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BLOOD AND URINE ELECTROLYTES DYNAMIC PATTERN OBSERVED AT DIFFERENT MONITORING STAGES IN PATIENTS SUFFERING FROM TOXIC SHOCK SYNDROME AND UNDERGOING VARIOUS TYPES OF INFUSION THERAPY

Abstract
Blood and urine electrolytes dynamic pattern observed at different monitoring stages in patients suffering from toxic shock syndrome and undergoing various types of infusion therapy.

The need to study how the infusion therapy affects the electrolyte composition of blood is a topical issue nowadays. Such a study will provide the necessary answers and help us to introduce the most effective infusion therapy strategies for patients suffering from severe hemodynamic disorders accompanying toxic shock syndrome (TSS). The study analyzes and summarizes the examination and treatment results of 111 patients suffering from various forms of severe infectious disease complicated by TSS. As a result of the study, it was determined that infusion therapy using a combination of hypertensive and colloidal solutions significantly contributes to the rapid restoration of electrolyte composition and compensates for acidosis. Given these data, a combination of 10% sodium chloride solution with 6% colloidal solution can be considered a preferable solution for initial infusion therapy in patients suffering from TSS.

Keywords: toxic shock syndrome, infusion therapy, electrolyte composition of blood.

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TSS — toxic shock syndrome

Relevance
Capillary organ perfusion is determined by three factors: the expulsion pressure, the arterioles lumen and blood rheology [7]. In the case of tissue perfusion restoration after long-term ischemia and hypotension three reperfusion paradoxes arise: calcium, oxygen and osmolal paradoxes. They are characterized by a sharp increase in the calcium and oxygen consumption by post-ischemic tissues and a significant increase in intracellular osmolality [6]. The main goals of infusion therapy in shock should be: the achievement of normovolemia and hemodynamic stabilization; the acid-base balance correction; the compensation of fluid loss from interstitial and intracellular spaces; the adequate gradient maintenance between colloid osmotic

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plasma pressure and pulmonary wedge pressure; the microvascular blood flow improvement; the prevention of cascade mechanisms and hypercoagulation activation; the normalization of oxygen delivery to tissues; and thus, the cellular metabolism and organ function support, and reperfusion damage prevention [1].

The need to study how the infusion therapy affects the electrolyte composition of blood is a topical issue nowadays. Such a study will provide the necessary answers and help us to introduce the most effective infusion therapy strategies for patients suffering from severe hemodynamic disorders accompanying toxic shock syndrome (hereinafter referred to as TSS).

The objective of the research was to study the response of hemodynamic parameters to different infusion therapy strategies.

Materials and Methods

The paper analyzes and summarizes the examination and treatment results of 111 patients with various forms of a severe infectious disease that has been complicated by toxic shock syndrome. The mean age was (69.35 ± 3.17) years: 66 (59.5%) for men and 45 (40.5%) for women. The patients were divided into four groups. The 1st group of 45 (40.5%) patients received isotonic saline solutions in a dosage of (21.9 ± 1.9) ml/kg of body weight as an initial infusion therapy. The 2nd group of 17 (15.3%) patients received a 6% gelatin solution with a molecular weight of 200,000, a substitution degree of 0.5 with a dosage of 8 ml/kg of body weight as an initial infusion therapy. The initial infusion therapy for 19 (17.2%) patients in the 3rd group was carried out with a combination of dextran-40 solution with a 10% sodium chloride solution in a ratio of 1:1 with a total dosage of 8 ml/kg of body weight. The last, 4th group consisting of 30 (27.0%) patients received an initial infusion with a combination of 6% gelatin solution 200 with a 10% sodium chloride solution in a ratio of 1:1 with a total dosage of 8 ml/kg of body weight.

The evaluation of pH and electrolytes (K+, Na+, Ca2+) in plasma and urine was performed using a Siemens 400/405 analyzer (Germany), with subsequent sodium, potassium and free water clearance calculation; the mercurimetric determination of Cl– concentration in plasma was performed.

The obtained data was processed in Microsoft Works 2014 and Statistic 2.2. Software. The correlation was determined using Pearson’s criterion. The correlation coefficient reliability estimation was assessed using the standard tables. At $p < 0.05$ the correlation coefficient indicated significant correlation dependence.

Results and Discussion

After initial infusion therapy was completed in the 1st group, the plasma sodium level on the second and fourth days was significantly higher than the level before the infusion. The sodium level in urine and potassium level in plasma did not change significantly. However, the potassium level in urine significantly decreased on the fourth and fifth days, which is presumably evidence of a reduction of hyperaldosteronism.

The Cl– level significantly increased on the second day of observation and remained significantly higher during the next 4 days. The level of ionized calcium significantly decreased on the fourth and fifth days. On day 5 it was below the normal level (1.1–1.3 mmol/l).

The pH during the observation period did not significantly differ from the initial level, which means that uncompensated acidosis persisted throughout the experiment.

The plasma sodium level in the 2nd group significantly increased immediately after the infusion and exceeded the normal limits. Thus, moderate hypernatriemia was registered immediately after the infusion, but during the subsequent observation stages this indicator did not significantly exceed the initial level.

The urine sodium concentration did not change significantly at all stages. The plasma potassium level significantly increased on the second day. However, during the other stages it did not significantly differ from the initial one. The urine potassium concentration did not change significantly. The level of plasma chlorides significantly increased on the second day of the study and exceeded the normal level. During the other...
stages this indicator did not significantly differ from the baseline and normal level. Ionized Ca\(^{2+}\) plasma level did not undergo significant changes and remained within normal limits. The pH of the blood did not significantly change during the observation period, remaining below the normal level. Thus, uncompensated acidosis persisted.

The plasma sodium level in the 3rd group significantly increased only on the third day of treatment and did not significantly differ from the plasma sodium level in the other groups during the whole period of the study (\(p < 0.05\)). The urine sodium concentration did not significantly change and did not differ from other groups. The plasma potassium level did not significantly change over the course of 5 days. The urine potassium concentration significantly decreased on the fifth day of the study and was significantly lower than the concentration in the blood and urine in the 2nd, 3rd, and 4th groups (\(p < 0.001\)). Plasma chloride levels were significantly higher than the initial level on the second, third, and fourth days after the start of infusion, and the chlorides level in the 1st group was significantly higher on the fourth and fifth days of treatment (\(p < 0.05\)). The ionized calcium level did not significantly change during the experiment, although on the last day of the study its concentration was slightly lower than the normal level. There were no significant differences in the sodium level in other groups. The 3rd group of the study as well as the previous ones were characterized by the presence of uncompensated acidosis, which persisted for 5 days of the study while the \(pH\) did not significantly change. Thus, this type of infusion therapy also did not contribute to a rapid and sufficiently significant improvement of tissue perfusion and recovery of aerobic metabolism.

In the 4th group, the plasma sodium level significantly increased immediately after the infusion and remained significantly higher than the previous value for 2–4 days. However, starting on the second day, it did not significantly differ from the normal level (\(p > 0.05\)). Thus, significant and prolonged hypernatremia did not occur. There were no significant differences in sodium level between the 4th group and other groups at the observation stages (\(p > 0.05\)).

Conclusions

Based on the results of the study, we can conclude that the combination of 10% sodium chloride solution with colloids does not worsen the water-electrolyte balance compared to standard solutions for infusion therapy of shock. Infusion therapy using a combination of hypertonic and colloidal solutions significantly contributes to the rapid restoration of the electrolyte composition and corrects acidosis. Given these data, a combination of 10% sodium chloride solution with 6% colloidal solution can be considered a preferable solution for initial infusion therapy in patients suffering from toxic shock syndrome.

Conflict of Interests

The authors declare no conflict of interests.
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