Assessment of Hemodialysis Adequacy by Online Clearance Monitoring

Articoli originali

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ABSTRACT

Measuring the uremic solute clearance is an important factor in analyzing the adequacy of maintenance hemodialysis (MHD) therapy. Conventionally hemodialysis (HD) adequacy was measured by urea removal through the Daugirdas single pool kt/V (spKt/V) formula. We aimed in our study to correlate online clearance monitoring (OCM) spKt/V to the Urea Reduction Ratio (URR) and Daugirdas spKt/V in maintenance hemodialysis patients. This single-center cross-sectional study, conducted at the hemodialysis unit in the nephrology department of SRM Medical College Hospital and Research Center, involved 100 participants undergoing maintenance hemodialysis (MHD) therapy for 200 sessions. The OCM with URR and Daugirdas spKt/V values were obtained from each session and the results were analyzed using SPSS software with $p < 0.05$ significance. In the results, we found that the OCM spKt/V, Daugirdas spKt/V, and URR showed positive correlations. These results emphasize that OCM can be an alternative method to assess dialysis adequacy for every session without the need for repeated blood sampling.

KEYWORDS: Hemodialysis, Adequacy, Online clearance monitoring, spKt/V

Introduction

Hemodialysis (HD) is the most common form of renal replacement therapy (RRT). Measuring the dialysis-delivered dose is an important factor in analyzing the adequacy of patients undergoing maintenance hemodialysis (MHD) therapy. Conventionally, HD adequacy was measured by sampling blood at pre- and post-hemodialysis therapy to calculate the urea removal through the Daugirdas spKt/V formula spKt/V = −ln(R-0.008×t) + (4-3.5×R) 0.55×UF/V. However, the drawback of conventional HD adequacy measurement is the requirement for blood sample collection during HD sessions [1]. An alternative non-invasive method named Online Clearance Monitoring (OCM) has evolved and uses a UV absorbance mechanism to measure the urea removal value at the dialysate outlet which calculates the spKt/V in the machine itself and provides the delivered dialysis dose at each dialysis session without the need of the blood urea samples [2].

Methods and Methodology

This single-center cross-sectional study, conducted at the HD unit in the nephrology department of SRM Medical College Hospital and Research Center, involved 100 participants undergoing MHD. A total of 200 HD sessions were included in the study, where all sessions were done with B. Braun Dialog+ machine. Patients who were on MHD therapy for more than three months and who were older than 18 were included; patients on AKI and other modalities were excluded. After getting approval from IEC (SRMIEC-ST0523-462), each participant's informed consent was recorded.

The pre- and post-HD urea samples were collected to calculate blood spKt/V by using the Daugirdas formula and the OCM Kt/V measurement was also obtained from the B Braun machine of the same session as were blood urea samples also collected. Likewise, two session data sets of blood urea spKt/V and OCM Kt/V for each patient for a total of 200 sessions were collected and compared for the similarities in the results by using statistical SPSS software in which p-value <0.05 is considered statistically significant.

Results

S.No	Variables	Sub-Variable	No of participants	Percentage	Mean	SD
1	Age (Yrs)	18-45	22	22%	53.35	12.88
		45-60	42	42%		
		>60	36	36%		
2	Gender	Male	66	66%	–	–
		Female	34	34%		
3	Dialysis Vintage	1-4 (Yrs)	39	39%	5.07	3.19
		4-8 (Yrs)	46	46%		
		>8 (Yrs)	15	15%		
4	Frequency of dialysis	Once	5	5%	2.22	0.52
		Twice	68	68%		
		Thrice	27	27%		
5	Pre HD Wt (kg)				61.45	13.91
6	Post HD Wt (kg)				58.52	13.51
7	Blood Flow Rate (ml/min)				282.15	35.43
8	Dialysate Flow Rate (ml/min)				500	0
9	Ultrafiltration Goal (UF) in (L)				3.16	1.05
10	Dry weight (kg)		100	100%	58.19	13.42
11	Pre-Urea	session 1 (mg/dl)	100	100%	105.78	30.95
		session 2 (mg/dl)	100	100%		
12	Post Urea	session 1 (mg/dl)	100	100%	29.74	13.1
		session 2 (mg/dl)	100	100%		

Table 1. Demographic and Hemodialysis data.

Table 1 represents the demographic and hemodialysis data of 100 MHD patients; the correlation between Daugirdas SpKt/V and OCM was significant, with a p-value of 0.001 and R^2 of 0.16. A significant relationship was also seen between OCM and URR, with a p-value of 0.012 and an R^2 of 0.06. Also, Daugirdas spKt/v with URR shows a significant connection with p-value (0.001) and R^2 (0.13) (Table 2) (Figure 1).

S. No	Method	N	Mean	p-Value
1	spkt/V	200	1.36 ± 0.13	0.001
	OCM	200	1.43 ± 0.20	R^2 = 0.16
2	OCM	200	1.43 ± 0.20	0.012
	URR	200	72 ± 7.74	R^2 = 0.06
3	spkt/V	200	1.36 ± 0.13	0.001
	URR	200	72 ± 7.74	R^2 = 0.13

Table 2. Comparisons of different adequacy measurements.

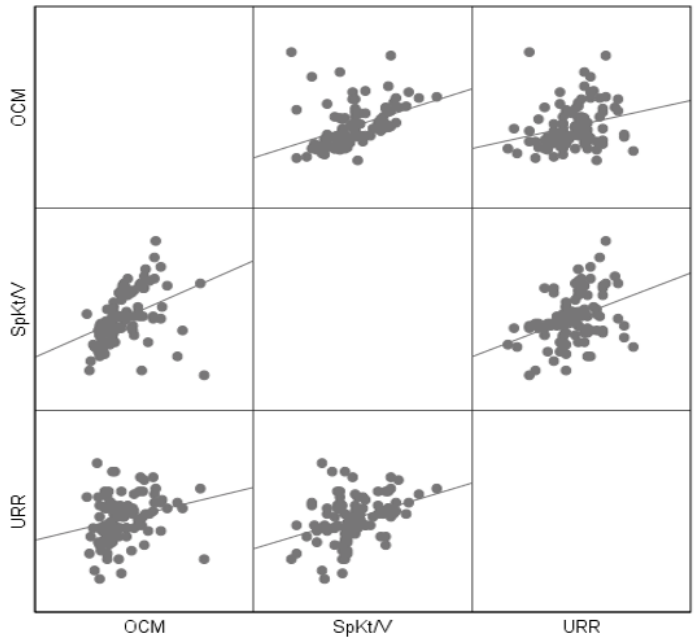

Figure 1. Linear Regression models for OCM, spKt/V, and URR.

Discussion

Urea is considered as the clearance marker due to its smaller molecular weight (60 Da), metabolic waste product, and large volume of distribution. The Daugirdas second generation of estimated single pool Kt/V formula −ln(R-0.008×t) + (4-3.5×R) 0.55×UF/V proposed by J.T. Daugirdas in 1993 is still followed worldwide. In this equation the symbols are represented as R = post-dialysis urea/pre-dialysis urea, t: dialysis time (hours), -ln = negative natural logarithm, UF = weight loss in kg, and V = anthropometric urea distribution volume in liters [1], which demands pre- and post-HD blood samples to monitor urea clearance level which involves manpower and cost expenses to process it. An alternative method was developed to overcome these issues and ease the adequacy monitoring for each dialysis session: Online Clearance Monitoring (OCM).

Various hemodialysis machines utilize different OCM methods. They are the Ionic or conductivity method, the Ultraviolet absorbance method, and the Ionic dialysance method. In B. Braun Dialog+ hemodialysis machine OCM works by the principle of UV spectroscopy which measures the Kt/V by ultraviolet absorbance of spent dialysate [2, 3]. This current study was done to establish the similarities among spKt/V by the Daugirdas formula, URR, and OCM spKt/V. The main finding of this

cross-sectional study is that the Daugirdas equation spKt/V was statistically correlated with OCM ($p = 0.001$, $R^2 = 0.16$) and URR ($p = 0.001$, $R^2 = 0.13$). Meanwhile, OCM also shows similar correlation with the URR ($p = 0.012$, $R^2 = 0.06$).

Our study findings concur with the study done by Baloğlu İ et al. who performed a cross-sectional study on 48 MHD patients to establish the correlation between OCM spKt/V, URR, and Daugirdas spKt/V with the results revealing that comparison between Daugirdas Kt/V and URR showed a statistically relevant significance ($p < 0.0001$, $r = 0.92$) and URR was positively correlated with two formulas, the relationship between Daugirdas Kt/V and URR was statistically significant [5].

In a study done by A. Alayoud, D. et.al., conducted on 35 patients on MHD to find the significance between Ionic dialysance in the Fresenius 5008 machine and the second-generation Daugirdas formula spKt/V showed the significant correlation between Kt/V OCM and Kt/V Dsp ($r = 0.71$, $p < 0.001$) [4].

We found there were more similarities among the mean spKt/V values of blood-based and OCM-based adequacy monitoring (1.36 vs 1.43), which concurs with the study done by Tayebi-Khosroshahi H et.al., conducted on 120 HD patients and OCM data obtained from Fresenius 4008 dialysis machine showed the mean values of Urea Clearance (spKt/V) obtained from blood samples and OCM were almost similar (1.20 vs. 1.11) [6]. This emphasizes the OCM spKt/V can be considered as an alternative method of monitoring dialysis adequacy for each dialysis session which eases the adequacy monitoring by reducing the need for blood samples.

Conclusion

OCM recorded at a HD machine can be considered an alternative method to assess dialysis adequacy without the need for blood sampling. OCM can be recorded at dialysis machines through which we can assess the dialysis adequacy of each session which helps us to make changes in dialysis prescription. Thus, adequacy can be measured in each dialysis session and not monthly.

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