Volumotherapy in shock (paediatrics)

With the exception of cardiogenic, obstructive and dissociative shock, patients always have absolute or relative hypovolaemia in the shock state. Depending on the type of deficit, we supplement the volume with crystalloids, colloids (hydroxyethyl starch, plasma) or erymass. The amount of fluid administered is guided by the assessment of the clinical response to fluid administration (blood pressure, heart rate, diuresis). Clinical criteria are more important than absolute values of CVP and PAWP in comprehensive patient monitoring. The limit of volumerexpansion is an increase in filling pressures without further improvement in circulation, i.e., an increase in CVP or PAWP without an increase in CO/CI. The clinical marker of hypervolaemia in children is progression of liver size on palpation of the abdomen.

Volume challenge

When the cause of shock is unclear, the volume challenge algorithm can be used to determine the reactivity of the circulation to intravascular volume repletion. Thus, the goal of the volume challenge is to differentially diagnose the cause of hypotension. The basis of the procedure is the administration of a sufficiently large volume of crystalloids in a short period of time: 20 ml/kg i.v. within 10 minutes. If the volume challenge causes at least a transient rise in cardiac output, mean arterial pressure and a concomitant fall in heart rate, further volume supplementation is desirable. With a significant rise in CVP and persistent hypotension, it is obvious that the cause is heart failure or obstructive shock. Volume challenge is not appropriate in patients with ARDS or intracranial hypertension.

Replacement solutions

Replacement solutions used in the treatment of hypovolaemia can be differentiated into two main types: electrolyte solutions = crystalloids and colloid solutions.

The preference for colloid or electrolyte solutions in the treatment of hypovolemic shock cannot be defended at present (in the context of haemorrhagic shock, some papers point to a better effect of colloids and plasma). Meta-analyses performed on the information available at the same time did not show statistically significant differences when evaluating mortality and morbidity parameters. At present, it can only be stated that the choice of crystalloids leads to the need for administration of larger volumes; on the contrary, the administration of colloids exposes the patient to the risk of anaphylactic reactions.

Patients with very narrow pulse pressure (pulse pressure, PuIP, i.e. the difference between systolic BP and diastolic BP → sTK - dTK) benefit more from colloids than crystalloids when adjusted to normal pulse pressure values.

From a pragmatic point of view, a combination of both types of solutions, colloids and electrolytes can be recommended. The administration of colloids can be justified by their better retention in the intravascular area. The solutions of choice among **crystalloids** are 1/1 PS, 1/1 Ringer, and more recently Plasmalyte (a crystalloid solution in which the ionic composition practically follows that of plasma). The solutions of choice among **colloids** are hydroxyethyl starches (6% Voluven®, 6% Tetraspan®).

The indication for administration of **fresh frozen plasma** (FFP) is the correction of coagulation abnormalities (prolongation of aPTT and Quick); it should not be a solution for volumerexpansion in the context of distributive forms of shock (sepsis, anaphylaxis), as it may have a hypotensive effect (probably mediated by vasoactive kinins). Plasma administration in the indication of haemorrhagic shock is fully indicated.

Crystalloids

Administration of crystalloids leads to their rapid redistribution throughout the extracellular space. In normovolemia, administration of crystalloids leads to an expansion of the circulating volume to 1/3 of the administered amount, but in half an hour only 16% remains in the circulation. If blood loss is to be covered by crystalloids, they should be administered in an amount 3-4 times greater than the blood loss. 1/1 FR or Ringer's solution are considered the optimal treatment solution.

Colloids

Hydroxyethylated starches (HES)

These are colloids with different molecular weights (sizes). They are polysaccharides similar to glycogen. Polymers with molecular sizes below 50 kDa are rapidly eliminated by glomerular filtration, larger molecules are hydrolysed. The size of the molecules therefore decreases substantially within a few hours after infusion. They are degraded by serum amylase (elevation of S-amylase is usually observed during HES administration), excreted by the kidneys and taken up by the reticuloendothelial system. Prolonged administration may lead to their accumulation in phagocytic cells. Anaphylactic reactions are extremely rare. High doses of HES may lead to dilution of coagulation factors, especially to a decrease in the concentration of complex f. VIII/vWF, prolonged bleeding time and prothrombin time. Contraindications to HES administration include hyperhydration, heart failure, pulmonary oedema, intracranial haemorrhage, hypernatraemia, hyperkalaemia, acute renal insufficiency.

Studies with hydroxyethylated starches with molecular weights of 100-1000 kDa (so-called pentafractions) have shown a reduction in capillary leakage during the development of systemic inflammation in

polytraumatized and septic patients. If these properties lead to a reduction in morbidity or mortality in the treatment of haemorrhagic shock, the use of colloidal solutions of this type could be considered most appropriate.
Currently, the most widely used are Voluven® (6% HES 130/0.4), which has been tested on paediatric patients, and Tetraspan® (6% and 10% HES 130/042). Voluven® is a solution of HES in 0.9% saline, the Na and Cl content is 154 mmol/l, and it is slightly hyperosmolar - osmolality 308 mOsm/l. Tetraspan® is HES in a solution similar in composition to blood plasma (physiological concentrations of Na, K, Ca, Mg, Cl are 118 mmol/l). The osmolality of the 6% and 10% solution is 296 and 297 mOsm/l, respectively.

Gelatine solutions

Another type of colloidal solutions are gelatin solutions. They are derived from bovine collagen and modified to increase the weight of the molecule. The haemodynamic effect is short-lived (2 to 3 hours). About 80 % of particles with a mass less than < 20 kDa are rapidly excreted by the kidneys. Some papers have noted the occurrence of hypercoagulable states.

Albumin

Human albumin is a polypeptide with a molecular weight of 65-69 kDa. It contributes about 80% of the oncotic pressure. The use of albumin in critically ill patients does not increase survival. There is currently no reason to use it in the treatment of traumatic shock. Albumin in hypovolemic shock is given by bolus: 5% albumin 20 ml/kg i.v. over 10 minutes.

Links

Source

- HAVRÁNEK, Jiří: *Šok*. (upraveno)

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