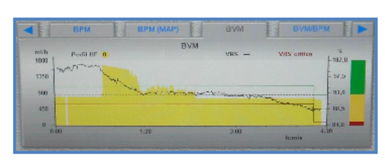
SENSITIVITY OF BLOOD VOLUME MONITORING FOR FLUID STATUS ASSESSMENT

Arias-Guillén M, Maduell F, Massó E, Fontseré N, Carrera M, Ojeda R, Vera M, Cases A, Campistol JM.
Department of Nephrology and Renal Trasplantation, Hospital Clínic Barcelona.

Introduction. Blood volume monitoring (BVM) is traditionally used to assess the degree of intradialytic vascular refilling. In recent years however, BVM has also come into focus for assessing the fluid status of dialysis patients. It has been shown previously that mortality increases significantly beyond a pre-dialysis fluid overload level >2.5L.
It was **the aim** of this study to evaluate how useful BVM is for the assessment of fluid overload.



Material and Methods.

- Observational cross-sectional study
- N: 55 patients in standard 4-5h online HDF treatment
- 37 men, 12 women.
- Age: 63 13 years.
- Relative blood volume (RBV) and pre-dialysis fluid overload (FO) were collected in more than 300 treatments , using the Fresenius BVM and Body Composition Monitor (BCM), respectively.
- Receiver-Operator-Characteristic (ROC) analysis was performed for different FO cutoff levels, using the slope of the RBV drop normalized by ultrafiltration volume as continuous variable.
- The area under the curve (AUC) of the ROC curves was used to assess sensitivity of BVM for FO classification.
- Pre- and postdialysis body weights were collected and systolic BP (SBP) and diastolic BP (DBP) were measured before and after dialysis.
- An overview of the different volume markers is provided in Table 1 .

Table 1. Overview of the different volume markers and their correlations with FO

Volume marker	Description / Definition	Unit	Correlation with FO (all data, N=317)	Correlation with FO (UFR between 400 and 675 ml/h, N=164)
FO	Fluid overload from bioimpedance spectroscopy	[L]	n.a.	n.a.
Slope4h	Linear slope of the relative blood volume over the full treatment normalized by UFR	[%/h/l/h]	**R=0.33** (p<0.001)	**R=0.52** (p<0.001)
RBV end	RBV value at treatment end	[%]	R=0.30 (p<0.001)	R=0.43 (p<0.001)
Volume index	RBV slope over full treatment normalized by UFR over postweight (ΔRBV/h/(UFR/postweight))	[%/h/ml /h/kg]	R=0.28 (p<0.001)	R=0.50 (p<0.001)
UFV	Ultrafiltration volume	[L]	R=0.18 (p=0.002)	R=0.19 (p=0.014)
BPsys	Pre-dialysis systolic blood pressure	[mmHg]	R=0.36 (p<0.001)	R=0.39 (p<0.001)

Results.

The degree of RBV drop was related with the pre-dialysis fluid overload level: patients with high fluid overload >5L had almost no RBV drop during the treatment, while patients who became dehydrated in the course of the 4h treatment presented a strong RBV drop (Figure 1, Table 2).

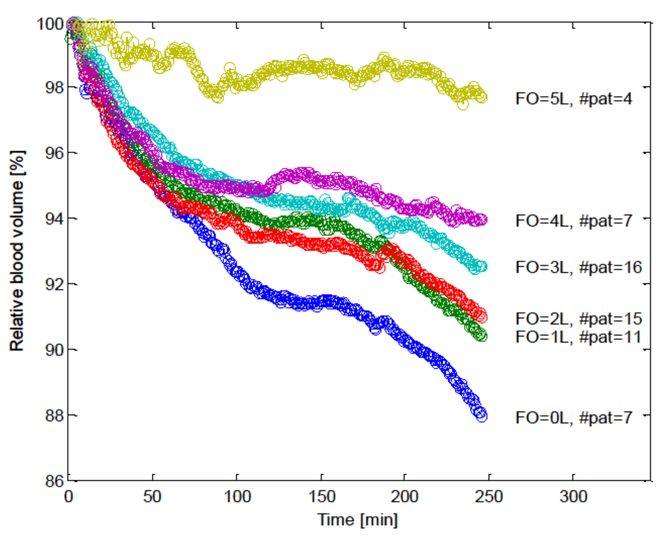


Figure 1. RBV curves during dialysis treatments, separated by pre-dialysis FO

Table 2: Data overview to Figure 1. Only treatments with a UF rate between the 25th and 75th percentile (400 to 675 ml/h) and treatment time >10th percentile (>245 min) were included.

FO group [L]	-0.5 to 0.5	0.5 to 1.5	1.5 to 2.5	2.5 to 3.5	3.5 to 4.5	4.5 to 5.5
Number of patients	7	11	15	16	7	4
Number of treatments	23	32	35	31	17	10
UF volume [L]	2.7 ± 0.5	2.6 ± 0.4	2.6 ± 0.4	2.7 ± 0.3	2.9 ± 0.3	2.6 ± 0.3
UF Rate [ml/h]	545 ± 82	532 ± 79	538 ± 77	555 ± 69	567 ± 61	511 ± 57
UF Rate index [ml/h/kg]	8.2 ± 2.0	7.8 ± 1.8	8.2 ± 2.1	8.3 ± 2.5	8.1 ± 1.4	6.9 ± 1.1
BP sys before HD [mmHg]	113 ± 25	124 ± 17	131 ± 33	140 ± 27	140 ± 20	153 ± 15
BP dia before HD [mmHg]	61 ± 18	61 ± 12	56 ± 15	66 ± 17	64 ± 18	62 ± 6
RBV slope full treat. [%/h]	-2.1	-1.6	-1.0	-1.2	-0.6	-0.3
RBV slope first 30min[%/h]	-6.0	-6.0	-7.6	-4.8	-6.0	-1.2
RBV slope last 30min [%/h]	-3.8	-2.5	-2.2	-2.2	-0.8	-1.2
RBV% at 260 min [%]	88.0 ± 4.8	90.4 ± 3.9	91.0 ± 4.7	92.5 ± 4.9	94.0 ± 3.2	97.7 ± 5.4
Slope4h [%/h/l/h]	-3.9 ± 0.6	-3.0 ± 0.4	-1.9 ± 0.4	-2.2 ± 0.3	-1.0 ± 0.1	-0.6 ± 0.1
Volume index [%/h/ml/h/kg]	-0.27 ± 0.06	-0.22 ± 0.07	-0.14 ± 0.04	-0.14 ± 0.04	-0.08 ± 0.01	-0.05 ± 0.01

ROC curves for three different FO cut-off levels (2, 3 and 4L) demonstrate best performance for high fluid overload (Figure 2). The highest AUC values were achieved at FO levels greater than 4L, indicating better performance of the Slope4h marker in detecting high fluid overload; lowest performance was found in medium FO ranges (Figure 3).

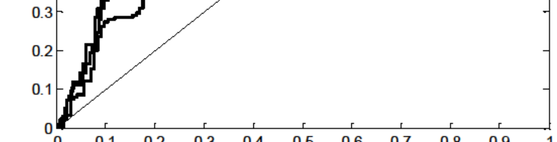
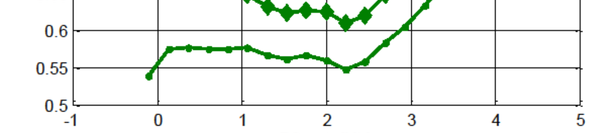


Figure 2. ROC curves for different FO cutoff levels, using the RBV slope normalized by UF volume as continuous variable.

Figure 3. AUC for different FO cutoff levels. High AUC values indicate better ability of blood volume monitoring to assess fluid status, using bioimpedance-derived FO as a reference.



Conclusions: Blood or plasma volume monitoring is well suited to detect high pre-dialysis fluid overload, less sensitive in low hydration status, and rather insensitive in a range between 1 and 3 litres.