DETERMINATION OF TOTAL BODY WATER: COMPARISON OF BIOIMPEDANCE SPECTROSCOPY WITH COMMON ANTHROPOMETRIC EQUATIONS

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1. BACKGROUND

- The assessment of total body water (TBW) is an important aspect of renal replacement therapy since it represents the urea distribution volume and is used for the determination of dialysis adequacy Kt/V.

$$\frac{K \times t}{V}$$

- Anthropometric equations are commonplace and easy to use, but may incur shortcomings regarding accuracy and precision.

2. AIMS

- To assess TBW errors introduced by different anthropometric equations in health and different diseases
- To investigate whether better estimates of TBW may be achieved with bioimpedance spectroscopy (BIS) when comparing these methods against a dilution reference.

3. STUDY DESIGN

- Retrospective analysis
- 132 subjects from three different centers, including 54 dialysis patients and 19 cirrhosis patients. No adjustment for center effects.

4. METHODS

BIS measurements

- BIS-Device: BCM-Body Composition Monitor (Fres. Med. Care)
- 50 frequencies from 5 kHz to 1 MHz
- Measurements before dialysis treatment
- ECW and ICW using new equations validated in [1].

$$ECW = (a/BMI + b) * (H^2 * W^{0.5}/R_0)^{2/3}$$
$$ICW = (c/BMI + d) * (H^2 * W^{0.5}/R_{inf})^{2/3}$$

(H = height, W = weight, R = resistance, BMI = body mass index)

- Only a small subset from the available cohort (32 dialysis patients) was used for setting up the these equations.

Reference methods

- Deuterium dilution in Kiel and New York
- Tritium dilution in Gothenburg

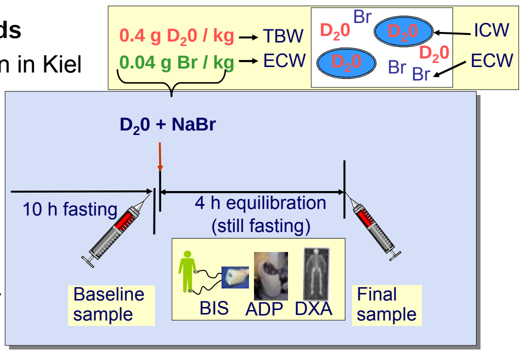

Figure1. Procedure of dilution measurements

Anthropometric TBW equations

(A=age, W=weight, H=height, S=sex, D=diabetes)

- Watson [2]:

male: 2.447 + 0.1074 H + 0.3362 W − 0.09516 A
female: −2.097 + 0.1069 H + 0.2466 W

- Hume-Weyers [3]:

male: 0.1948 H + 0.2968 W − 14.0129
female: 0.3445 H + 0.1838 W − 35.2701

- Chertow [4]:

$$-0.04\,W + 0.13\,H - 0.07\,A - 0.02\,S + 0.58\,D - 0.0007\,W^2$$
$$-0.03\,A\,S + 0.11\,S\,W + 0.001\,A\,W + 0.002\,H\,W$$

4. RESULTS

- In 53 subjects with extreme BMIs (<20 and >30 kg/m^2), the precision of BIS (SD=2.8 L) was about 1 L better as compared to the anthropometric equations (3.7-3.9 L) (see table below).
- The SD of paired differences was more than half a litre smaller in BIS than in the anthropometric measures.
- The same tendency was found in the subgroups of healthy subjects, dialysis and cirrhosis patients.
- The Chertow equation significantly overestimated TBW.

TBW_{D2O} – TBW <method>	All subj. (n=132) mean ± SD	Healthy (n=59) mean ± SD	Dialysis (n=54) mean ± SD	Cirrhosis (n=19) mean ± SD	Extreme BMIs (<20 & >30) (n=53)
BIS	0.4 ± 3.0 L	0.4 ± 3.2 L	0.3 ± 3.1 L	0.5 ± 2.3 L	0.5 ± 2.8 L
Watson	0.3 ± 3.6 L	0.1 ± 3.7 L	0.7 ± 3.3 L	-0.2 ± 4.3 L	-0.5 ± 3.7 L
Chertow	-3.3 ± 3.7 L	-4.3 ± 3.8 L	-2.8 ± 3.7 L	-3.5 ± 4.3 L	-3.7 ± 3.9 L
Hume-Weyers	-0.4 ± 3.6 L	-0.7 ± 3.5 L	0.0 ± 3.5 L	-0.6 ± 4.0 L	-0.9 ± 3.7 L

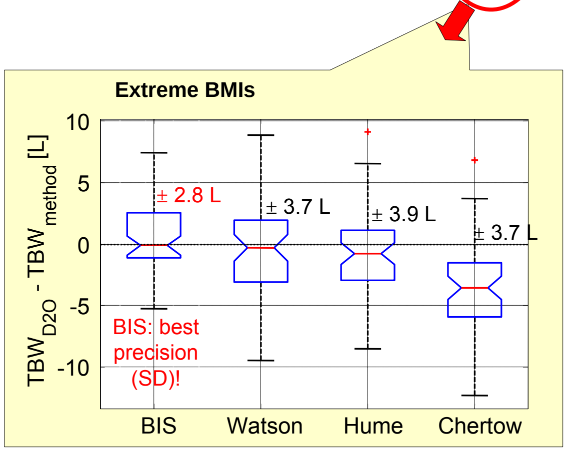

Figure 2. Validation results for subjects with extreme BMIs (<20 & >30 kg/m²).

5. CONCLUSIONS

- In comparison with anthropometric equations, BIS offers significantly better precision (SD) for the determination of TBW in both healthy subjects and patients with abnormal fluid status.
- While anthropometry works quite well in the "normal, average" population, BIS shows clear advantages especially in extremes of body composition

6. REFERENCES

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