UDC 616-073.175

A MODERN LOOK AT THE ASSESSMENT OF FLUID THERAPY BY USING BIOIMPEDANCE MEASUREMENT IN THE PERIOPERATIVE PERIOD IN CHILDREN

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✓ ***Resume***

Infusion therapy in children undergoing anesthetic treatment is challenging as their hydration status is difficult to assess. Many methods are invasive, making them inapplicable in pediatric practice. Modern medicine requires non-invasive but precise methods.

Materials and methods: We analyzed the current literature on infusion therapy for the perioperative period, where the method of research was the measurement of bioimpedance.

Result: The article presents a modern view on the infusion therapy of the perioperative period based on bioimpedansometry for anesthesia in children. The analysis of the studies is carried out and the more vulnerable parts of the studied topic are indicated. The tactics of work are set for further deeper study.

Conclusion: Bioimpedance monitoring allows continuous monitoring of body fluids and, if necessary, immediate correction during the entire perioperative period.

Key words: bioimpedance analysis, anesthesiology, infusion therapy, children's age.

СОВРЕМЕННЫЙ ВЗГЛЯД НА ОЦЕНКУ ИНФУЗИОННОЙ ТЕРАПИИ ПУТЕМ ПРИМЕНЕНИЯ БИОИМПЕНДАНСОМЕТРИИ В ПЕРИОПЕРАЦИОННЫЙ ПЕРИОД У ДЕТЕЙ

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✓ ***Резюме***

Инфузионная терапия у детей с анестезиологическим лечением - сложная задача, поскольку их гидратационный статус трудно оценить. Многие методы являются инвазивными, что делает их неприменимыми в педиатрической практике. Современная медицина требует неинвазивных, но точных методов.

Материалы и методы: Мы проанализировали современную литературу по инфузионной терапии периоперационного периода, где методом исследования было измерение биоимпеданса.

Результат: В статье изложен современный взгляд на инфузионную терапию периопеционного периода основанный на биоимпедансометрии при анестезиологическом обеспечении у детей. Проведен анализ исследований и указаны более уязвимые части изучаемой тематики. Поставлена тактика работа для дальнейшего более глубокого изучения.

Заключение: Мониторинг биоимпеданса позволяет осуществлять постоянный мониторинг жидкостей организма и при необходимости немедленную коррекцию в течение всего периоперационного периода.

Ключевые слова: биоимпедансный анализ, анестезиология, инфузионная терапия, детский возраст.

BOLALARDA PERIOPERATIV DAVRDAGI BIOIMPEDANSIYA OLISHIDAN FOYDALANISH VA SIVI TERAPIYASINI BAHOLASHNING ZAMONAVIY QARASHI

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Anestetik davolanadigan bolalarda infuzion terapiya qiyin, chunki ularning hidratsiya holatini baholash qiyin. Ko'p usullar invaziv bo'lib, ularni pediatrik amaliyotda qo'llash mumkin emas. Zamonaviy tibbiyot invaziv bo'lmagan, ammo aniq usullarni talab qiladi.

Materiallar va usullar: Perioperativ davr uchun infuzion terapiya bo'yicha mavjud adabiyotlarni tahlil qildik, bu erda tadqiqot usuli bioimpedansni o'lchash edi.

Natija: Maqolada bolalardagi behushlik uchun bioimpedansometriyaga asoslangan perioperativ davr infuzion terapiyasining zamonaviy ko'rinishi keltirilgan. Tadqiqotlar tahlili o'tkazilib, o'rganilayotgan mavzuning zaif tomonlari ko'rsatilgan. Ish taktikasi yanada chuqurroq o'rganish uchun belgilanadi.

Xulosa: Bioimpedansni kuzatish butun perioperativ davrda tana suyuqligini doimiy ravishda kuzatib borish va kerak bo'lganda darhol tuzatish imkonini beradi.

Kalit so'zlar: bioimpedans tahlillari, anesteziologiya, infuzion terapiya, bolalar yoshi.

Relevance

Infusion therapy in children with anesthetic management is a difficult task, since their hydration status is difficult to assess. Markers such as invasive are widely used, the resulting intravascular pressure is recognized to have serious deficiencies as a measure of hydration and does not provide any information about the extravascular or intracellular state of the fluid. Many methods are invasive, which makes them not applicable in pediatric practice. Modern medicine requires non-invasive but precise methods.

In the whole world medicine at the moment one of the important problems is infusion therapy. By the

beginning of the XXI century in Europe and the USA, the main provisions of a multidisciplinary method for accelerated recovery of surgical patients after elective operations were formulated. A new concept has appeared in the English-language literature, denoted by two terms: "Fast-Track Surgery" (FTS) and "accelerated recovery after surgical operations" (Enhanced Recovery After Surgery - ERAS). In these protocols, special attention is paid to fluid therapy and perioperative fasting. should be emphasized that fasting before surgery, starting at midnight, has become firmly established in clinical practice. This approach was justified by the risk of food and water retention in the stomach with the subsequent occurrence of regurgitation and aspiration during induction of anesthesia. The side effects of such a limitation are obvious: the possibility of hypovolemia, depletion of glycogen stores and hypoglycemia, metabolic stress, which led to the emergence of the above mentioned protocols in world practice and a more detailed study of this issue.

M. S. Brady et al. (2010) published a meta-analysis of 22 randomized studies of preoperative fasting. The results suggested that stopping the intake of fluids, including juices, water, tea, and coffee, 2 hours before surgery did not increase the incidence of aspiration complications in elective surgery compared to patients who fasted from midnight to surgery. In addition, no differences were found in the amount of gastric contents and its pH [41.]. This point of view was confirmed in subsequent publications [42]. The European Society of Anesthesiologists recommends taking clear liquids 2 hours before induction of anesthesia, and also avoiding solid food for 6 hours [43].

Especially in pediatric practice, where hypovolemia and hypoglycemia can lead to more formidable complications than in adult patients, in our opinion, requires careful research. We paid special attention to the problem of the adequacy and effectiveness of infusion therapy in the perioperative period in children. Since this task, in our opinion, remains quite relevant at the present time, which is due to both the anatomical and physiological characteristics of the child's body and the peculiarities of the surgical intervention. Infusion therapy during anesthesia in children has remained a subject of debate over the past decades [3,4] Errors in perioperative fluid administration in children can lead to serious complications and even death [5]. Accurate monitoring of fluid balance in patients after surgery is challenging. The most common method for determining the composition of the human body and its constant perioperative monitoring today is bioimpedance analysis. The practical application of bioimpedance analysis in anesthesiology and resuscitation began in the 1960s with the work of the French anesthesiologist A. Tomasset with the aim of assessing the composition of the human body, water sectors of the body, and then to study other components of the body composition [7].

One of the researchers (M. Tsukamoto., Et al. (2017)), in his works devoted to intraoperative fluid administration in pediatric practice using bioelectrical impedance analysis during dental surgery, indicated that fluid therapy is important for achieving optimal results in the postoperative period. [8,9,10]. Recently, fluid restriction has been recommended to reduce complications following major surgery, but has remained unknown in minimally invasive surgery [8-10].

Other studies have also shown that preoperative oral intake of clear liquids can be safe up to 2 hours before surgery, and light snacks can be consumed up to 6 hours before surgery [11, 12]. However, the typical fasting times are often longer than expected 6-10 hours [11]. Especially, pediatric patients may be more vulnerable to dehydration because they have a relatively large portion of total body water (TBW) body weight compared to adults. [13]

E. Itobi ID from the UK, in their study investigated the effect of edema on recovery after major abdominal surgery and the potential value of multifrequency bioimpedance measurements. In their opinion, generalized edema is often observed in patients with acute surgical complications who are in critical condition and require intensive supportive treatment after surgery [14]. Hanged mortality of patients was observed with pathological fluid accumulation in the perioperative period [15,16]. Generalized edema can also occur in ward surgical patients who do not show signs of critical illness [17]. The tendency to accumulate fluid is well known, it is a physiological response to surgical injury, but the mechanisms leading to generalized edema are not fully understood, the prevalence of generalized edema after routine major surgery has not been established [18,19]. But there is anecdotal evidence that this may be associated with poor clinical outcome, and none of this has been scientifically evaluated [17]. Mattha? and Ernstbrunner et al., In their study "Bioimpedance spectroscopy for assessing the status of patients before and after general anesthesia," studied the postoperative fluid distribution. All patients undergoing anesthesia and surgery usually receive intravenous fluid therapy during surgery to correct anesthesia and surgery associated with hemodynamic disturbances. The timing, quantity and specific type of its introduction, however, remain controversial [20]. Based on the assumption of preoperative dehydration and significant amounts of intravenous fluid, it is still common clinical practice, although a positive perioperative fluid balance with postoperative increase in fluid weight on the basis is associated with major complications [21-25].

Materials and methods

We have analyzed the modern literature on infusion therapy of the perioperative period, where the method of research was bioimpedance measurement. Based on these data, the bioimpedance analysis of body composition was taken as the basis of their methodology, which is based on the differences in the electrical resistivity of biological tissues due to the different content of fluid and electrolytes in them. The analysis allows, based on the measured values of electrical resistance (impedance) of the human body and anthropometric data, to assess the state of protein, fat and water metabolism, the intensity of metabolic processes, correlate them with intervals of normal values of signs, assess the reserve capabilities of the body and the risks of diseases [2, 10]. Currently, there are quite a few reports in the literature [6,30] about the possibility of using bioimpedance measurements of the body when it is probed with currents of different frequencies to control the state of water balance. Fundamental research on mathematical modeling of bioimpedance measurements using high-resolution three-dimensional geometric models of the human body made it possible to visualize the measurement sensitivity areas and confirmed the importance of the method for assessing changes in body composition and fluid balance [4]. The BIA VSM data allow to give a comprehensive assessment of the state of the volume and nutritional status, and the

availability of computer support - to track the results of changes in dynamics. The device is intended for use in clinical practice, the output protocols of the method contain estimates of the following parameters:

- volemic status - the volume of total body fluid (OBF), the volume of extracellular fluid (VF), the volume of intracellular fluid (ECF), the percentage of lack or excess of extracellular fluid, the ratio of VF / ECF, the level of hypo- or hyperhydration (l);

- nutritional status - lean mass (HM), fat mass (FM), cell mass (BM), lean mass index (ITM), fat mass index (FFM), body mass index (BMI) [44].

The goal of E. Itobi ID from the UK was to gain a better understanding of the processes that lead to postoperative edema by using multifrequency bioimpedance analysis (BIA) to monitor total body water redistribution (TBW) after major abdominal surgery.

Results and discussion

Research by M. Tsukamoto., Et al. (2017) patients were 2 to 12 years old, ASA risk I, preoperative fasting, oral intake of light food allowed until midnight, and clear liquid until 6:00 am. Patients who were scheduled for induction of anesthesia from 8:15 AM (the first on the surgical day) did not receive a preoperative fluid load. None of the patients were premedicated. Patients received a crystalloid load of 10 ml / kg / h from the induction of anesthesia before the start of the surgical procedure, and from 1 to 3 ml / kg / h during the operation [8]. Their research showed that fluid changes lead to a decrease in intracellular water using BIA during general anesthesia. The introduction of fluid provides correction of the existing fluid deficit and to compensate for perioperative fluid shifts between intracellular and extracellular. And in low-trauma surgery, there is no concern about fluid loss and fluid shear that may be associated with highly traumatic surgery. [35,36] In this study, the opinion on highly traumatic surgery remains unclear as indicated by the author. In addition, there are no specific figures on the amount of infusion load. If only the general opinion is that low-traumatic operations do not require more detailed correction of infusion therapy. The author also pointed out that not all patients had a fasting time of 2-3 hours, in many cases it exceeded [8]. Also, in this study, extracellular water loss occurred and intracellular water decreased due to preoperative fasting and low fluid therapy during general anesthesia, although hemodynamic changes were stable and there were no complications in the postoperative period [8,34]. All data were taken from a study of 16 patients, which, in our opinion, cannot bear the recommendatory nature of this method in order to correct the infusion therapy of the perioperative period..

The study by E. Itobi ID included 38 patients, among them there were no differences in the sex ratio, the risk assessment of the American Society of Anesthesiologists [13] between patients, the bioimpedance analysis was measured on days 1, 3 and 5 after surgery. included in the study, but the 20 patients who developed edema were older than those who did not develop edema (mean 73 (9) versus 63 (14) years; P = 0.007). Fluid intake during the first 5 days after surgery was the same in both groups, but those with edema excreted less total fluid (16.9 (2.4) versus 19.7 (3.5) liters; P = 0.022). Edema was associated with delayed transport of solid food (P = 0 001) and bowel opening (P = 0 020), prolonged hospital stay (mean 17 (range 8-59) versus 9 (range 4-27) days ; P = 0.001) and more postoperative complications (13 of 20 versus four of 18 patients; p = 0.011). The preoperative ratio of whole body impedance at 200 kHz and impedance at 5 kHz was higher in those who subsequently developed edema (0 81 (0 03) versus 0 78 (0 02); P = 0 015). Fluid balance calculations in this study showed that some patients are able to accumulate large volumes in the postoperative period without developing clinical obvious edema. Such fluid can accumulate in parts of the body that are not readily available clinically. Fluid retention within the gastrointestinal tract following major abdominal surgery has been attributed to a combination of albumin sequestration and decreased motility with potentially adverse effects [14,15]. The most important clinical finding from this study is that the presence of edema is associated with slower postoperative recovery. Patients with edema had significantly more complications, a slower recovery of bowel function, and a longer hospital stay. According to our data, the study has several disadvantages. First, the sample size was small, which means that the risk of type II error was high. Second, although there was complete agreement between observers in the diagnosis of edema, it is recognized that the detection of edema may be influenced by factors such as skin elasticity and interstitial tissue compliance, which are known to be age dependent. Matth and Ernstbrunner, etc., in their study in 71 women aged 45 ± 15 years with a body weight of 67 ± 13 kg and anesthesia duration of 154 ± 68 minutes, the preoperative fluid overload increased from 20.7 ± 1.1 L to 0.1 ± 1.0 L, which corresponds to 25.1 ± 7.5% and 0.8 ± 6.7% of the normal extracellular volume, respectively (both p 0.001), after patients received 1.9 ± 0.9 L intravenously crystalloid liquid. Perioperative urinary excretion was 0.4 ± 0.3 L. The increase in extracellular volume was accompanied by an increase in the total volume of body fluid, while the intracellular volume increased insignificantly and did not reach statistical significance (p = 0.15). Net perioperative fluid balance (fluid volume injected minus urinary excretion) was significantly associated with changes in extracellular volume (r2 = 0.65), but was not associated with changes in intracellular volume (r2 = 0.01). Routine intraoperative fluid administration results in a significant and clinically significant increase in the extracellular compartment. BIS measurements have yielded plausible results and may be useful to guide intraoperative fluid therapy in future studies [39]. The results indicate the full use of the method in the perioperative period in adults. But there is no analysis in pediatric practice. Which allows us to explore more deeply in pediatric anesthesiology.

Conclusions

At the moment, there is no doubt about the demand for protocols for the infusion of patients in the perioperative period. That would improve the rapid recovery of patients in the postoperative period from a medical and economic point of view of this problem. Bioimpedance monitoring allows continuous monitoring of body fluids and immediate correction, if necessary, during the entire perioperative period. In the future, based on the data obtained, it is possible to develop infusion therapy for the perioperative period in children. In practical medicine, it is possible to provide data on the infusion of children with anesthesiological support in surgical practice.

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Entered 09.09.2020