

Role of the New Bioimpedance Monitoring Device (Seca®) and Human Atrial Natriuretic Peptide in Assessing Volume Status in Hemodialysis Patients

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Research Article

Keywords: Bioimpedance analysis, Dry weight, Hemodialysis

Posted Date: March 11th, 2021

DOI: <https://doi.org/10.21203/rs.3.rs-272375/v1>

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Abstract

Background There is no evidence on how to use the information from bioimpedance analysis (BIA) devices in clinical management, including setting of target dry weight (DW), or improving outcomes in hemodialysis (HD) patients.

Methods Here, we investigate preferable cut off values of fluid status (extracellular water/total body water ratio; ECW/TBW) detected by a new and more accurate BIA device (Seca®) in 78 HD patients.

Results Patients with an ECW/TBW of more than 45% and human atrial natriuretic peptide (HANP) value of ≥ 50 pg/mL had a higher blood pressure and cardio-thoracic ratio on chest x-ray examination.

Conclusions Our results suggests that ECW/TBW of more than 45% and HANP value of ≥ 50 pg/mL were overhydrated and had a worse prognosis.

Background

Fluid overload is an important prognostic factor of poor outcomes in hemodialysis (HD) patients. Chronic overhydration can cause hypertension, left ventricular hypertrophy, congestive heart failure, pulmonary edema and an increase in all-cause mortality in these patients¹. Although bioimpedance analysis (BIA) devices are increasingly being used in the clinical management of HD patients, there is no evidence on how to use information from BIA devices in clinical management, including setting of the target dry weight (DW), or improving outcomes in HD patients. The newly developed Seca® medical body composition analyzer 525 (Seca GmbH & Co. KG, Hamburg, Germany) demonstrates 98% correlation with the deuterium oxide (D_2O) method of estimating total body water (TBW) ratio, and 94% correlation with the sodium bromide (NaBr) dilution method of estimating extracellular water (ECW)². Here, we report preferable cut off values of fluid status (ECW/TBW) detected by the device in 78 HD patients.

Methods

This study was approved by the research ethics committee of St Luke's International Hospital (approval number 18-R013), and informed consent was obtained from all patients prior to enrollment in the study. The study was performed in accordance with the principles of the Helsinki Declaration. This observational study was conducted at the Kidney Center of the hospital between July and October 2020. Inclusion criteria were patients aged 18 years and over who underwent HD for more than three months, and gave their written, informed consent for study participation³. Exclusion criteria included patients with pacemakers, limbless patients and those who refused to participate in the study³. In all patients, BIA was performed using the Seca® medical body composition analyzer 525 (Seca GmbH & Co. KG, Hamburg, Germany), 20 min after the HD procedure, with the patients in the supine position. The parameters assessed by BIA were intracellular water, ECW, TBW, fat-free mass, skeletal lean mass, skeletal muscle mass, body cell mass, bone mineral content and phase angle (PhA)³. The ECW/TBW was subsequently

calculated from the sum of each segment. Student's t-test or two-sample Wilcoxon test was applied for continuous variables, and the Chi-square test was used for categorical variables. P-values less than 0.05 were considered statistically significant.

Results

Parameters related to dry weight determination in the 78 HD patients are shown in **Table 1**. Since previous reports have stated that the preferable value of HANP after HD is 50-60 pg/mL⁴, we calculated the cut off value of the ECW/TBW ratio corresponding to an HANP level of 50 pg/mL, which was found to be 45%. Based on these values (HANP 50 pg/mL and ECW/TBW ratio 45%), we divided the patients into four groups (**Table 1** and **Figure 1**). Systolic BP of patients in group 4 was 158 ± 22 mmHg and in group 1 was 134 ± 16 mmHg, which was a statistically significant difference ($p < 0.001$). Further, the cardio-thoracic ratio (CTR) of patients in group 4 was $50.8 \pm 4.7\%$ and in group 1 was $46.5 \pm 5.7\%$, which was also a statistically significant difference ($p = 0.017$). None of the patients in group 1 required the use of vasopressors, although eleven patients (31.4%) in group 4 required vasopressors during the HD session. This difference was statistically significant ($p = 0.011$).

Table 1

All patients' and each groups' parameters related to Dry weight determination.

	All patients (n=78)	Group 1 (n=21)	Group 2 (n=13)	Group 3 (n=9)	Group 4 (n=35)	p value
Age	66.9±12.6	59.1±9.3	73.9±9.8	57.8±16.5	71.3±10.7	P=0.002 (1/2)
						P=0.001 (1/4)
						P=0.007 (2/3)
						P=0.009 (3/4)
Male (%)	63/78 (80.8)	21/21	9/13	9/9	24/35	P=0.019 (1/4)
BMI	22.6±3.5	23.6±3.3	22.6±4.0	21.4±2.5	22.2±3.6	ns
Dry weight	63.4±13.4	66.5±14.0	60.4±12.3	63.2±12.2	62.2±13.8	ns
SBP (mmHg)	150.2±21.3	134.2±15.7	152.9±20.6	152.9±11.4	158.4±21.6	P=0.042 (1/2)
						P<0.001 (1/4)
DBP (mmHg)	78.7±12.5	80.1±11.4	75.5±12.0	85.1±9.4	77.3±13.8	ns
CTR (%)	49.1±5.3	46.5±5.7	50.5±4.9	47.1±4.6	50.8±4.7	P=0.017 (1/4)
Vasopressor (%)	13/78 (16.7)	0/21	2/13	0/9	11/35	P=0.011 (1/4)
Amezinium metilsulfate/ Droxidopa						
EF (%)	59.2±9.3	59.9±5.8	61.4±5.4	61.5±4.4	57.5±12.5	ns
HANP (pg/mL)	61.4±36.4	29.9±10.8	32.9±10.3	65.2±19.7	89.8±32.5	P=0.003 (1/3)
						P<0.001 (1/4, 2/4)
						P=0.017 (2/3)
						P=0.046 (3/4)
NT-ProBNP (pg/mL)	4156±7505	1159±839	1080±839	5064±8238	6942±9733	P=0.027 (1/4)

CRP (mg/dL)	0.37±0.73	0.28±0.53	0.45±0.91	0.21±0.33	0.44±0.84	ns
Alb (g/dL)	3.7±0.6	3.9±0.3	3.5±1.1	3.8±0.4	3.6±0.4	ns
E/T (%)	46.1±3.9	42.2±1.8	47.4±1.6	43.3±1.6	48.7±3.4	P<0.001 (1/2, 1/4, 3/4) P=0.003 (2/3)
BMI, body mass index; SBP, systolic blood pressure; DBP, diastolic blood pressure; CTR, cardiothoracic ratio; EF, ejection fraction; HANP, human atrium natriuretic peptide; NT-ProBNP, n-terminal-pro brain natriuretic peptide; CRP, C-reactive protein; Alb, albumin; E/T, extracellular water/total body water ratio; ns, not significant.						

Discussion

Determination of the appropriate target DW in HD patients is not easy, since there is no gold standard method. Generally, we comprehensively consider blood pressure, CTR, presence of edema and HANP when determining DW. However, there is no evidence on how to use the information from BIA in clinical practice, including setting of DW, because very few studies have used the ECW/TBW ratio as a guide for evaluating body fluid status in HD patients^{3,5}. In our study, patients with an ECW/TBW ratio of more than 45% and an HANP value \geq 50 pg/mL had a higher blood pressure and CTR, suggesting that these patients were overhydrated. Both higher blood pressure and CTR in HD patients have been reported to be predictors of poor prognosis^{6,7}. Intradialytic hypotension is a serious complication in HD patients and is closely associated with a variety of adverse events, including increased cardiovascular diseases and all-cause mortality⁸. Therefore, patients in group 4 in our study were thought to have a worse prognosis. Since the Seca® is a newly introduced device, prospective controlled trials are required to determine its role in helping clinical assessment of hydration status in HD patients.

Declarations

Ethics approval and consent to participate

This study was approved by the research ethics committee of St Luke's International Hospital (approval number 18-R013), and informed consent was obtained from all patients prior to enrollment in the study.

Consent for publication

Not applicable.

Availability of data and materials

Not applicable.

Competing interests

The authors declare that they have no competing interests.

Funding

None.

Authors' contributions

KW and MN originated the idea and designed the study. KW, YI, TF, MN and FT collected and analyzed data. KW and MN were responsible for writing the manuscript. All authors read and approved the final manuscript.

Acknowledgments

Not Applicable

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Figures

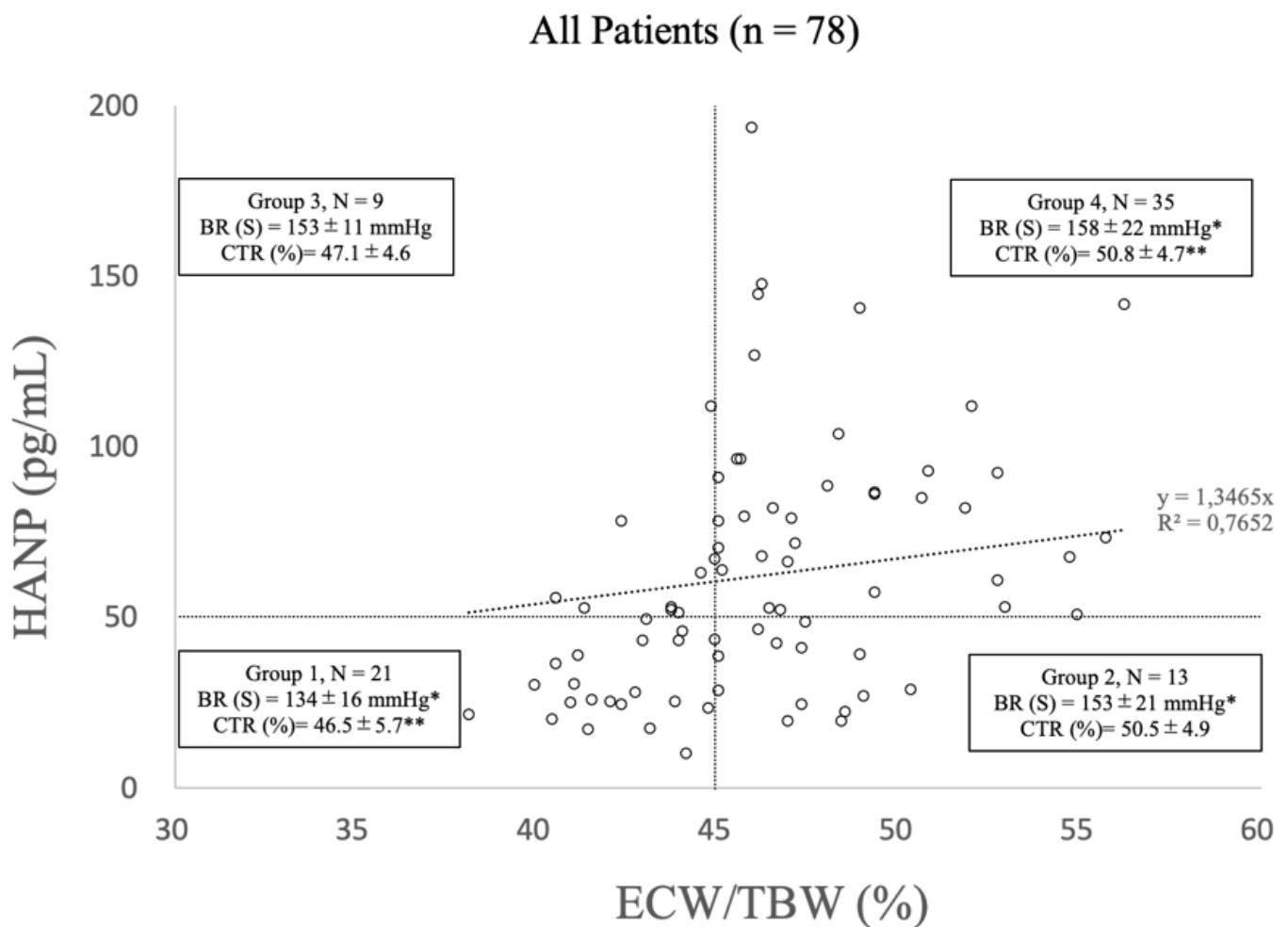


Figure 1

Relationship between HANP and ECW/TBW in all patients (n=78) *p<0.001 (G1 vs G4) p=0.042 (G1 vs G2), **p=0.017; HANP, human atrium natriuretic peptide; ECW/TBW, extracellular water/total body water ratio; BP(S), systolic blood pressure; CTR, cardiothoracic ratio.