 115 subjects previously underwent hemodialysis with QD 500 ml/minute, then cross-over and underwent hemodialysis with QD 650 ml/minute. Kt/V was measured on day 30 of each treatment using Daugirdas' estimated single-pool Kt/V. Kt/V = -log e ((urea post HD / urea pre-HD) -0.008t) + ((4-3.5 (urea post HD / urea pre-HD)) x ((Pre-HD Weight - Post HD Weight) / Post HD Weight)). The difference in mean Kt / V was analyzed using the Wilcoxon Signed-Rank test. This study focuses on controlling variables to maximize the variance of variables related to the research hypothesis, minimizing the variance of confounding variables that may affect the experimental results, but are not the aim of the study. In addition, this study minimizes the variance of errors, including measurement errors. For this reason, researchers controlled for confounding variables in the form of duration and frequency of HD, Quick of Blood (QB), type of dialyzer (Ko-A) and vascular access by making these variables the same between the first measurement and the second measurement.

RESULT

Table 1. Distribution of Characteristics of Research Subjects in the Dialysis Unit, Fatmawati Hospital

Characteristics of Subjects	All	HD 2 times/week	HD 3 times/week
Subjects	115	104 (90,4%)	11 (9,6%)
Age (Years)	53 ± 15	53 ± 16	52 ± 12
Comorbid Disease			
Hypertension	54 (46,8%)	48 (46,2%)	6 (54,5%)
Dm	48 (41,7%)	44 (42,3%)	4 (36,4%)
Others (Glomerulonephritis, Malignancy, Urinary Tract Stones, Etc.)	13 (11,5%)	12 (11,5%)	1 (9,1%)
Vascular Access			
Jugular CDL	33 (28,7%)	32 (30,8%)	1(9,1%)
Femoral CDL	3 (2,6%)	2(1,9%)	1(9,1%)
Av Fistula	79 (68,7)	70(67,3%)	9 (81,8%)
Long of hemodialysis (Years)	3,5 ± 5	4,1 ± 5	2,9 ± 1

Table 2. Distribution of IDWG, UFG, Blood Pressure and Laboratory Parameters With QD 500 ml/minute and QD 650 ml/minute (n = 115)

Parameter	QD 500 ml/minute	QD 650 ml/minute	P
IDWG (Kg)	1,6 ± 0,8	1,9 ± 0,7	0,371
UFG (Liter)	2,7 ± 0,8	2,9 ± 0,8	0,177
Systolic Blood Pressure	151 ± 25	156 ± 22	0,305
Diastolic Blood Pressure	82 ± 18	83 ± 13	0,590
MAP	105 ± 19	107 ± 15	0,411
Intradialytic Hypotension	7,3 %	5,2%	0,625
Hb	9,7 ± 1,9	10 ± 1,6	0,099
Phosphate	5,9 ± 1,4	5.0 ± 1,4	0,023
Calcium Ion	1,01 ± 0,13	0,98 ± 0,07	0,448

This study also saw the differences in several parameters when the HD was done with QD 500 ml/minute and QD 650 ml/minute. There was no difference in Inter Dialytic Weight Gain (IDWG), Ultrafiltration Goal (UFG), blood pressure and the incidence of intradialytic hypotension, hemoglobin (Hb) and calcium ion between the two groups (p> 0.05). There was a decrease in phosphate from 5.9 ± 1.4 to 5.0 ± 1.4 (p = 0.023).

Table 3. Distribution of Hemodialysis Adequacy Achievement with the Matching/Crossed Over Technique and the Wilcoxon Signed Rank Analysis Test at the Dialysis Unit at Fatmawati Hospital, Jakarta (n = 115)

	All subject		p	HD 2 times/week		p	HD 3 times/week		P
	500 ml/mnt	650 ml/mnt		500 ml/mnt	650 ml/mnt		500 ml/mnt	650 ml/mnt	
Kt/V	1,49 ± 0,3	1,69 ± 0,17	0,006*	1,49± 0,3	1,72 ± 0,18	0,009*	1,49± 0,43	1,48± 0,21	0,317

Description: * p <0.05

There was an increase in Kt / V in all subjects and in subjects with HD 2x / week (p <0.05). However, in the subject of HD 3x / week there was no difference in Kt / V (p = 0.317).

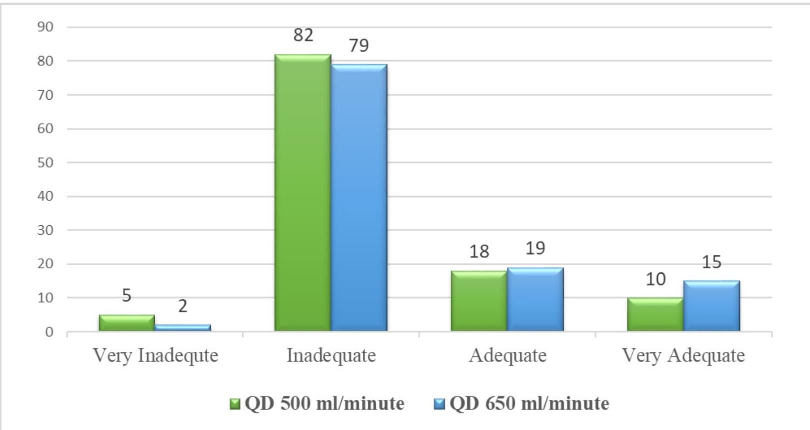

Figure 1. Comparison of HD Adequacy Achievement with QD 500 ml/min and 650 ml/min in the Dialysis Unit Fatmawati Hospital (n= 115)

Information:

HD 2 times : Very Inadequate: Kt /V<1, Inadequate: Kt / V 1-<1.8, Adequate: Kt/V≥1.8-2, Very Adequate: Kt / V>2.

HD 3 times : Very Inadequate: Kt /V<0.6, Inadequate: Kt / V 0.6-<1.2, Adequate: Kt/V≥1.2-1.4, Very Adequate: Kt / V>1.4

Figure 1 above shows a shift in the achievement of HD compliance to a better category; The very inadequate and inadequate adequacy category decreased from QD 500 ml / minute to QD 650 ml/minute, and conversely, the adequate and very adequate category experienced an increase in number.

Table 4. Cross Distribution of HD Adequacy Comparative Analysis With QD 500 ml/minute to 650 ml/minute at the Dialysis Unit at Fatmawati Hospital (n = 115)

HD Adequacy categories (Kt/V)		QD 650 ml/minute					*p-Value*
		Very Inadequate	Inadequate	Adequate	Very Adequate	**Total**	
QD500 ml/minute	Very Inadequate	1	3	1	0	**5**	**0.006**
	Inadequate	1	75	4	2	**82**	
	Adequate	0	1	13	4	**18**	
	Very Adequate	0	0	1	9	**10**	
	Total	**2**	**79**	**19**	**15**	**115**	

From the cross table above, it can be seen that in HD with a QD of 500 ml/minute, the total subject in the very inadequate category is 5, then on the cross over to QD 650 ml/minute, it changes to 2; Of the 5 subjects, 1 of them remained in the very inadequate category, 3 subjects rose to the inadequate category, and 1 subject became adequate. Likewise, at the time of QD 500 ml/minute, 82 subjects were in the inadequate category, then with a QD of 650 ml/minute it changed to 79. Of the 82 subjects, 1 subject became very inadequate (down category), 75 subjects remained in the inadequate category. adequate, 4 subjects rose to adequate, and 2 subjects became very adequate. The changes for each category can be seen in the table above.

The increase in QD to 650 ml/min also led to a decrease in the residual dialysate. The average remaining part A dialysate (2 HD sessions) was 0.55 liters, and part B 1.3 liters per HD session. Within a month part A remains 508.2 liters, and part B remains 2.402.4 liters. The remaining dialysate for 1 month with a QD of 500 ml/minute reached 8.038.8 liters, while with a QD of 650 ml/minute it was reduced to 2.905.2 liters.

DISCUSSION

This study found an increase in hemodialysis adequacy in all subjects and in subjects with HD 2 times/week (1.49 ± 0.3 vs 1.69 ± 0.17 and 1.49 ± 0.3 vs 1.72 ± 0.18). With the same HD duration, vascular access, dialyzers and the same amount of quick ~~of~~ blood (QB), the mean Kt/V for all respondents at dialysate velocities of 500 ml / minute and 650 ml/minute had a difference of 0.2 while in the data twice HD is 0.23. The difference in Kt / V in this study was greater than that of Cha (2016). Cha obtained an increase in Kt / V by increasing QD from 500 ml/minute to 700 ml / minute (1.41 ± 0.23 vs 1.46 ± 0.24; p = 0.007.[7] Research Azar AT (2009) on patients HD 3x / week obtained an increase in Kt / V of 5.88% (p = 0.013) by increasing the QD from 500 ml/minute to 800 ml/minute.[8]

One of the quality parameters of hemodialysis is the achievement of good HD adequacy, which is influenced by the mass transfer area coefficient (CoA). CoA to urea on the dialyzer increases with increasing QD.[3,5,6] This results in better urea clearance, which affects the achievement of HD adequacy. Similar findings were also found in Bhimani's (2010) study. Bhimani increased QD from 350 ml/minute to 500 ml/minute and 800 ml/minute obtained an increase in urea clearance of 232 ± 3, 252 ± 7, 281 ± 3 (p <0.001) and phosphate clearance of 168 ± 6, 178 ± 9, 194 ± 8 (p <0.001). In his research, Bhimani obtained results where urea and phosphate clearance were significantly increased by increasing dialysate flow rate.[9]

In this study, an increase in QD from 500 ml/minute to 650 ml/minute also had a significant effect on decreasing serum phosphate (5.9 ± 1.4 vs 5.0 ± 1.4; p = 0.023). Phosphate is a toxin with a small molecular size of less than 500 Da and is well dialyzed. Yu's study showed that post-dialysis phosphate levels decreased significantly compared to pre-dialysis (0.84 ± 0.21 vs 2.00 ± 0.53 mmol / L; p <0.01).[10] Apart from hemodialysis, phosphate levels are also affected by food and phosphate-binding drugs. In this study, all subjects received the same phosphate binding drug, namely calcium carbonate. However, this study did not control for the amount of phosphate in the diet of the study subjects, so there could be a biased.

Hemodialysis with low QD (<500 ml/minute) is often performed in patients with hemodynamically unstable conditions.[1] This study found that an increase in QD was not correlated with a decrease in blood pressure and the incidence of intradialytic hypotension (p> 0.05).

Some of the research subjects experienced a decrease in Kt/V and a decrease in the HD achievement category. This is due to the increase in IDWG and UFG, namely 1.6 kg to 1.9 kg and 2.7 liters to 2.9 liters. The increase in IDWG and UFG led to an increase in the volume of urea distribution. The increase in urea clearance due to the increase in QD was not proportional to the increase in the volume of urea distribution, resulting in a decrease in the value of Kt/V. The addition of too large an IDWG (> 5% dry body weight) or > 0.5 kg/day) makes post HD dry weight not to be achieved. The dry weight that is not achieved can also reduce the achievement of HD compliance.

The increase in QD from 500 ml/minute to 650 ml/minute also had a positive impact on reducing the amount of hospital wastewater. With a QD of 500 ml/minute, the remaining dialysate was 8. 038.8 liters, down to 2.905.2 liters with a QD of 650 ml/minute. From the hospital management side, this will reduce the burden on the hospital in terms of costs and human resources to manage the liquid waste.

This study had limitations, namely, the small sample size did not monitor the patient's phosphate intake, and only used Kt/V as a parameter for hemodialysis adequacy.

CONCLUSION

Hemodialysis service providers must always think critically and look for innovative ways to improve the achievement of hemodialysis adequacy amidst various limitations. Many things affect HD adequacy, if one factor is limited in optimizing it in achieving good adequacy, then there are still many factors that can be used to improve the achievement of HD adequacy. One of the factors that can be used to increase adequacy is the use of a larger QD. An increase in QD to 650 ml/min can provide a significant increase in Kt/V and is not correlated with changes in patient hemodynamics.

Suggestions for further research are to control UFG in looking for a correlation between adequate hemodialysis and QD or other confounding variables and the number of samples to be multiplied, the time to carry out research can be considered in order to achieve more accurate research results. In addition, it is very important to find the most effective way for patients to be compliant and obedient in controlling IDWG.

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