

ABSTRACT

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Title of Doctoral Thesis: **The clinical application of bioimpedance spectroscopy in polytrauma patients and in pregnant women**

Introduction and Objectives: Bioimpedance spectroscopy (BIS) is a non-invasive method determining the amount of body fluids and their distribution into the extracellular (ECW) and intracellular (ICW) space, based on the tissue resistance. It has already been applied in many clinical trials in healthy volunteers and in different groups of patients to assess body composition. Furthermore, it seems to be useful in nutritional counseling. However, in critically ill patients hospitalized in intensive care unit (ICU) or in pregnant women, this method has not been used in routine clinical practice as yet. Both of these groups are characterized by the state of increased body fluids. For this reason, BIS could be applied in respective groups of patients. Hence, the main aims of this doctoral thesis were: **1)** to describe in detail the principle and the previous use of BIS; **2)** to use the BIS to determine the degree of hyperhydration of patients with polytrauma (PP), and to evaluate the results with the other monitored parameters; **3)** to describe the development of changes in the body composition of healthy pregnant women (body weight, fluids and fat mass) and apply the BIS in pregnant women after preterm premature rupture of membranes (pPROM).

Methods: **1)** Studies using BIS were preceded by thorough published literature research using bibliographic databases. **2)** The prospective observational study was performed with 25 PP and a group of 25 healthy volunteers. The BIS has been repeatedly measured for evaluation of changes in body fluids volume from the third to the eleventh day of hospitalization in the ICU. The fluid balances, calculated as the difference between fluid intake and output according to standard procedures were also observed. The relationship between the acquired BIS data and the results of the metabolic examination by indirect calorimetry was also evaluated. **3)** A cohort study was conducted in healthy primipara (58), pregnant women after pPROM (97) and healthy non-pregnant women as a control group. BIS, indirect calorimetry and determination of fat mass by skinfold calipers method were performed three times during pregnancy. BIS was used in women in labour and 24 hours later. This method was also applied in pregnancy with pPROM diagnosis just after the hospitalization. The obtained data from both experimental studies were analyzed by Graph-Pad Prism7 and MS Excel 2016. Values were considered as statistically significant at $p < 0,05$.

Results: **1)** Review of literature found that the BIS determination of total body water (TBW) and ECW in a group of critically ill patients relate to the results of standard dilution method. In addition, besides other methods the equations for determination of TBW and ECW in surgical patients were defined using BIS measured parameters. Therefore we used them in the experimental part of this work. Other studies

with critically ill patients describe a certain prognostic value of BIS measured data, the possibility of assessing malnutrition and distribution volume of some medications to enable appropriate dosing. Similarly, the equation for calculation of TBW in pregnant women was developed and validated. BIS appears to be a tool suitable for monitoring changes in body fluids during pregnancy, predicting hypertensive disorders, edema and birth weight. **2)** This study found that PP accumulate excess fluids exclusively in the extracellular space. The development of these changes is very individual. Throughout the study period, fluid intake was associated with an increase in fluid balance ($r = 0.879$; $p < 0.001$) however, it did not correlate with diuresis ($r = -0.022$; $p = 0.744$). The cumulative fluid balance corresponded with BIS measured value called fluid excess, which is the extra amount of water in extracellular space in comparison with the healthy population. This value measured in ICU on days 5–7 was statistically significant related to the duration of mechanical ventilation ($r = 0.791$; $p = 0.001$). Measured body fluids also appear to be correlated with energy expenditure (EE) and oxidation of nutritional substrates in PP with nutritional support (for example for TBW with EE it was $p = 9.058 \cdot 10^{-12}$). **3)** The average weight gain in pregnant women corresponded to 14.98 kg, which consisted of fat (4.5 kg), TBW (7 liters), and the remainder was the weight of the fetus (3398 g). If these parameters were increasing, the EE was marked by a directly proportional rise. The most significant correlation was between EE and ECW ($r = 0.700$; $p = 1.35 \cdot 10^{-20}$), the actual body weight of pregnant women ($r = 0.683$; $p = 2.74 \cdot 10^{-20}$) and fat mass ($r = 0.595$; $p = 1.43 \cdot 10^{-14}$). Our results show, that at first only ECW increased, then after the 30th gestational week an increase in both ECW and ICW could be observed. During the pregnancy altogether with increasing the total amount of body fluids, the resistance measured by BIS decreases and was specified if it is related to the actual waist circumference ($r = -0.524$; $p = 1.18 \cdot 10^{-12}$). The lowest value of resistance was marked during the delivery period (approximately about 575 Ohm), both in healthy delivering pregnant women and in pregnant women after pPROM who were in labour compared to those that delivered one week or later after pPROM who had consistently higher resistance values ($p < 0.0001$).

Conclusions: BIS has proven to be a useful tool for monitoring body fluids in PP, especially using the parameter of fluid excess, which is a promising prognostic value according to this study. Therefore this method could be applied in future to the indication of individualized fluid therapy and according to the obtained correlations; it could help to manage nutritional support. In the study with pregnant women, using BIS enabled assessment of the development of body fluids and thus indirectly the quality of maternal adaptation to the gestation. Similarly, as in the study with PP, measured data were associated with EE of pregnant women, which could contribute to recommendation of a suitable diet. The value of extracellular resistance appears to be useful for predicting the term of delivery after pPROM. When these findings are confirmed through other research, this simple method could be used for the precision of timing of fetal lung maturation corticosteroid therapy with the aim to enhance benefit and minimize the risks of this treatment.