BLOOD PRESSURE VARIABILITY GRADUALLY INCREASES FROM THE FIRST TO THE SECOND INTERDIALYTIC DAY IN PATIENTS UNDERGOING HEMODIALYSIS

Antonios Karpetas,[1] Charalampos Loutradis,[2] Antonios A. Lazaridis,[2] Athanasios Bikos,[3] Georgios Tzanis,[2] Georgios Koutroumpas,[4] Konstantinos Mavromatidis,[1] Vasilios Liakopoulos,[5] Pantelis Zebekakis,[5] Luis M. Ruilope,[6] Gianfranco Parati,[7] Pantelis A. Sarafidis[2]

1) Therapeutiki Hemodialysis Unit, Thessaloniki, Greece; **2)** Department of Nephrology, Hippokration Hospital, Aristotle University of Thessaloniki, Greece; **3)** Pieria Hemodialysis Unit, Katerini, Greece; **4)** Hemodialysis Unit, Achillopouleion General Hospital, Volos, Greece; **5)** Section of Nephrology and Hypertension, 1st Department of Medicine, AHEPA Hospital, Aristotle University of Thessaloniki, Greece; **6)** Department of Preventive Medicine and Public Health, School of Medicine, Universidad Autónoma de Madrid/IdiPAZ and CIBER in Epidemiology and Public Health (CIBERESP), Madrid, Spain; **7)** Department of Cardiovascular, Neural and Metabolic Sciences, IRCCS S.Luca Hospital, Istituto Auxologico Italiano & Dept of Medicine and Surgery, University of Milan-Bicocca, Milan, Italy

54TH ERA-EDTA CONGRESS Madrid, Spain June 3rd-6th 2017

ARISTOTLE UNIVERSITY OF THESSALONIKI

INTRODUCTION AND AIMS

Patients with end-stage-renal-disease under hemodialysis have increased cardiovascular risk [1] and experience severe BP fluctuations during the dialysis session and the subsequent interdialytic period [2]. Assessment of short-term and mid-term (day-by-day over 48hours) BP variability (BPV) has become feasible mainly through the wider availability of noninvasive home and ambulatory blood pressure monitoring (ABPM) [3]. BPV may be an additional risk factor for cardiovascular events and preliminary data suggest increased BPV with advancing stages of CKD. This is the first study to examine BPV during the whole intra- and interdialytic period in hemodialysis patients with ABPM.

METHODS

A total of 160 patients receiving maintenance hemodialysis had 48-hour ABPM with the Mobil-o-Graph device during a regular dialysis session and the subsequent interdialytic interval. Brachial and aortic BPV were calculated with validated formulas and were compared between Day 1 and Day 2 of the interdialytic period (44-hours), Day 1 and Day 2 of the total 48-hour interval (including the dialysis session), and between the two respective daytime periods and nighttime periods.

RESULTS

Table 1 presents demographic characteristics, routine laboratory data and dialysis-related parameters of the study participants. All brachial systolic BPV indices [standard deviation (SD): 14.75±4.38 vs 15.91±4.41, p=0.001; weighted SD (wSD): 13.80±4.00 vs 14.89±3.90, p<0.001; coefficient of variation (CV): 11.34±2.91 vs 11.93±2.94, p=0.011; average real variability (ARV): 11.38±3.44 vs 12.32±3.65, p<0.001)] were increasing from Day 1 to Day 2 during the 44-h interdialytic period (Table 2, Figures 1-3). Similarly, all indexes of diastolic BP variability were significantly increased in Day 2, with the exception of CV. Aortic systolic and diastolic BPV indices displayed a similar pattern. Further, all studied brachial systolic and diastolic BPV indexes were also lower during daytime 1 than daytime 2 (systolic ARV 11.56±3.98 vs 12.44±4.03, p=0.002); systolic ARV was lower in nighttime 1 compared to nighttime 2 (11.20±5.09 vs 12.18±4.66, p=0.045) (Table 3, Figures 2-3). No significant increase was noted in the proportion of reverse dippers (35.6% to 38.8%) from Day 1 to Day 2 (Table 4). In multivariate regression analysis pre-hemodialysis SBP, age and diabetes were independently associated with increased SBP ARV (Table 5).

Characteristic		Value	Characteristic		Value
N		160	N		160
Age (years)		63.4 ± 14.1	Serum creatinine (mg/dl)		8.26 ± 2.48
Sex	Male, n (%)	95 (59.4)	Serum calcium (mg/dl)		8.96 ± 0.74
	Female, n (%)	65 (40.6)	Serum phosphate (mg/dl)		5.1 ± 1.5
Height (cm)		168.3 ± 9.00	Parathormone (ng/L)		289.5 ± 212.5
Weight (kg)		74.0± 14.8	RAAS blockers	ARBs, n (%)	31 (19.4)
BMI (kg/m^2)		26.1 ± 5.0		ACEIs, n (%)	9 (5.6)
Dialysis vintage (months)		37.8±37.4		Renin inhibitors, n (%)	1 (0.6)
Residual Urine output (>0 ml/24h)		111 (69.4)		Aldosterone blockers, n (%)	2 (1.3)
Diabetes mellitus, n (%)		54 (33.8)	CCBs, n (%)		78 (48.8)
Hypertension, n (%)		128 (80.0)	Loop diuretics, n (%)		58 (36.3)
Dyslipidemia, n (%)		43 (26.9)	B-blockers, n (%)		83 (51.9)
Peripheral Vascular Disease, n (%)		10 (6.3)	Central active, n (%)		30 (18.8)
Coronary Heart Disease, n (%)		36 (22.5)	Statins, n (%)		68 (42.5)
Heart Failure, n (%)		11 (6.9)	EPO, n (%)		125 (78.1)
Stroke, n (%)		14 (8.8)	Pre hemodialysis SBP (mmHg)		145.0 ± 23.6
Smoking history, n (%)		27 (16.9)	URR (%)		67.0 ± 8.9
Hematocrit (%)		35.0 ± 3.8	UF rate (ml/kg/h)		7.3 ± 4.1
Serum urea (mg/dl)		138.4 ± 36.6	Interdialytic weight gain (kg)		1.86±1.06

Table 1. Baseline characteristics of study participants

Variable	48-h period including hemodialysis and the interdialytic period		P value	44-h interdialytic period		P value
	Day 1 (24-h period)	Day 2 (24-h period)		Day 1 (20-h period)	Day 2 (24-h period)	
Brachial SBP (mmHg)	130.52 ± 17.40	133.51 ± 17.54	<0.001	130.22 ± 18.39	133.51 ± 17.54	<0.001
Brachial SBP SD (mmHg)	15.44 ± 4.67	15.91 ± 4.41	0.169	14.75 ± 4.38	15.91 ± 4.41	0.001
Brachial SBP wSD (mmHg)	14.40 ± 4.26	14.89 ± 3.90	0.107	13.80 ± 4.00	14.89 ± 3.90	<0.001
Brachial SBP CV (%)	11.85 ± 3.28	11.93 ± 2.94	0.747	11.34 ± 2.91	11.93 ± 2.94	0.011
Brachial SBP ARV (mmHg)	11.12 ± 3.22	12.32 ± 3.65	<0.001	11.38 ± 3.44	12.32 ± 3.65	<0.001
Brachial DBP (mmHg)	77.94 ± 11.30	78.37 ± 11.17	0.256	77.19 ± 11.59	78.37 ± 11.17	0.002
Brachial DBP SD (mmHg)	10.86 ± 2.62	11.10 ± 2.39	0.252	10.69 ± 2.66	11.10 ± 2.39	0.042
Brachial DBP wSD (mmHg)	10.12 ± 2.37	10.52 ± 2.18	0.040	10.00 ± 2.48	10.52 ± 2.18	0.008
Brachial DBP CV (%)	14.15 ± 3.65	14.37 ± 3.45	0.404	14.04 ± 3.55	14.37 ± 3.45	0.204
Brachial DBP ARV (mmHg)	8.39 ± 1.98	9.29 ± 2.12	<0.001	8.77 ± 2.20	9.29 ± 2.12	0.002
Aortic SBP (mmHg)	118.57 ± 15.35	121.72 ± 15.51	<0.001	118.50 ± 16.00	121.72 ± 15.51	<0.001
Aortic SBP SD (mmHg)	14.33 ± 4.30	14.80 ± 4.14	0.104	13.89 ± 4.19	14.80 ± 4.14	0.002
Aortic SBP wSD (mmHg)	13.50 ± 4.06	13.86 ± 3.61	0.186	13.09 ± 3.95	13.86 ± 3.61	0.006
Aortic SBP CV (%)	12.13 ± 3.43	12.19 ± 3.17	0.773	11.74 ± 3.16	12.19 ± 3.17	0.047
Aortic SBP ARV (mmHg)	10.73 ± 3.15	12.05 ± 3.33	<0.001	11.12 ± 3.37	12.05 ± 3.33	<0.001
Aortic DBP (mmHg)	79.51 ± 11.41	79.92 ± 11.37	0.301	78.79 ± 11.64	79.92 ± 11.37	0.005
Aortic DBP SD (mmHg)	10.58 ± 2.43	10.79 ± 2.30	0.276	10.46 ± 2.52	10.79 ± 2.30	0.074
Aortic DBP wSD (mmHg)	9.82 ± 2.18	10.16 ± 2.08	0.060	9.72 ± 2.30	10.16 ± 2.08	0.015
Aortic DBP CV (%)	13.49 ± 3.27	13.68 ± 3.14	0.435	13.43 ± 3.18	13.68 ± 3.14	0.285
Aortic DBP ARV (mmHg)	8.14 ± 1.81	8.99 ± 1.95	<0.001	8.53 ± 2.00	8.99 ± 1.95	0.002

Table 2. Blood pressure and BPV parameters of ambulatory brachial and aortic SBP and DBP in the two-days period of the 48-h period including hemodialysis and the interdialytic period and the two-days period of the 44-h interdialytic period.

Variable	44-h interdialytic period					
	Daytime 1	Daytime 2	P value	Nighttime 1	Nighttime 2	P value
Brachial SBP (mmHg)	131.37 ± 18.67	134.06 ± 17.74	0.001	127.93 ± 19.77	132.21 ± 19.93	<0.001
Brachial SBP SD (mmHg)	14.44 ± 4.61	15.61 ± 4.43	0.001	12.52 ± 4.77	13.43 ± 4.83	0.039
Brachial SBP CV (%)	11.01 ± 3.17	11.66 ± 2.95	0.015	9.80 ± 3.33	10.24 ± 3.64	0.168
Brachial SBP ARV (mmHg)	11.56 ± 3.98	12.44 ± 4.03	0.002	11.20 ± 5.09	12.18 ± 4.66	0.045
Brachial DBP (mmHg)	78.73 ± 11.98	79.26 ± 11.69	0.188	74.14 ± 12.27	76.07 ± 11.40	0.001
Brachial DBP SD (mmHg)	10.19 ± 2.81	10.85 ± 2.46	0.007	9.61 ± 3.12	9.86 ± 2.95	0.368
Brachial DBP CV (%)	13.14 ± 3.71	13.94 ± 3.67	0.012	13.20 ± 4.48	13.18 ± 4.30	0.977
Brachial DBP ARV (mmHg)	8.65 ± 2.44	9.25 ± 2.37	0.004	9.16 ± 3.39	9.63 ± 3.23	0.127
Aortic SBP (mmHg)	119.25 ± 16.33	122.12 ± 15.98	<0.001	117.09 ± 17.43	120.95 ± 17.51	<0.001
Aortic SBP SD (mmHg)	13.43 ± 4.54	14.23 ± 4.16	0.012	12.41 ± 4.55	13.13 ± 4.83	0.092
Aortic SBP CV (%)	11.28 ± 3.48	11.68 ± 3.19	0.113	10.65 ± 3.59	10.95 ± 4.06	0.378
Aortic SBP ARV (mmHg)	10.99 ± 3.78	11.87 ± 3.71	<0.001	11.43 ± 5.02	12.69 ± 5.19	0.015
Aortic DBP (mmHg)	80.45 ± 12.04	80.92 ± 11.95	0.276	75.61 ± 12.34	77.54 ± 11.71	0.001
Aortic DBP SD (mmHg)	9.84 ± 2.63	10.30 ± 2.26	0.035	9.49 ± 3.10	9.87 ± 2.99	0.176
Aortic DBP CV (%)	12.39 ± 3.33	12.96 ± 3.27	0.042	12.75 ± 4.28	12.93 ± 4.20	0.644
Aortic DBP ARV (mmHg)	8.32 ± 2.26	8.73 ± 2.09	0.033	9.08 ± 3.45	9.82 ± 3.27	0.019

Table 3. Blood pressure and BPV parameters of ambulatory brachial and aortic SBP and DBP in the two daytime (daytime1, daytime 2) and two nighttime (nighttime 1, nighttime 2) periods of the 44-h interdialytic period.

Time period	Dipping profile				
	Non dippers	Reverse dippers	Dippers	Extreme dippers	p
Day 1 (20-hour period)	78 (48.8%)	57 (35.6%)	23 (14.4%)	2 (1.3%)	0.895
Day 2 (24-hour period)	74 (46.3%)	62 (38.8%)	21 (13.1%)	3 (1.9%)	

Table 4. Dipping profile of the study participants in Day 1 and Day 2 of the 44-h interdialytic interval.

Parameter	Univariate analysis		Multivariate analysis	
	Unadjusted Odds Ratio (95% CI)	P	Adjusted Odds Ratio (95% CI)	P
Age (per year increase)	1.060 (1.030-1.090)	**<0.001**	1.043 (1.005-1.082)	**0.025**
Dialysis Vintage (per month increase)	0.996 (0.987-1.005)	0.411		
Female Gender	1.595 (0.821-3.099)	0.168	1.245 (0.507-3.059)	0.632
BMI (per kg/m^2 increase)	1.027 (0.961-1.098)	0.436		
Diabetes	3.619 (1.798-7.283)	**<0.001**	2.466 (1.025-5.931)	**0.044**
Hypertension	1.824 (0.724-4.591)	0.202		
Peripheral Vascular Disease	8.783 (1.794-42.991)	0.007	3.320 (0.498-22.122	0.215
Coronary Heart Disease	3.199 (1.484-6.892)	0.003	1.430 (0.511-4.007)	0.496
Heart Failure	3.686 (1.028-13.213)	0.045	2.364 (0.433-12.919)	0.321
Dyslipidemia	1.560 (0.757-3.215)	0.228		
Stroke	1.066 (0.339-3.354)	0.913		
Smoking	1.470 (0.620-3.488)	0.382		
PreHD SBP (per mmHg increase)	1.023 (1.008-1.038)	**0.003**	1.024 (1.005-1.045)	**0.015**
Δ 24hSBP$_{mean}$ (per mmHg increase)	1.021 (0.980-1.063)	0.320		
Δ 24hDBP$_{mean}$ (per mmHg increase)	1.022 (0.954-1.096)	0.533		
UF rate (per ml/kg/h increase)	0.980 (0.897-1.071)	0.653		
URR (per % increase)	1.007 (0.963-1.053)	0.759		
Interdialytic weight gain (per kg increase)	1.166 (0.855-1.589)	0.331		
RAAS blockers	1.037 (0.488-2.202)	0.926		
Aldosterone blockers	1.925 (0.118-31.384)	0.646		
Centrally active agents	1.118 (0.488-2.560)	0.793		
β blockers	1.666 (0.853-3.255)	0.135	1.665 (0.706-3.925)	0.244
Loop diuretics	1.321 (0.669-2.607)	0.423		
CCBs	1.278 (0.661-2.473)	0.466		
EPO	2.901 (0.601-13.997)	0.185	3.369 (0.502-22.611)	0.211
Statins	2.072 (1.059-4.054)	0.033	2.077 (0.874-4.934)	0.098
Hematocrit (per % increase)	1.032 (0.943-1.129)	0.495		
Parathormone (per pg/ml increase)	0.999 (0.997-1.001)	0.250		

Table 5. Factors associated with high SBP ARV in the 44-h interdialytic period in univariate and multivariate analysis.

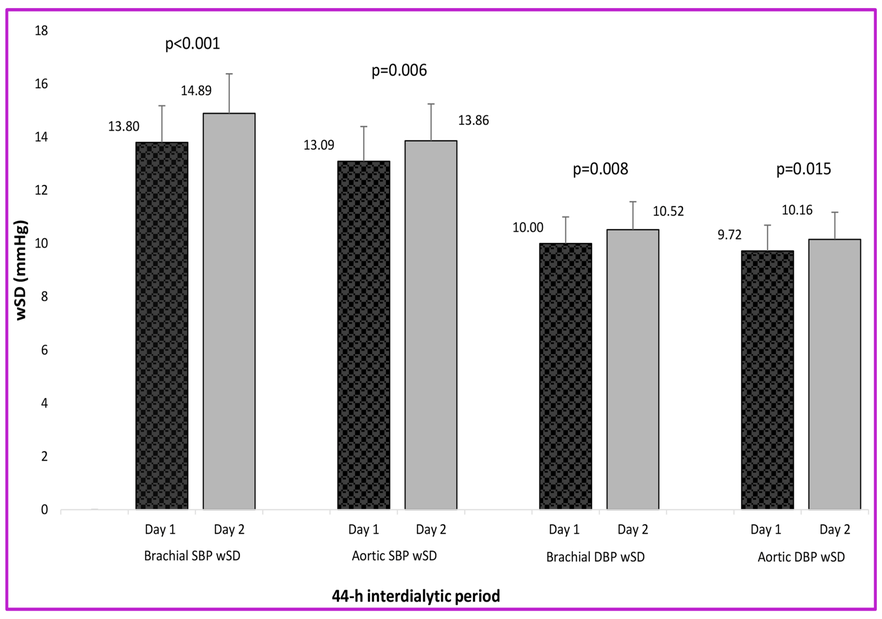

Figure 1. Levels of (a) brachial SBP wSD; (b) aortic SBP wSD; (c) brachial DBP wSD; aortic DBP wSD during Day 1 and Day 2 of the 44-h interdialytic period

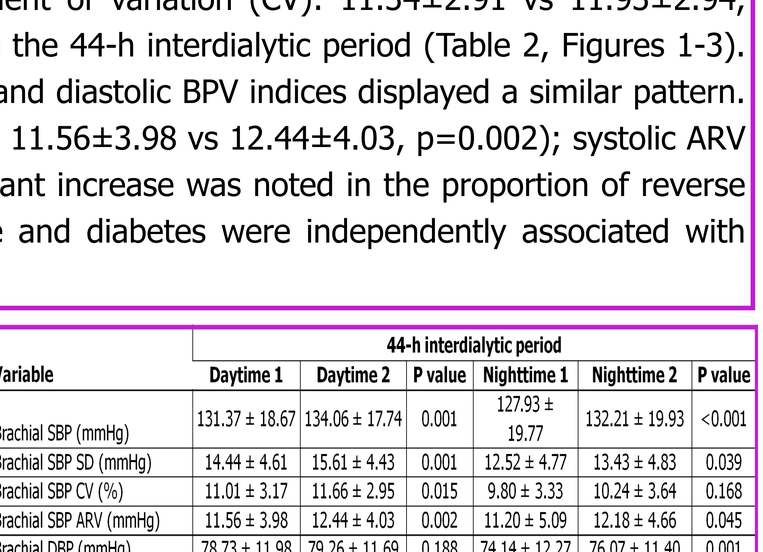

Figure 2. Levels of brachial SBP ARV in Day 1 and Day 2, as well as the daytime (daytime 1, daytime 2) and nighttime (nighttime 1, nighttime 2) periods of the 44-h interdialytic period

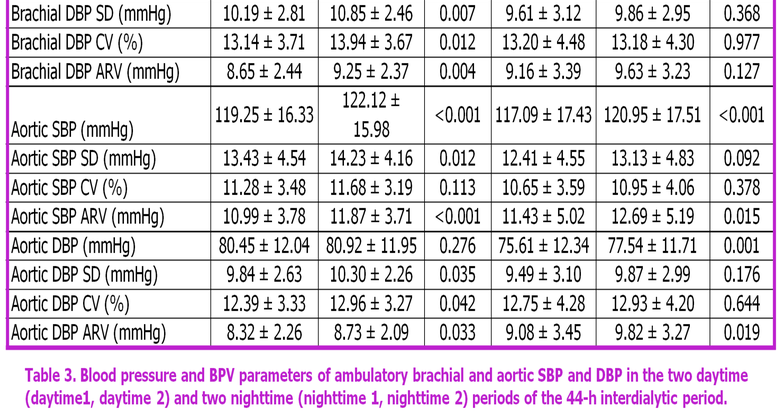

Figure 3. Levels of aortic SBP ARV in Day 1 and Day 2, as well as the daytime (daytime 1, daytime 2) and nighttime (nighttime 1, nighttime 2) periods of the 44-h interdialytic period

CONCLUSIONS

- This study is the first to use 48-hour ABPM to examine BPV over the dialysis session and a subsequent regular 2-day interdialytic interval in hemodialysis patients. We found that BPV is increased in Day 2 compared to Day 1 during the interdialytic period in hemodialysis patients; this could be another mechanism involved in the complex cardiovascular pathophysiology and increased cardiovascular mortality of these individuals.

REFERENCES

- Saran R, Li Y, et al. US Renal Data System 2015 Annual Data Report: Epidemiology of Kidney Disease in the United States. Am J Kidney Dis. 2016; 67: Svii, S1-305.
- Georgianos PI , et al. Pro: Should we move to more frequent haemodialysis schedules? Nephrol Dial Transplant 2015; 30:18-22.
- Parati G, et al. Blood pressure variability: assessment, predictive value, and potential as a therapeutic target. Curr Hypertens Rep 2015; 17:537.

DOI: 10.3252/pso.eu.54ERA.2017