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The Provision of Medical Assistance to Victims of the Earthquake in Armenia (for the 30th Anniversary of the Tragedy)

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ABSTRACT The article presents the organization of specialized medical care to patients with crush syndrome, acute liver and kidney failure (ALKF), and endotoxic shock, who suffered in the earthquake in Armenia, delivered via air ambulance to N.V. Sklifosovsky Research Institute.
In the present report we defined characteristics of medical supplies, qualified and specialized treatment of patients with combined trauma.

Keywords: crush syndrome, emergency situations, earthquake, specialized medical care
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ARF — acute renal failure
ARHF — acute renal and hepatic failure
CIC — circulating immune complexes
COLIH — Central Order of Lenin Institute of Hemotransfusion
LARHF — laboratory for acute renal and hepatic failure
UV — ultraviolet exposure of blood

INTRODUCTION

To eliminate the medical consequences of the earthquake that occurred on December 7, 1988, 22 scientific and clinical employees of N.V. Sklifosovsky Institute and 3 representatives of other medical organizations: E.K. Sahakyan — assistant of the department "Emergency medical care with a series of lectures on disaster medicine", L.D. Bykovnikov — Assistant of the Department of Neurosurgery, N.A. Semashko Moscow Medical Institute and V.V. Kizhaikin — Deputy Head of the Health Department of the Dzerzhinsky District of Moscow for Civil Defense. The medical group was headed by the director of the N.V. Sklifosovsky Research Institute professor V.G. Teryaev.

On December 9, 1988, the second group of employees of the Institute, consisting of 5 people, flew to Yerevan: S. Strakovsky and S.V. Sergeyev from the Department of Traumatology, A.A. Nazarenko and A.A. Yarmagomedov from the Laboratory of Acute Renal and Hepatic Failure (LARHF) and Professor I.I. Shimanko, the head of the LARHF, who headed this group of doctors.

On December 10, by the order of the Minister of Health of the USSR E.I. Chazov to assist his Armenian colleagues in organizing an emergency medical support system for the victims from the hospital in the village of Maralik, the director of the N.V. Sklifosovsky Research Institute professor V.G. Teryaev, head of the Scientific Department of Disaster Medicine B.M. Gazetov, V.V. Kizhaikin and E.K. Sahakyan left for Armenia [1-3].

The medical and nursing group of the Institute, which remained in the hospital in the village of Maralik, continued to provide medical assistance to the victims under the leadership of M.M. Abakumov.

For 12 days of work, medical workers of the Institute provided qualified medical care to 810 victims.

All patients who received first and qualified medical care in the village hospital and who needed specialized medical care were transferred to hospitals in Yerevan and other cities of the country, since most of the medical institutions were destroyed by the earthquake, and the remaining, functioning part of them could not accept all arriving patients from disaster sites.

Then, 439 victims were delivered to Moscow, of which 76 people were hospitalized at the N.V. Sklifosovsky Institute, and the other patients were admitted to other specialized hospitals in the capital.

Professor L.L. Stazhadze and the head of the department of emergency medical care of the institute, Doctor of Medical Sciences L.G. Kostomarova remained in the Institute, and conducted the organizational preparation of the Institute for victims.

For the administrative and economic service of the Institute, the entire medical and nursing team and employees of laboratory departments, the preparation for receiving victims was different from earlier emergencies, including mass poisoning. A special feature was the admission of a large number of patients with severe combined, multisystem and multiple trauma.

A group of specialists consisting of Professor V.P. Okhotsky, chief traumatologist of the city of Moscow, S.G. Musselius, leading researcher of LARHF and G.I. Tseplyaeva , head of LARHF were instructed to organize the reception of victims and carry out their distribution in the specialized departments of the Institute.

In the period from December 8 to December 20, 76 victims were treated at the Institute. Most of them were saved by rescuers from under the rubble of destroyed structures within 3 hours to 3 days from the moment of the earthquake. According to the severity of the condition, some patients were transferred to the Institute from other Moscow hospitals to provide highly qualified care due to the presence of severe post-traumatic complications and acute renal failure. The selection of this group of seriously ill patients was carried out by the head of the 2nd Trauma Department prof. V.P. Okhotsky and experienced doctor of LARHF D.V. Yanshin. Thus, in the N.V. Sklifosovsky Institute, the heaviest contingent of earthquake victims was concentrated relative to other city hospitals.

The procedure for organizing the reception of victims did not violate the usual round-the-clock rhythm of clinical work and scientific activities of the Institute.

RESULTS AND DISCUSSION

Highly qualified medical care provided by doctors in hospitals in Armenia with the active participation of employees of the N.V. Sklifosovsky Institute, saved the lives of many seriously ill patients and ensured their reliable transportation to hospitals in Moscow [1].

In total, there were 78 victims with a crash syndrome at the Institute.

The hospitalized patients, most of whom had a hard time transporting to Moscow, underwent urgent intensive care in the intensive care unit. After stabilization of the condition, the patients were transferred to the appropriate departments of the institute.

Thirty-six patients with the clinic of traumatic toxicosis complicated by acute renal failure (ARF) were referred to LARHF, and 42 patients with severe traumatic bone injuries and purulent wounds were sent to the 2nd Trauma Department.

The council of doctors receiving the victims determined the sequence of treatment measures, emergency and planned laboratory and instrumental studies for the near future.

Treatment of patients was carried out with intensive work of the paraclinical services of the Institute and, first of all, it concerned the clinical and biochemical laboratory (headed by professor P.P. Golikov and V.P. Vakhtel). The number of studies during the day was many times higher than the number of analyzes performed on ordinary days. The study of the dynamics of homeostasis indices provided invaluable assistance to doctors in determining the therapeutic tactics adequate to the condition of patients, as well as in choosing the sequence and mode of extracorporeal detoxification methods.

In the most serious condition, the victims were admitted who were under the rubble for more than a day. Most of them were inhibited, indifferent, not oriented in time and location. The pulse rate reached 130–140 beats / min, blood pressure was in the range of 80–60 and 60–50 mm Hg, and the respiratory rate was 24–32 per minute.

Conservative treatment of patients in LARHF and in the 2nd Trauma Department was carried out in compliance with the general principles of intensive therapy for endotoxicosis and concomitant trauma complicated by a purulent-septic process.

The treatment of the victims, first of all, was aimed at relieving the pain syndrome and normalizing the psycho-emotional state, stabilizing the hemodynamic and ventilation parameters, and correcting the water-electrolyte balance. Particular attention was paid to the comprehensive detoxification of the body. Supporting the immune status of patients was extremely important for the prevention and successful treatment of purulent-septic complications. Normalization of hemorheological parameters played an important role in the restoration of microcirculation, elimination of inflammation and the development of reparative processes in the area of traumatic soft tissue injuries [2–4]. Psycho-neurological disorders were managed as a positive result of treatment was achieved.

The use of radioisotope methods made it possible to assess the structural and functional changes in the affected soft tissues. Tetrapolar rheoplethysmography helped assess the state of general and local blood circulation was, and monitor the effectiveness of the treatment.

In case of anemia and unstable hemodynamic parameters, the ratio of the injected donor blood, its components, blood products and blood substitutes was strictly regulated and equaled 1.0:10.0:8.6:54.3, respectively.

The level of plasminogen, antithrombin III, alpha-2 macroglobulin in plasma and urine was used to assess the severity of disseminated intravascular coagulation syndrome (DIC) [5, 6]. Based on the data obtained, the revealed violations were corrected, including immunocorrective therapy, the introduction of leukomass, hyperimmune antimicrobial and antitoxic plasmas, vaccines, T- and B-activin. Against the background of multiple organ failure (MOF), individual manifestations of the disease became dominant and were defined as severe complications of the main process. Among the complications requiring intensive care were endotoxic shock, thrombohemorrhagic syndrome, hemo- and pneumothorax, hydrothorax, pulmonary hyperhydration, bleeding at the site of deep incisions and gastrointestinal bleeding, as well as general exhaustion.

To reduce the severity of endotoxemia and for the purpose of immune correction, the patients underwent ultraviolet hemotherapy with the Isolde MD-73M apparatus. After ultraviolet irradiation of blood (UV), the patients' health improved, there was a tendency to normalize body temperature. In patients with a septic condition and pneumonia, shortness of breath decreased, an improvement in the acid-base state in the blood was noted, a persistent increase in the average level of immunoglobulins G from 7.2 to 9.86 (by 36%), an increase in the content of T-lymphocytes by 25% and B-lymphocytes — by 32%, a decrease in the concentration of circulating immune complexes: large — by 32%, small — by 28%. The level of antimicrobial antibodies during the entire observation period had a tendency to increase. Hyperbaric oxygenation and ultraviolet irradiation of blood improved microcirculation in organs and tissues, contributed to normalization of indicators of central, peripheral and intraorganic hemodynamics [7, 8].

With preserved diuresis, the normalization of volemia, detoxification and restoration of central hemodynamics were achieved by the administration of colloidal solutions of hemodynamic action (polyglucin, gelatinol, hemodez, neohemodesis), adrenomimetics and electrolyte solutions (glucose with insulin, 4% sodium bicarbonate solution). If necessary, the rate of diuresis was maintained by the introduction of furosemide and mannitol (in the second case, at a dose of 1 g / kg of body weight).

In hypoproteinemia, the correction of the protein composition of the blood was carried out by the introduction of a 10% albumin solution at a dose of 3 ml / kg body weight and protein, 5-6 ml / kg body weight.

In order to reduce blood viscosity, increase renal blood flow and prevent platelet aggregation, patients were injected with trental, curantil, no-shpa and nicotinic acid. The hematocrit level was maintained within 25-30%. Correction of the aggregate state of blood was accompanied by an improvement in microcirculation in the area of traumatic damage to soft tissues and thereby contributed to an increase in the intensity of reparative processes in the affected area. With suppressed fibrinolysis, fibrinolytically active plasma was used to restore diuresis. At the stage of restoration of neuromuscular conduction, patients were injected with B vitamins, ascorbic and nicotinic acids [5, 8].

In LARHF, the organization of the treatment and diagnostic process for 10 days was carried out under the leadership of S.G. Musselius, and in the following days — I.I. Shimanko, who returned to the Institute from Armenia.

Injuries to soft tissues caused by compression were located in the limbs and trunk in various combinations, in some cases only in the upper or lower limbs. On the pale, with a bluish tinge of the skin of the open parts of the body, upper and lower extremities, in places of compression, multiple conflicts and islets of wet necrosis were determined. Areas of soft tissue injury extending beyond the anatomical boundaries of the limb were unevenly edematous. In the early stages after injury in the area of the affected muscle tissue, according to the data of morphological studies, zones of ischemic coagulation necrosis and significant interstitial edema with foci of destruction and swelling of muscle fibrils were found [9].

Intoxication was manifested to a greater extent when the muscle mass of the lower extremities was compressed than when the comparatively smaller muscle mass of the upper extremities was compressed. The involvement of the muscles and soft tissues of the trunk in the pathological process aggravated the severity of the disease due to a decrease in the motor activity of patients and the entry of a large amount of toxins into the general bloodstream through numerous collaterals.

Complex treatment of patients with extensive destruction of soft tissues included conservative and active methods of detoxification, symptomatic and corrective treatment of homeostasis [2, 8].

The high degree of endotoxemia in acute renal and hepatic failure (ARHF) was evidenced by a high level of average weight molecules in the blood, which was 40–70% higher than normal values. The lifespan of paramecia, which is normally 20–25 minutes, decreased in patients to 11–12 minutes. The leukocyte index of intoxication in the victims reached 6.4 units (norm 1 unit), which also indicated a high degree of endotoxemia due to myolysis and MOF. The concentration of myoglobin in the blood of victims with ARHF reached 80,000–100,000 ng / ml (the norm is 20–80 ng / ml) [8].

Treatment of patients included a set of therapeutic measures (see above), as well as methods of conservative and active detoxification of the body and correction of homeostasis indicators. The treatment regimen for each patient with MOF was drawn up according to the dynamics of the patient's clinical condition and the results of laboratory and instrumental research methods. The treatment required an individual approach for each individual patient, for which a daily correction of conservative therapy was carried out and the optimal set of methods for active detoxification of the body was established [4, 10].

All patients on a mandatory basis and, as a rule, repeatedly underwent therapeutic plasma exchange on the domestic apparatus "PF-05" and two centrifuge-type apparatus, supplied to the institute by order of Academician A.I. Vorobyov, Director of the Central

Order of Lenin Institute of Blood Transfusion. The availability of equipment determined the possibility of uninterrupted, without any restrictions and timely plasmapheresis procedures with adequate compensation of protein losses. Indications for plasma exchange and the mode of the procedure were established according to the patient's clinical condition, blood levels of myoglobin, proteins, and changes in other significant clinical and biochemical blood parameters.

Repeated sessions of hemosorption, plasma exchange and plasmasorption were a highly effective therapeutic complex in detoxifying the body. In patients with the initial stage of acute renal failure, these methods contributed to the accelerated recovery of renal function [11].

Active treatment of patients with acute renal failure was carried out using the "artificial kidney" apparatus of the "Fresenius" and "Gambro" companies. During dialysis-filtration methods, the highest rate of elimination of low-molecular-weight toxic metabolites was observed during hemodiafiltration - creatinine clearance was 158-196 ml / min. In patients with anuria and overhydration, intensive infusion therapy was not limited in volume, since hemodiafiltration effectively corrected the water-electrolyte composition of the blood, and in patients with a drained thoracic lymphatic duct, correction was achieved using lymphodiafiltration [4].

Dialysis-filtration methods of treatment were supplemented with sorption detoxification to remove medium-molecular toxic metabolites from the body: hemosorption, plasma sorption and lymphosorption. A significant and sustained decrease in the content of nitrogenous toxins, myoglobin and oligopeptides of average molecular weight in the blood contributed to the acceleration of the recovery of renal function and activated reparative processes in damaged areas of soft tissues.

During their stay in the department, 36 patients underwent 725 hemo-, plasma- and lymphodialysis procedures, in 17 of them underwent 53 hemo-, plasma- and lympho-sorption procedures [8].

In the 2nd Traumatology Department of the Institute (headed by Professor V.P. Okhotsky and E.I. Mustonin) there were 42 victims with open infected bone fractures, purulent wounds of soft tissues, patients with fasciotomies and deep incisions made in hospitals in Armenia.

To ensure full treatment of the victims, the staff of medical and nursing personnel was increased. In the department, premises were allocated for victims with "clean" wounds and a dressing room for patients with purulent infection. Active methods of treatment in the presence of acute renal failure or acute renal and hepatic failure were carried out by the staff of the acute renal failure and the toxicology department of the Institute in a specially equipped ward for patients with amputated limbs. Onsite therapeutic plasma exchange, sessions of hemodiafiltration, magnetic hemotherapy and ultraviolet irradiation were carried out [7, 8].

It should be noted that upon admission to the department of seriously ill patients, communication with many of them was rather difficult due to their poor knowledge of the Russian language. The speech and motor excitement of the victims limited the possibility of a thorough collection of anamnesis of the disease and their examination. Senior researcher A.G. Suvalyan, fluent in Armenian. Most of the patients demanded the administration of painkillers, complaining of intolerable, tearing pain in the affected limbs. The introduction of 2.0 ml of Relanium only for a short time eased the condition of the patients, relieved psychomotor agitation. This situation persisted during the first day of the patients' stay in the department. Later, the situation returned to normal and the victims were treated as usual.

General and local treatment of patients was complex and included a complex of therapeutic (see above) and surgical measures. If the skin was damaged, the wound was surgically treated. In the case of infection of soft tissues, in order to accelerate the cleansing of the wound surface from purulent discharge, the focus was sanitized, drainage materials (sorption tissue AUT-M, helevin) and enzymes were used. Antibiotics were administered parenterally, including the endolymphatic route.

To prevent staphylococcal and Proteus infections, immunization and local sorption were performed.

When staphylococcus was detected in the wound culture, lotions were used with a solution of furacilin, in which 1 million units of penicillin.were diluted.

The introduction of Proteus vaccine in combination with antibiotics for a week led to an increase in the titer of specific antibodies and the purification of the wound surface from purulent discharge [12].

When soft tissues were melted with purulent discharge, the wound was treated with a solution of chlorhexidine, furacilin and sodium hypochlorite at a concentration of 1200 mg / l.

According to indications, 21 patients underwent staged necrectomy within the viable tissues.

Intensive treatment included a set of measures aimed at maintaining the patient's immune status. For this purpose, patients were prescribed T-activin, hyperimmune plasma, leukomass, gammaglobulin were injected intravenously, and ultraviolet irradiation was performed.

Local treatment of wound surfaces within 35–45 days promoted wound healing and made it possible to carry out reconstructive plastic surgery. In patients with fractures, osteoplastic operations were combined with osteosynthesis with external fixation devices.

Conducting sessions of hyperbaric oxygenation accelerated wound healing, promoted the restoration of kidney and liver function, and led to a decrease in toxemia. At the same time, the deep incisions made before the transfer of patients to the institute worsened the condition of the patients, were the gateway for microbial invasion, creating conditions for the development of infectious complications, and with heparinization, which was necessary for extracorporeal methods, the area of the cut skin became a source of bleeding. The implementation of hemostasis in the tissues melted by the inflammatory process was fraught with great difficulties: the ligatures were cut through, the pressing dressings were quickly soaked in blood and edematous fluid. Hemostasis turned out to be only temporary and a dressing change was required in a short time. To stop bleeding, it became necessary to administer hemostatic drugs.

All operations and dressings were often carried out under the cover of non-inhalation anesthetics, which have a minimal negative effect on vital organs: heart, lungs, and brain. In long-term traumatic interventions, ether was used for anesthesia.

Active surgical tactics included revision of the injury area. In the postoperative period, scintigraphy was used to assess the reparative processes in tissues, as well as to prepare patients for skin grafting. In the presence of fractures, plaster splints and skeletal traction were used to fix the fragments. To avoid the danger of compression, circular plaster casts were applied at different times as the edema disappeared [13].

Skeletal stretching of the limb along the axis made it possible to eliminate the displacement of bone fragments in length and at an angle. The use of the Beler splint worsened the general condition of the patients, since with the elevated position of the lower extremities, the flow of decay products of soft tissues and ischemic toxins into the general bloodstream increased. Therefore, skeletal traction was performed along the horizontal plane. The Ilizarov apparatus, used in patients with open limb fractures, was removed at different times after its application due to pain in the places where the wires were inserted and signs of suppuration that appeared.

With a crush syndrome, sometimes the question arose about amputation of a limb - a source of endogenous intoxication, which poses a threat to the victim's life. For health reasons, 7 amputations and 7 re-amputations were performed. Operations were performed only in the following cases:

1. In connection with the ineffectiveness of the blood supply to soft tissues after the restored blood flow in the damaged artery and the appearance of symptoms indicating the development of gangrene.

2. If it is impossible to perform reconstructive operations to restore the destroyed limb.

3. With progressive wound and general infection with the development of sepsis and a threat to the patient's life. In this case, the ineffectiveness of complex treatment was taken into account.

After the amputation was performed, the state of soft tissues was dynamically monitored, which made it possible to avoid the development of a purulent-inflammatory process in possibly preserved aseptic areas of muscle necrosis. For visual monitoring of the condition of muscles and tissue, the optimal were the imposition of retension sutures on the wound and repeated ultrasound examinations. In case of hyperthermia for 3-5 days and ineffectiveness of antibiotic therapy, the purulent process in the limb stump was excluded first of all. For this, a thorough revision of the soft tissues was carried out. If an infection was suspected, re-dressings were performed using antiseptics (solution of iodopyrone, betadine, etc.). The formation of stumps for the purpose of subsequent prosthetics began after the acute inflammation subsided and in the presence of pronounced granulations [13].

Morphological examination of the amputated limbs revealed colliquation massive necrosis of skeletal muscles. In the lumen of the vessels, along with the formed elements of blood, bacterial emboli of a coccal nature were found. Gross injuries to the soft tissues of the lower extremities were observed with deep incisions - tissue prolapse into the wound with massive fibrin and detritus deposits. The increase in edema, expansion of the zone of necrosis of skeletal muscles and the formation of abscesses were clearly revealed. In the perifocal zone, progression of dystrophic changes in muscle fibers was observed up to necrosis. On the periphery of skeletal muscle necrosis, calcification of necrotic muscle fibers with elements of regeneration was noted. Morphological studies have confirmed the difficulty of determining the boundaries of viable tissues by clinical signs [9].

Rehabilitation treatment of victims with prolonged compression syndrome included the use of physiotherapy exercises, physiotherapy, acupuncture, vibration massage, percutaneous neuroelectrostimulation and laser therapy. Complex treatment contributed to the normalization of the function of external respiration, indicators of central hemodynamics and the aggregate state of the blood, which was accompanied by the acceleration of the recovery processes in the affected soft tissues [14].

Of the 78 victims who were treated in two departments of the N.V. Sklifosovsky Institute, 75 people were discharged in satisfactory condition to continue rehabilitation treatment at their place of residence. Three patients died, all of them were in the LARHF. The mortality rate was 3.8%. The patients died from complications associated with the crush syndrome at various times from the moment of admission to the Institute. A 35-year-old male patient M. with concomitant trauma and acute renal failure died on the 2nd day with symptoms of acute cardiovascular failure (endotoxic shock); A 35-year-old female patient D. with extensive soft tissue injury (two lower limbs and trunk) and acute renal failure died on the 8th day from severe endogenous intoxication and concomitant purulent complications; a 64-year-old male patient S. died on the 14th day from septic endocarditis against the background of severe sepsis.

CONCLUSION

Today, the treatment of patients with crush syndrome remains relevant. This is associated, first of all, with the difficulties faced by the doctor in determining the therapeutic tactics: solving the issue of surgical intervention (decompression in the zone of the compartment focus, indications for necrectomy and amputation of the limb, etc.), the choice of the optimal detoxification method for the patient and its sequence in conducting with other methods, establishing a dialysis-filtration procedure mode to eliminate water-electrolyte disturbances, prescribing synergistically active antibacterial and immunocorrecting drugs, etc.

The deviation from the general principles of complex treatment presented in the article sometimes ended tragically for the victim: the development of a purulent-septic complication, life-threatening bleeding, disability, loss of social and psychological usefulness to the victim, etc.

The modern approach to the treatment of patients with crush syndrome is carried out at a high technological level. This is facilitated by the achievements of recent years in the development of laboratory and instrumental diagnostic methods, round-the-clock highly informative monitoring of the patient's condition, the creation of new biocompatible materials and equipment that allow active detoxification methods to be carried out for a long time, for example, hemodiafiltration, around the clock.

The treatment tactics presented in the article, including complex detoxification, correction of homeostasis indicators, treatment of damaged and infected soft tissues, allows life-threatening deep incisions and fasciotomies to be abandoned, which are mistakenly performed for the prevention and treatment of acute renal and multiple organ failure, as well as strictly differentiated indications to amputation of a limb, saving the life of the victim.

Thus, this article aims to present the results of treatment thirty years ago and show that modern advances in the treatment of patients with crush syndrome are the continuity of the activities of specialists of that time, including the highly professional team of doctors of the N.V. Sklifosovsky Institute, who made a significant contribution to the development of methods for diagnostics and treatment of victims of the earthquake in Armenia.

1. Urgent treatment of victims with a crush syndrome in the early post-compression period is primarily aimed at relieving pain syndrome, psychoemotional disorders, restoring the function of vital organs and body systems.

2. Hemisorption, therapeutic plasma exchange, plasmasorption, prolonged arteriovenous filtration and lymphosorption, used in the early period of traumatic toxicosis, contribute to effective detoxification of the body, reduce the risk of developing multiple organ and, above all, acute renal failure, and also accelerate recovery processes in the area of traumatic soft tissues.

3. Deep and superficial incisions create a high risk of developing septic complications and sepsis. Decompression subcutaneous fasciotomy does not have a decisive effect on the relief of compartment syndrome, but at the same time, a prolonged release of edematous fluid occurs through the incised skin and an entrance gate for infection is created.

4. Indications for limb amputation in patients with crush syndrome should be strictly limited and arise only when the patient's life is threatened and only in case of ineffectiveness of intensive treatment.

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