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Fluid resuscitation in pre-hospital care

Resuscytacja płynowa w opiece przedszpitalnej

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Summary

Fluid therapy he constitutes the important aspect of the medical care above persons, at which leveling the volume level of blood is necessary. Normal performance of therapy płynowej to contribute perhaps to receive satisfying final results of the treatment. With soundness fluid therapy there is balanced therapy. For the conduct fluid therapy colloids are being used as well as krystaloidy which characteristics are describing cases when exactly they should be applied. Examinations are showing negative aspects fluid therapy in more late stages of the treatment. Płynoterapia she is important and, in many clinical situations, with irreplaceable method of the patient care. Correct, based on the professional experience of the lifeguard as well as on notifications from the world of science, conducting therapy is contributing to improve final results of treating the injured person. In spite of the knowledge about resulting benefits from the application płynoterapii in practice, farther she is a method which requires the improvement and the further improvement.

Streszczenie

Płynoterapia stanowi ważny aspekt opieki medycznej nad osobami, u których konieczne jest wyrównanie objętościowego poziomu krwi. Prawidłowe wykonanie terapii płynowej przyczynić się może do otrzymania zadowalających końcowych wyników leczenia. Najlepszą formą płynoterapii jest terapia zbilansowana. Do przeprowadzenia płynoterapii wykorzystuje się zarówno koloidy, jak i krystaloidy, których charakterystyka określa przypadki, kiedy dokładnie powinny być one stosowane. Badania wykazują negatywne aspekty płynoterapii w późniejszych etapach leczenia. Płynoterapia jest ważną i – w wielu sytuacjach klinicznych – niezastąpioną metodą opieki nad pacjentem. Prawidłowe, oparte na doświadczeniu zawodowym ratownika, a także na doniesieniach ze świata nauki, przeprowadzenie terapii płynowej przyczynia się do polepszenia końcowych wyników leczenia osoby poszkodowanej. Pomimo wiedzy na temat korzyści wynikających z zastosowania płynoterapii w praktyce, dalej jest ona metodą, która wymaga poprawy oraz dalszego udoskonalania.

Conflict of interest
Konflikt interesów
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Water constitutes 45-65% of the total human body weight. The amount of water depends mainly on the age of the individual. Therefore, it is crucial to maintain homeostasis of the human body as homeostasis excludes any disturbances in the functioning of the organism, including the disturbances caused by loss of water or other body fluids. Due to some diseases, prior clinical surgeries, and injuries, it may be necessary to externally support the physiological functions of the body by means of delivering fluids through the circulatory system in order to maintain its proper functioning. In the medical field, such activities are called fluid therapy (1).

The main goal of fluid therapy is the supplementation of the vascular bed, which consequently contributes to a stabilization of preload. A significant advantage of fluid therapy is the almost immediate body response. The procedure is undoubtedly justified by the positive reaction (a stabilized pulse, general beneficial effects on health, an increased blood pressure values) to fluids. However, if the patient's condition deteriorates im-

mediately after such a positive reaction, the medical team performing fluid therapy should continue it by further delivering fluids and simultaneously diagnose the cause of their loss (2).

Nowadays, fluid therapy is mainly associated with the tasks performed by doctors and nurses specialized in anesthetics. The reason is that fluid therapy is one of the most frequent methods applied in the professional tasks of this group of specialists. However, this therapy is also applied as a part of prehospital- and hospital treatment, e.g. in emergency medicine departments (3). Fluid therapy is used when it is required to stabilize blood volume and restore a proper level of oxygen content in cells and tissues. Moreover, fluid therapy is perceived as a justified supplementary procedure in cases of threat of life or health in order to stop the potential coagulation disorders and to protect proper physiological renal functions.

In spite of the significance of fluid therapy, which is undoubtedly an important element of patient's care when fluid therapy is required, medical professionals emphasizes other equally important aspects called ABC. According to them, it is necessary to secure the respiratory tract, providing ventilation if required in the specific situation, and to secure circulation by means of using two or more peripheral venous access elements.

- A – B – airway – breathing,
- C – circulation (4).

The basic indications for the application of fluid therapy in the treatment of an injured patient are traumas causing loss of blood or other body fluids. In both prehospital care and hospital emergency treatment, traumas are one of the major indications for including fluid therapy in the process of treatment. Hypotension (caused by a hemorrhage, a serious dehydration or other factors) also constitutes a clear reason to apply fluid therapy while providing assistance in hospital emergency departments. Moreover, basic recommendations also include continued prehospital treatment activities and further actions in the form of fluid resuscitation in cases of e.g. sudden cardiac arrest (5). Apart from the above mentioned indications, there are more to be found in the specialized literature. Frequent indications for fluid therapy include:

- shock: any types of shock. The most frequent is the hypovolemic shock. The group also includes the anaphylactic shock and the septic shock,
- burns: a loss of liquids caused by a higher permeability of blood- and lymphatic vessels,
- dehydration caused by an increased loss of liquids due to e.g. diarrhea, vomiting. It is especially in pediatric patients that these factors are serious because of the risk of a sudden life threat condition,
- other cases of liquid deficiency in the body (6).

A formulation of the major indications for fluid therapy in an injured is a crucial assistance for the individuals who provide medical care. In spite of numerous articles and case studies, fluid therapy remains the subject of further new research and discussion. One of the main aspects considered in the context of fluid therapy is the proper selection of the infusion fluid (7).

THE SELECTION OF THE INFUSION FLUID IN FLUID THERAPY

The current literature considers the best infusion fluid available on the market. The major requirements identified by medical professionals are:

- the fluid should improve perfusion after the application of a low volume of the fluid,
- the fluid should have a beneficial effect on the oxygen management (i.e. the levels of oxygen uptake and delivery to the body),
- the fluid should be composed of elements defined by other regulations (pH, electrolyte volume),
- the fluid should have as long duration of action as possible (8).

Crystalloids

Crystalloids are infusion fluids composed of electrolytes or carbohydrates. The major indications for the application of crystalloids in fluid therapy are securing basic demand for liquids, compensating for losses of liquids, and eliminating electrolyte disorders in the organism. Inspite of the significant role of this group of fluids in the fluid therapy procedures, there are numerous negative aspects having a direct impact on the condition and the life parameters of the patient. The most important issue related to crystalloids is that the solution remains in the bed for a very short time. It has been estimated that, about 60 minutes after the injection, there is only 20% of the initial volume of the fluid in the vessels. It is caused by the possibility of diffusion through capillaries. About 80% of the volume delivered to the patient remain outside of the blood vessels and do not compensate for the losses. Another aspect of crystalloid-based fluid therapy that can be unpleasant to the injured is the risk of edema caused by a high amount of sodium in the solution. Currently, the most frequent crystalloids are e.g.:

- 5% glucose,
- 0.9% NaCl,
- Ringer's lactate,
- Ringer's solution,
- multielectrolyte fluid,
- sterofundin.

They are all characterized by a close relationship of plasma content to ions. In cases of loss of electrolytes caused by vomiting and diarrhea, 0.9% NaCl fluids are recommended (9). Nowadays, there are numerous medical products that meet the requirements on the Polish pharmaceutic market. One of the leading producers is Baxter. Natrium Chloratum 0.9% (Baxter) is an example of a ready and balanced fluid used in cases of serious loss of electrolytes.

Colloids

Another group of fluids applied in fluid therapy is the group of colloids. Their major feature is that they elevate oncotic pressure and, as a consequence, water is transported to blood vessels. This phenomenon provides a very effective and prompt therapeutic effect.

As estimated in the literature, 1 l of colloids equals 4 l of crystalloids. Despite the effectiveness of colloids, the indications for their use are insufficient supply of crystalloids and any contradictions related to the application of crystalloids (e.g. the risk of pulmonary edema).

Colloids have been divided into two groups based on their origin, i.e.:

- natural colloids, e.g. albumins,
- synthetic colloids (gelatins, starch solutions, and dextrans).

In crystalloids, the important role is to compensate for basic electrolyte losses whereas in colloids, the characteristic feature is the possibility to replace plasma with colloids and to balance the intravascular volumes of the body. Due to the ability of binding water particles, colloids remain in vessels much longer than crystalloids (colloids do not diffuse through the vessel membrane). The major example of a colloid used in fluid therapy is the modified fluid gelatin (9). There are numerous products available on the Polish market, e.g. human albumin 50 g/l (Baxter).

Fluid therapy in out-of-hospital care

Based on experience and the knowledge of indications and contradictions of fluid therapy, the application of this method in treatment is expected to lead to the best possible therapeutic benefit. Medical professionals assume that the basic objectives of a balanced fluid therapy are:

- minimizing the risk of coagulopathy,
- limiting the exploitation of blood products and blood-based materials,
- maintaining proper blood circulation and providing an undisturbed process of gas exchange,
- minimizing the risk of late complications caused by the application of excessive volumes of infusion fluid (10).

Based on the above mentioned criteria, several principles have been established and they facilitate the duties of a paramedic. Maintaining perfusion of the significant body organs is claimed to be crucial and confirms the essential need of fluid therapy in patients, i.e. the need to secure the unlimited passage and transport of oxygen and nutrients in the body. Other crucial aspects worth implementing in the everyday practice of a paramedic are:

- the need of limiting the volume of crystalloids administered to the injured (as a consequence of the observation that low levels of fluid remain in the vascular bed),
- the need of identifying and controlling an external bleeding (the process has to start prior to the intravenous injection of the fluid),
- verifying if a simultaneous internal bleeding occurs (in which case fluid therapy may be impossible),
- indicating the priorities of the actions to be performed by the rescue team to the patient (in numerous cases, an immediate transportation of the patient to a medical unit and surgical activities might be more important),
- initiating a prompt balanced fluid resuscitation by means of blood products in a proportion 1:1:1 for red blood cells concentrate, fresh frozen plasma and platelet concentrate (11).

The research focused on the influence of fluid therapy on patient's condition in their perioperative period, as well as on postoperative complications notice e.g. a higher mortality in cases where an early fluid therapy was applied with a fluid volume of over 4000 ml, hyperchloremia and its consequences, i.e. a higher mortality rate caused by a rising level of acidosis in the body, coagulopathy, and finally, renal failure and dysfunctions of other internal organs of the body. The negative consequences of fluid therapy are also included in the studies concerning respiratory failure and infections occurring as a result of surgical treatment in cases where fluid therapy was applied as a part of medical care procedures (12-14). Owing to the available analyses and the research on the consequences of applying fluid therapy, medical professionals tends to transform their procedures by means of applying a balanced and rational fluid therapy. The above mentioned positive and negative aspects of fluid therapy motivate medical specialists to further improve this type of treatment. Fluid therapy is one of the most frequent therapeutic interventions by Baxter.

Fluid therapy in burns

According to the literature, a burn is a damage of skin and, in many cases, tissue and organs located deeper in the body. The damage can be caused by heat, electric current, solar- and ionizing radiation, as well as chemical substances (15). There are four degrees of burns depending on the thickness and the scope of the burn:

1. First-degree burn is a damage that only affects the epidermis. Related symptoms are pain and reddening of the parts of skin after having contact with the factor causing the burn.
2. Second-degree burns can be divided into IIA and IIB degree burns, i.e.:
   - IIA: the damage involves the epidermis and, partially, the dermis. This type of burn results in blistering (blisters filled with the serous fluid),
   - IIB: the damage is visible in the epidermis and the full thickness of the dermis. This type of burn results in a white hue of the skin with some reddening spots. The pain is not as acute as in IIA burns due to the damage of nerve endings.
3. Third-degree burn is characterized by complete necrosis of the dermis, its vessels, nerves and fat tissue. This type of burns is frequently related to the necessity of a skin transplantation.
4. Fourth-degree burn is characterized by similar consequences to those related to third-degree burns but is more extended. In this case, necrosis also involves deep tissues: muscles, tendons, and bones. The tissues directly affected by the factor causing the burn are charred (16).

The fluid therapy applied in cases of this type of tissue damage considers the application of crystalloids, crystalloids and colloids, and a concentrated salt solution. In spite of the implementation of this principles in medical practice, it is claimed that there are cases of significant underestimation resulting from (above all) a late transportation to the medical unit and an inadequate supply of fluids during transportation (17).

The following methods are used in the estimation process:

- the Parkland formula – this formula is applied in cases of burns that do not cover more than 20% of the body surface. In such situations, Ringer's lactate is used (4 ml/1 kg of body mass within 24 h: 50% of the volume is used within the initial eight hours and the other 50% is applied within the further 16 hours),
- the Brooke formula – within the initial 24 hours, crystalloids in the form of Ringer's lactate (1.5 ml/kg) and colloids, i.e. 5% albumins (0.5 ml/kg) are applied. The procedure is similar to the Parkland formula, i.e. half of the volume is applied within the initial eight hours and further half within the subsequent 16 hours,
- Monafo, concentrated salt – within the initial 24 hours, a crystalloid including 250 mmol Na/1 l is applied (18). The selection of the infusion fluid mainly depends on the composition of the fluid, patient's blood pressure, the osmolarity of the serum, diuresis, and the volume of the applied fluid (18).

The tables 1-3 illustrate the flow values depending on the particular size of the venous catheters, the composition of intravenously administered crystalloids, and the features of hypertonic solutions.

Tab. 1. Different sizes of catheters and a comparison of flow speed (19)

Size		External diameter		Speed
Gauge (G)	**French (F)**	**inch**	**mm**	**(ml/min)**
14	6.30	0.083	2.10	–
16	4.95	0.065	1.65	96.3
18	3.72	0.049	1.24	60.0
20	2.67	0.035	0.89	39.5
22	2.13	0.028	0.71	24.7
24	1.68	0.022	0.56	–

Tab. 3. Features of hypertonic solutions (19)

	7.5% NaCl	**7.5% NaCl**	**7.5% NaCl**	**7.5% NaCl**
	10% HAES	**6% HAES**	**10% dex 60**	**6% dex 70**
	200/0.5	**200/0.5**		
Na (mmol/l)	1232	1232	1232	1283
CT (mmol/l)	1232	1232	1232	1283
Osmolarity (mmol/l)	2464	2464	2464	2567
HAES (g)	100	60		
Dextran (g)			100	60
COP (mmHg)	40	30	85	70
pH	4.9	4.9	4.6	4.6

CONCLUSIONS

1. Fluid therapy is a significant and, in many clinical cases, an irreplaceable method of medical care.
2. A properly applied fluid therapy based on the experience of the paramedics and the scientific findings contributes to an improved final therapeutic effect of treatment.
3. Fluid therapy performed by paramedics should be oriented to the methods of a balanced emergency fluid therapy.
4. Despite numerous positive aspects of the application of fluid therapy in practical medical care, fluid therapy should be further improved.
5. Unfortunately, fluid resuscitation in both children and adults remains fiction.

Tab. 2. The composition of intravenously administered crystalloids (19)

Osmolarity	**mEq/l**						**(mOsm/l)**	
Fluid	**Na**	**Cl**	**K**	**Ca**	**Mg**	**buffer**	**pH**	
Plasma	141	103	4-5	5	2	bicarbonate (26)	7.4	289
0.9% NaCl	154	154					5.7	308
7.5% NaCl	1283	1283					5.7	2567
Ringer's lactate	130	109	4	3		lactate (28)	6.4	273
Normosol or plasma-Lyte	240	98	5		3	acetate (27) gluconate (23)		

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