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Emergency Medicine

Infusion solutions supply in critical circumstances and disasters

Katrzyna Parzuchowska[1], Radosław Ziemba[1], Jan Hołyński[2], Adam Ziemba[3], Jarosław Hołyński[4], Ewa Ziemba[5]

[1]Military Centre for Pharmacy and Medical Technology in Celestynow, Poland
[2]Military Centre for Pharmacy and Medical Technology in Celestynow, Poland
[3]Łódź, Poland
[4]Military Centre for Pharmacy and Medical Technology in Celestynow, Poland
[5]Institute of Psychiatry and Neurology in Warsaw, Poland

Author's address:
Radosław Ziemba, Military Centre of Pharmacy and Medical Technique, ul. Wojska Polskiego 57, 05–430 Celestynów, Poland; e–mail: zx11@op.pl

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Summary:

Proper supply of infusion fluids to appropriate destinations during critical situations and catastrophes depends on meeting the requirements of distribution and logistics. The need for central storage of fluid reserves and subsequent decentralization of medical supplies for immediate casualty management under extreme circumstances is directly related to appropriate quantitative and qualitative supply. Effectiveness of emergency rescue services and appropriate medical services depends on gathered fluid reserves, particularly blood products, which should be immediately delivered to the victims of catastrophe according to their needs. Created norms for the use of infusion fluids during mass events as well as their distribution should fulfill international standards and criteria developed for the rescue services.

Key words: infusion fluids — critical circumstances,disasters.

Standards of conduct and practice in critical circumstances and during catastrophes developed by appropriate military services and special emergency rescue services ensure effective supply of goods based on operating medical equipment that proves effective in all conditions. The system of supply of infusion fluids is based on the norms of consumption of blood replacement and blood-based products. It should fulfill the fundamental requirements for infusion into human circulation. Infusion fluids are administered in order to replenish the intravascular volume, e.g.: following a massive hemorrhage in a form of crystalloids and/or colloids (sterile aqueous solution of chemical substances devoid of pyrogens, non-toxic, iso – or hyperosmolar to blood plasma). Infusion fluids may be divided into crystalloids or colloids.

Crystalloids

Crystalloids are aqueous solutions, inexpensive to produce, easily available, free of allergens, containing mineral salts: sodium chloride, potassium chloride, calcium chloride, magnesium chloride, sodium acetate or sodium lactate in proportions allowing for intravenous infusion in men. The most frequently used fluids are: normal saline [0.9% sodium chloride solution], multi-electrolyte solution [PWE], Ringer and lactated Ringer solution and a mixture of normal saline and 5% glucose solution [in 2:1 proportion].

Administration: for short-lasting replacement of plasma volume, as they quickly diffuse into the extravascular space following intravenous infusion.

Colloids

Colloids are aqueous solutions of multiparticle substances – usually glucose polymers or gelatin derivatives – their production is more expensive than crystalloids. Colloids may disrupt coagulation or cause allergic reactions [anaphylactic shock]. The most commonly used fluids include HES [hydroxyethyl starch, molecular weight of 45000], Voluven [6% and 10%] and Gelafusin – 3-5.5% solutions of synthetically modified gelatin with molecular weight of 25000-35000.

Use: to restore plasma volume deficiencies, as they are slower to diffuse into the tissues and fill the vascular bed well by maintaining osmotic pressure. Colloid osmotic pressure of dextran 70 is about 8.0 kPa and that of dextran 40 is about 23 kPa [it is 3.5-4 kPa in case of plasma]. A 3.5% dextran 70 solution and a 2.5% dextran 40 solution are isosmotic to plasma, while water binding capacity in the circulation amounts to 20-25 ml/g of dextran.

Oxygen-carrying products [so-called, true blood replacement products]

Oxygen-carrying products are compounds of recombined hemoglobin and perfluorocarbons [Fluosol DA], possessing the ability to bind oxygen and carry it to the tissues. As this preparation is non-toxic, its characteristics and clinical usefulness for life-saving purposes was tested on severely wounded soldiers with traumatic chest and lung injuries, accompanied by massive hemorrhages. They remain at a phase of clinical studies.

According to numerous publications based on experiences in critical circumstances, including mass catastrophes and results of warfare, provision of infusion fluids during hazardous times and in special situations should take into account the most common injuries.

Supply of infusion fluids encompasses three most important issues:

1) storage of large amounts of infusion fluids ready for immediate use and/or,
2) rapid initiation of fluid production in the absence of production in the existing factories that have storage capabilities in pharmaceutical warehouses,
3) logistics and organization of distribution points.

The most severe and most common traumatic injuries requiring administration of infusion fluids include massive hemorrhages and burns. Massive injuries constitute about 20% of cases, 25-35% of which require immediate filling of the vascular bed in order to maintain adequate intravascular pressure and restore proper tissue perfusion in the presence of progressing ischemia, as well as to secure renal filtration pressures.

Massive hemorrhage always requires administration of blood replacement fluids to fill the vascular bed and maintain systolic blood pressure of 85 mmHg until blood or plasma preparations may be given.

A safe reserve that should be secured for the casualties amounts to about 4.5 liters of fluid per person [blood and/or blood replacement fluids], including:

- 1-1.5 l of plasma/person,
- 0.5-1.0 l of full blood/person,
- 2-3 l of blood replacement fluids/person.

Experiences acquired to date indicate that, in case of mass injuries, provision of plasma products and blood constitute one of the largest problems. The amount of infusion fluid needed per person is the source of discrepancies in available literature. Blood replacement fluids constitute an alternative during life-threatening situations, critical circumstances and large-scale catastrophes, when we deal with signs of shock, including dehydration, hemorrhage with loss of <1000 ml of blood volume.

Supply of blood and blood products is always insufficient under life-threatening circumstances. Therefore, infusion fluids constitute fundamental measures of securing mass events. Predicted demand for infusion fluids in critical situations is about 5 mln liters for a period of 10 weeks, which should be secured by the national pharmaceutical industry. The time of storage for infusion fluids depends on the type and packaging, as well as

means of storage of strategic reserves for a period of 3-5 years.

The need for constant replenishing infusion fluids during critical situations may not be possible to accomplish. Therefore, it is strategically important to fulfill the following criteria:

1) The necessity to store infusion fluids – storage decentralization
2) Diversification of production and logistics as well as infusion fluid storage should be the decision of central crisis management supply and be available to all subordinate rescue services.
3) Provision of supply fluids is particularly important during mass bodily traumas caused by burns and radiation injuries. It increases to 100% compared with other injuries.
4) The most important and most relevant for clinical practice infusion fluids are the following solutions: dextrans, Ringer, lactated Ringer solutions, colloid solutions.
5) Coordination of actions and cooperation with countries possessing readily available reserves and/or production lines ready to replenish storage deficiencies within an integrated logistics network of NATO member countries.
6) Joint multinational strategic programs and missions for gaining practical experience, resulting in adequate supply and reaction time during critical situations and/or catastrophes.

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