Underestimation of intradialytic change in extracellular fluid volume using whole body bioimpedance in the presence of high ultrafiltration

Samer R. Abbas[1], Fansan Zhu[1], George A. Kaysen[2], Peter Kotanko[1], Nathan W. Levin[1]

1) Renal Research Institute NY, New York, USA; 2) University of California, Davis, CA, USA

Background and Aims

Whole body bioimpedance spectroscopy (wBIS) has become a standard method to measure extracellular volume (ECV) in dialysis patients. However, the accuracy of measurement of ECV by wBIS with high ultrafiltration rates (UFR) during and/or after dialysis can be influenced by redistribution of fluid within body compartments since the ratio of volume to resistance differ significantly between the trunk and limbs[1]. We hypothesize that fluid distribution between trunk and limbs could be altered by different UFR during and/or after dialysis. Since high UFR is a major cause of intradialytic hypotension (IDH), the aim of this study was to investigate the relationship of divergence (error; defined as ultrafiltration volume minus intradialytic ECV change by wBIS) to UFR in patients with and without IDH. We planned to use the measured error in wBIS to detect hemodynamically significant re-distribution of ECV during hemodialysis (HD) treatment.

Methods

Multiple measurements with wBIS were performed (Hydra 4200 Xitron Technologies INC, San Diego, CA) pre_ and post_HD treatment. Whole body ECV was calculated using Xitron equation[2]. Intradialytic change in ECV (ΔECV) equals pre_HD ECV – post_HD ECV. Patients were classified in three groups: 1) control group (CG) no intradialytic hypotensive events, 2) intradialytic decrease in systolic blood pressure group (ΔSBP ≥20 mmHg) at any time and 3) IDH group as defined as presence of symptoms and of nurse intervention, and decrease of systolic blood pressure ≥20 mmHg (K/DOQI; EBPG[3]). UFV and UFR were obtained from the dialysis machine. UFR normalized to pre_HD weight (NUFR) was used for analysis. Linear regression models were built to relate NUFR to divergence. Groups were compared by unpaired t-test.

Results

Fifty seven HD patients (34 male, 54.9±13.6 years; Table 1) contributed 441 measurements (median=9). Divergence in control group was (0.42±0.78 L) and significantly ($p<0.05$) lower compared to the SBP decrease group (0.62±0.87 L) and the IDH group (0.79±0.68 L, $p<0.01$), respectively (**figure 1**). The correlation coefficients (R^2) between NUFR and divergences were 0.38 ($p<0.0001$), 0.42 ($p<0.0001$) and 0.30 ($p<0.001$), respectively.

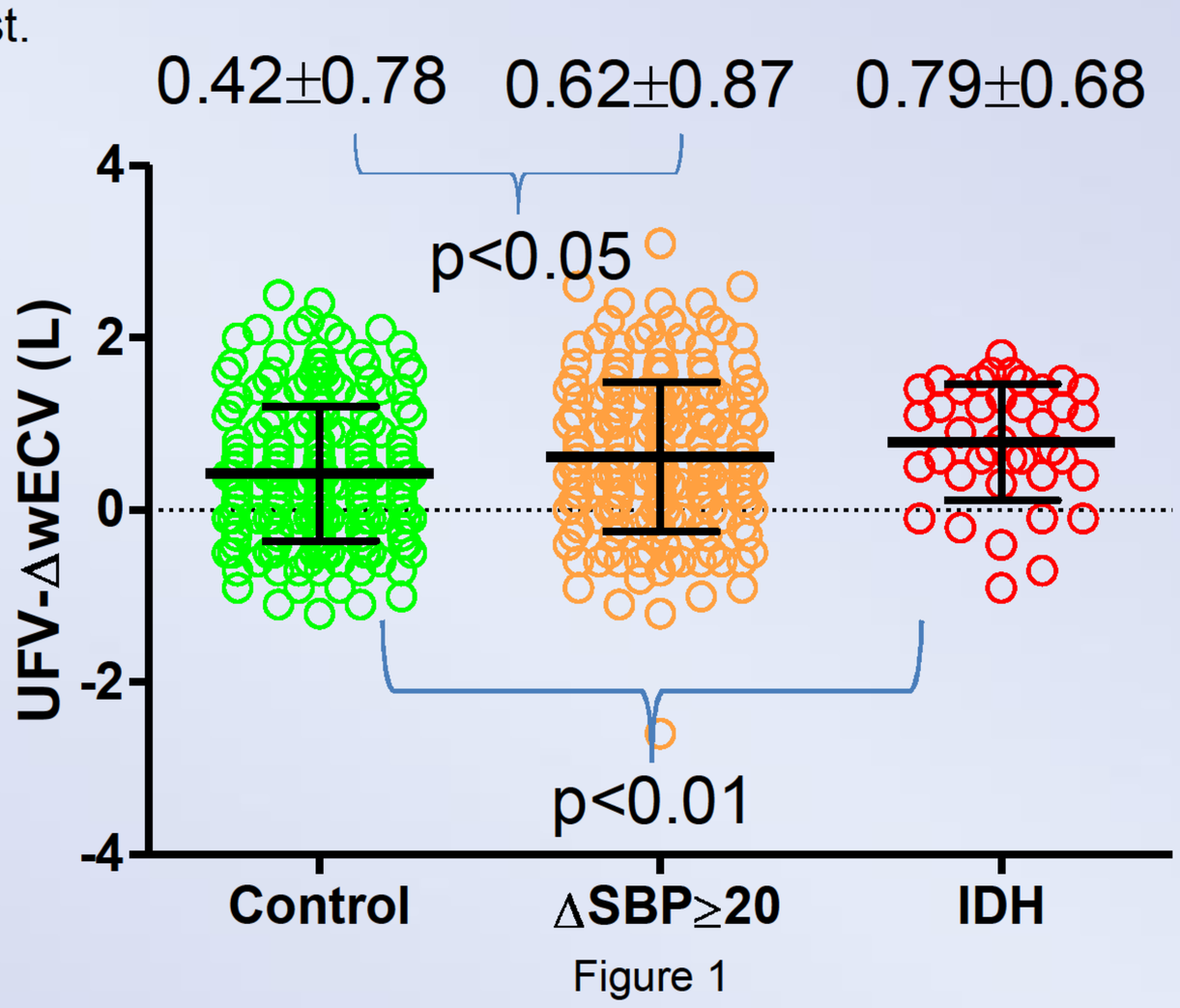

Figure 1

Conclusion

This study shows that increasing UFR influences the accuracy of wBIS measured during and/or immediately after HD. Apparent underestimation of intradialytic change in ECV using wBIS at high UFRs is due largely to removal of plasma water from the central body compartment (trunk) as a result of different resistance / volume ratios in trunk and limbs. Larger decreases in the trunk ECV than in the limbs is accompanied by little increase in the trunk resistance and therefore of less increase in whole body resistance. This result in increasing divergence with more severe IDH during HD was associated with relatively higher UFRs than in control group so that a larger divergence was observed in IDH group. Measurement of the divergence may be useful to predict IDH during HD treatment.

Table 1: Summary of results

Group	# of measurement	UFV [mL]	NUFR [mL/h/kg]	ΔSBP [mmHg]	ΔWt [kg]	ΔECV [L]
Control	206	2.8 1.1#$	9.8 3.5#$	-2 12#$	2.5 1.1#$	2.3 0.9#$
IDH	40	3.3 0.9	11.8 3.6	37 15	3.0 1.0	2.5 0.9
ΔSBP ≥ 20 mmHg	195	3.2 1.1	10.5 3.8	16 18	2.9 1.1	2.6 1.0

(#), ($) significant difference between control and IDH groups and between control and ΔSBP ≥ 20 mmHg groups, $p<0.01$; respectively

References

1) Abbas SR et al: Effect of change in fluid distribution in segments in hemodialysis patients at different ultrafiltration rate on accuracy of whole body bioimpedance measurement. J Appl Physio (1985). 2014 Mar 27. [Epub ahead of print]

2) De Lorenzo et al: Predicting body cell mass with bioimpedance by using theoretical methods: A technological review. J Appl Physiol 1997;82:1542-1558.

3) Kooman J et al: EBPG guideline on haemodynamic instability. Nephrol Dial Transplant 2007;22 Suppl 2:ii22-44.

DOI: 10.3252/pso.eu.51era.2014

Poster presented at: 51 ERA-EDTA CONGRESS AMSTERDAM 2014