ACCURACY OF BIOIMPEDANCE SPECTROSCOPY (BIS) TO DETECT FLUID STATUS CHANGES IN HEMODIALYSIS PATIENTS

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1. INTRODUCTION
• The BCM uses the technique of bioimpedance spectroscopy (BIS) to identify the resistances of extracellular (ECW) and total body water (TBW). 1
• ECW and TBW are calculated via a model based approach. 2, 4
• A unique body composition model allows to calculate overhydration (OH) and body composition in terms of fat mass and lean tissue mass (LTM). 3
• The clinical application of BIS is aimed at screening and monitoring patients (e.g. chronic kidney disease) with respect to changes in the fluid and nutrition status.
• The accuracy of BIS to determine ECW and TBW has been demonstrated elsewhere 4
• It is not yet proven how accurate BIS is at detecting changes in the fluid status.
• During the hemodialysis treatment the patient’s fluid status is influenced by UFV.
• In theory UFV is withdrawn exclusively from the ECW, while intracellular water (ICW) remains unchanged.

HYPOTHESIS
• The change of the fluid status induced by UFV is reflected in the extracellular (ECW) and total body water (TBW)
• The volume of the intracellular water (ICW) is not influenced by fluid removal
• The overhydration (OH) in the patients is reduced by the UFV
• The body composition (fat, lean tissue mass (LTM)) is not influenced by UFV

AIM OF THE STUDY
How accurate can the BCM – Body Composition Monitor measure changes in fluid status induced by ultrafiltration (UFV) ? What is the best time for a Bioimpedance Spectroscopy (BIS) measurement - can measurements be performed directly after a hemodialysis treatment ?

2. SUBJECTS AND METHODS
Subjects:
• 45 hemodialysis patients (Georg-Haas dialysis center, Giessen) separated in two groups
• Patient details are listed in Table 1.
• Group 2 was especially chosen to cover a wide BMI range.
• All patient parameters were not statistically different between the two groups
• UFV of both groups was not statistically different.

Protocol:
• Both patient groups (N1=33, N2=12) were measured several times with BIS: before the treatment (preHD), directly at the end, 30 min and 2 h after the end of the treatment (see Figure 1).
• Group 1 was measured pre HD and post HD based
• Group 2 was measured pre HD, post 30 min and post + 2 h
• UFV was determined after the treatment and was corrected for drink intake and possible saline infusions.
• Drink intake was only allowed in the first 60 min of the 4 hour hemodialysis treatment.

3. RESULTS
• The change in ECW (ΔECW) and TBW (ΔTBW) was not significantly different to the UFV at the time of all post measurements.
• The change in OH (ΔOH) reflected the UFV at all post treatment measurements.
• Directly at the end of the treatment (post HD) ΔICW, ΔFat and ΔLTM were significantly different from zero
• After 30 min (post + 30 min) ΔICW, ΔFat and ΔLTM were all not different from zero which could also be shown 2 h (post + 2 h) after the end of the treatment.

4. DISCUSSION
• The BCM – Body Composition Monitor can predict changes in ECW and TBW caused by UFV very precisely.
• The determination of the body composition by the BCM – Body Composition Monitor is not influenced by the hydration status of the patient
• BIS measurements should not be performed during or directly after the hemodialysis treatment (e.g. vasodilation effects might influence the measurement result)

5. CONCLUSIONS
• The overhydration (OH) measured with the BCM – Body Composition Monitor accurately reflects changes in the fluid status induced by ultrafiltration.
• As expected the UFV is completely reflected in the change in OH.
• BIS measurements should not be performed directly at the end of the hemodialysis treatment but 30 min later.

6. REFERENCES

Table 1: Patient details

<table>
<thead>
<tr>
<th>Measurements</th>
<th>Group #1</th>
<th>Group #2</th>
</tr>
</thead>
<tbody>
<tr>
<td>pre HD</td>
<td>post HD</td>
<td>post HD + 30 min</td>
</tr>
<tr>
<td>post HD + 2 h</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>33</td>
<td>12</td>
</tr>
<tr>
<td>Weight [kg]</td>
<td>61.15 ± 2</td>
<td>89.7 ± 37*</td>
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<tr>
<td>Height [cm]</td>
<td>167 ± 7.8*</td>
<td>165.5 ± 11.3*</td>
</tr>
<tr>
<td>BMI [kg/m²]</td>
<td>27.7 ± 4.8*</td>
<td>32.6 ± 12.1*</td>
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<tr>
<td>UFV [L]</td>
<td>2.56 ± 0.8*</td>
<td>2.45 ± 1.27*</td>
</tr>
<tr>
<td>ECW [L]</td>
<td>17.9 ± 3.2*</td>
<td>18.45 ± 5.95*</td>
</tr>
<tr>
<td>ICW [L]</td>
<td>18.7 ± 4.5*</td>
<td>19.9 ± 4.2*</td>
</tr>
<tr>
<td>TBW [L]</td>
<td>36.7 ± 7.4**</td>
<td>38.4 ± 9.6*</td>
</tr>
</tbody>
</table>

* = n.s.d. between groups

Figure 1: Setup of the study

Table 2: Results

<table>
<thead>
<tr>
<th>Measurements</th>
<th>pre HD → post HD</th>
<th>pre HD → post +30 min</th>
<th>pre HD → post +2 h</th>
</tr>
</thead>
<tbody>
<tr>
<td>UFV (Δweight) [L]</td>
<td>2.5±0.79</td>
<td>2.5±0.79</td>
<td>2.5±0.79</td>
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<tr>
<td>Δ ECW [L]</td>
<td>2.48 ± 1.0</td>
<td>2.45 ± 1.12</td>
<td>2.42 ± 1.13</td>
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<tr>
<td>Δ TBW [L]</td>
<td>1.92 ± 1.63</td>
<td>2.54 ± 1.4</td>
<td>2.45 ± 1.13</td>
</tr>
<tr>
<td>Δ OH [L]</td>
<td>2.78 ± 1.1</td>
<td>2.44 ± 1.09</td>
<td>2.45 ± 1.3</td>
</tr>
<tr>
<td>Δ ICW [L]</td>
<td>-1.34 ± 1.54</td>
<td>p&lt;0.001</td>
<td>0.025 ± 0.77*</td>
</tr>
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<td>Δ Fat [kg]</td>
<td>0.9 ± 1.37</td>
<td>p&lt;0.001</td>
<td>-0.39 ± 0.9*</td>
</tr>
<tr>
<td>Δ LTM [kg]</td>
<td>-1.12 ± 1.7</td>
<td>p&lt;0.001</td>
<td>-0.44 ± 1.49*</td>
</tr>
</tbody>
</table>

* = n.s.d. from UFV, ** = n.s.d. from Zero