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EVALUATION OF THE RELIABILITY OF DIFFERENT METHODS FOR THE DETERMINATION OF THE HYDRATION STATUS IN HAEMODIALYSIS PATIENTS

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G. Casagrande, C. Bianchi, E. Merlo, S. Panzeri, D. Vito

Laboratory of Biological Structure Mechanics (L*a*BS), Department of Chemistry, Materials and Chemical Engineering "Giulio Natta", Politecnico di Milano, Milan, Italy

Introduction

Determination of the hydration status in Haemo-Dialysis (HD) patients is crucial to correctly assess the dry weight and calculate the amount of excess fluid to be removed by ultrafiltration (UF). The Total Body Water (TBW) is the sum of plasma, interstitial and intracellular fluid, it can be estimated by different techniques, from mathematical equations to bioimpedance analysis. Several formulas were used to estimate initial Total Body Water (TBW_0) based on demographic or anthropometric data. The aim of this study was to compare the different available methods to identify the most objective and reliable method to be used for a correct identification of the TBW in patients undergoing haemodialysis.

Materials and Methods

The total amount of fluids in a patient at the beginning of a HD treatment TBW_0 was calculated by using a classic anthropometric formula (TBW_0-A), the Watson formula (TBW_0-W) and the Watson formula modified with a correctional term (TBW_0-Wc), accounting for the part of fluids not drained by the kidneys. The last equation was applied using either real end session weight (TBW_0-W_cR) or the clinically prescribed dry weight (TBW_0-W_cP). TBW_0 was computed using the listed methods for 450 haemodialysis sessions pertinent to 70 patients dialyzed in two different dialysis centres (Alessandro Manzoni Hospital, Lecco, Italy; EOC Lugano, Switzerland). The results have been compared and statistically analysed.

Anthropometric formula

$$TBW_0 - A = C_2 \cdot W_0$$

Where C_2 = 0,57 l/kg and W_0 is the weight of the patient at the beginning of the session

Classical Watson formula

$$TBW_0 - W_{male} = 2{,}447 - 0{,}09516 \cdot Age + 0{,}1074 \cdot Height + 0{,}3362 \cdot W_0$$

$$TBW_0 - W_{female} = -2{,}097 + 0{,}1069 \cdot Height + 0{,}2466 \cdot W_0$$

Watson formula also considers sex, age and height of the patients.

The Watson formula has been modified accounting for the fluid overload due to the treatment intermittence.

Corrected Watson formula

...using prescribed (P) Dry Weight DW

$$TBW_0 - W_cP_{male} = 2{,}447 - 0{,}09516 \cdot Age + 0{,}1074 \cdot Height + 0{,}3362 \cdot DW + (W_0 - DW)$$

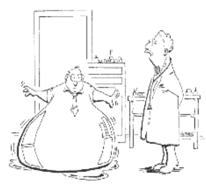
$$TBW_0 - W_cP_{female} = -2{,}097 + 0{,}1069 \cdot Height + 0{,}2466 \cdot DW + (W_0 - DW)$$

➔ DW is the ideal weight the patient has to reach at the end of each dialysis session.

...using real (R) weight at the end of the previous session W_{end}

$$TBW_0 - W_cR_{male} = 2{,}447 - 0{,}09516 \cdot Age + 0{,}1074 \cdot Height + 0{,}3362 \cdot W_{end} + (W_0 - W_{end})$$

$$TBW_0 - W_cR_{female} = -2{,}097 + 0{,}1069 \cdot Height + 0{,}2466 \cdot W_{end} + (W_0 - W_{end})$$



Your tests reveal that you are retaining fluids!

Results

TBW_0-A values calculated with the anthropometric formula to evaluate results always higher than when calculated using the other formulas; they shows also the highest standard deviation. The lowest values were instead obtained by evaluating TBW_0-W with the classical Watson formula. As shown in Fig.1 the two corrected Watson formulas allow to obtain superimposable values (TBW_0-W_cR, TBW_0-W_cP), in the range of those determined with TBW_0-A (overestimation) and by TBW_0-W (underestimation). Compared with Biompedance analysis measurements, the modified Watson formula, thanks to the correctional term, allows obtaining more precise measurements of the total amount of body fluids at the beginning of each dialysis session.

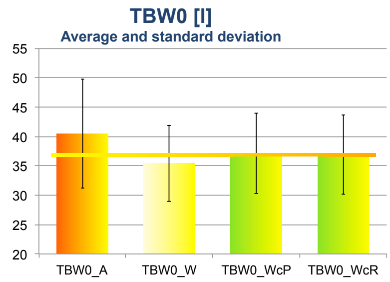


***Fig.1.** Comparison of the mean values (bars with standard deviations) of TBW_0, evaluated with the different proposed methods.*

Statistical Analysis

The differences among the set of values were statistically significant; exception made for TBW_0-W_cR and TBW_0-W_cP.

Implications

The erroneous calculation of TBW_0 can impact on the clinical evaluations when predictive algorithms or patient-specific models of the fluid and mass exchanges during an HD were used.

Use in predictive algorithms or indexes

Plasma Refilling Index (PRI), derived from parameters clinically measured during HD: useful to study plasma-refilling.

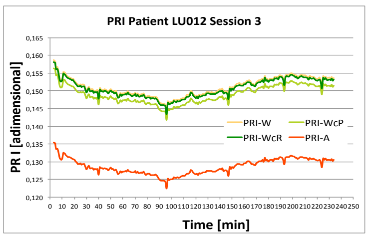


***Fig.2.** Plasma refilling index trends evaluated using different formulas to calculate TBW_0.*

Patient specific compartmental modeling of the mass and fluid exchanges into a patient during HD

The initial volume of each compartment, in multi-compartmental models, is a function of TBW_0. Moreover the variation of the blood volume is clinically evaluated as a percentage of the initial value. The use of inaccurate formulas for the evaluation of TBW_0 can amplify simulations errors, that *i.e.* results higher using TBW-A.

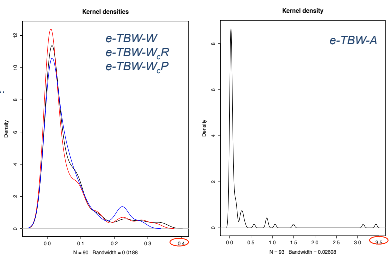


***Fig.3.** The kernel density of the simulation errors with the respect to clinically recorded data.*

Discussion and Conclusions

TBW_0-W_cP enables to reach estimations of the TBW_0 comparable to the ones calculated considering the real end session dry weight (TBW_0-W_cR), with the advantage to be suitably used in a predictive algorithm. The anthropometric formula, as well as Watson equation without correctional term, showed to be a less robust methods.

References

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