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State of Hemostasis System at Exposure of the Thermal Agent during Shock and Toxaemia

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Abstract--- *The evaluation of informative significance of homeostasis disturbance by degree of severity was carried out, and then the development of prognostic algorithms and verification of their effectiveness. It should be noted that all patients had deep burns from 10% to 45% of the body surface. Exactly these victims made up the basic array with the help of which the tasks on estimation of information significance and development of prognostic algorithm were solved. Adequate preoperative measures allowed to improve both the indices of the circulatory system and the clotting system in patients with mild and medium degree of plasmoporia*.

Keywords--- *Thermal Burn, Disseminated Intravascular Clotting Syndrome, Hemostasis, Infusion Therapy, Frank Index, Plasma Therapy, Necrectomy, Burn Shock, Hypercoagulation*.

I. INTRODUCTION

Burns are one of the most destructive types of skin lesions and its appendages. According to different authors, burns and burn disease account for 6.1 to 38.4% of all injuries [1, 2, 17], and mortality remains high, especially in the phases of toxaemia and septicotoxinemia. The main causes of mortality at the stage of acute burn toxaemia are purulent-septic complications combined with endogenous intoxication of metabolic and microbial origin. They firmly hold the first place among the causes. At the same time, the risk of early sepsis (by the 4th-5th day after the injury) increases up to 75-90% with deep burns on the area more than 10-15% of the body surface. Despite the vast experience in the treatment of burns in domestic and foreign combusiology, more than 40% of victims become disabled [3, 4, 21], so they represent a serious medical and social problem. Burned disease is one of the most severe pathological processes, often accompanied by a serious complication of the hemostasis system - the syndrome of disseminated intravascular blood coagulation (DIC), which in the absence of timely diagnosis and adequate treatment rapidly progresses and leads to death [10, 11, 14, 19]. After a burn, not only platelet aggregation is increased, but also red blood cells. Blood clotting is accelerated in such patients, fibrinolysis is inhibited, and chronic form of ICE syndrome often develops [4]. Propensity to hypercoagulation in old age, aggravated after a burn, combined with a decrease in blood flow during shock, significantly increases the risk of thromboembolic complications. Acute disturbances of cerebral circulation, thrombosis and embolism of pulmonary arteries, iliac arteries and other arteries of large circulation circle are not a rare complication in these patients [6, 7, 8, 9, 12, 15, 16]. In case of extensive deep burns, various pathological processes are initiated immediately after the injury, forming the pathogenesis of the burn disease. One of the first to destabilize the hemostasis system in the form of DVS syndrome with thrombosis and bleeding [5]. The problem of prevention, diagnosis and treatment of hemostasis system disorders remains one of the most urgent today. In combusiology it is especially acute, as hemorrhagic complications are the main cause of death of seriously burned people due to gastrointestinal bleeding [2,3,20].

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II. MATERIALS AND METHODS

The data on burn victims who were treated in the Samarkand branch of Republican Research Center for Emergency Medical Care (RRCEMC) in the period 2016-2019 were implemented. The informative significance of the homeostasis disturbance was assessed in terms of severity, and then prognostic algorithms were developed and their effectiveness checked. It should be noted that all patients had deep burns from 10% to 45% of the body surface. Exactly these victims made up the basic array with the help of which the tasks on estimation of information significance and development of prognostic algorithm were solved. To solve the tasks, this array was divided into groups: Group I - 105 patients were patients without homeostasis correction and surgical blood loss prevention, and Group II - 112 patients with deep burns who received homeostasis correction and surgical blood loss prevention. The average age in Group 2 was slightly higher than in Group 1 patients ($p < 0.05$). Although, in general, the victims of both groups could be attributed to the same age category: from 35 to 45 years. The main difference between the groups concerned indicators reflecting the severity of the burned skin (total area, area of deep burns, Frank index). In Group 2, they were significantly higher than in Group 1, which once again confirms the well-known fact that the severity of thermal trauma is primarily dependent on the area and depth of burns.

The given data testify to the fact that the overwhelming majority of the victims (82,95 %) were admitted to the burn unit of the Samarkand branch of RSCEMP already in the first 6 hours after the thermal trauma. The late admission of patients (16; 7.37 per cent) was noted from the nearest districts where first medical aid was provided to them in the conditions of surgical departments of subbranches.

In accordance with the prognostic Frank index (IF), which characterizes the severity of the burn injury and is determined in conventional units (1% of superficial burn I-II-IIIA degree is taken for 1 unit (unit), 1% of deep burn IIIB-IV art. 3 units) and taking into account the severity of inhalation injury (at IT I-II degree additionally summed up 15 units...), for IT of III-IV degree - 30 units) patients are divided into 4 groups: Group I - IF < 30 units - 21 patients (9.67%). II - IF 30-60 units - 153 (70,51%), III - IF 61-90 units - 32 (14,75%), IV - IF > 90 units - 11 (5,07%) (Table 2.4). Burned with a favorable forecast (IF up to 60 units) amounted to 80.18%, with doubtful and unfavorable forecast (IF over 60 units) - 19.82%.

The most frequent burns were in the area of the torso and limbs (32.5% of patients), head and limbs (27.22%) and torso (14.62%). Isolated facial and lower limb lesions were typical for contact burns. In structure of burns of upper and lower extremities the lesions of only right parts were more often found in left parts.

Multiple localization was observed in 26 (11.98%) patients who received burns with flame or boiling water. Inhalation trauma combined with skin burns was observed in 28 patients (12.9%). Usually, they had a severe course of burn shock. There was no special difference in localization of burn wounds by groups.

Those burned with burn shock and in the presence of inhalation trauma were placed in the Burn Resuscitation Department, where all necessary examinations were performed in parallel with treatment. Complaints of the victim were fixed, at physical examination the level of consciousness was marked (in case of oppression of consciousness the degree of his disorders was assessed on the Glasgow scale), percussion and auscultation of lungs and heart, palpation of abdomen were carried out, neurological status was assessed, heart rate and respiration rate were

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calculated. Systolic and diastolic pressure levels were measured along the short stroke. Other instrumental methods included chest X-ray, electrocardiography, and diagnostic fibrobronchoscopy in case of suspected inhalation trauma.

All burnt in a state of burn shock performed a catheterization of the central vein by Seldinger for infusion therapy and monitoring of the central venous pressure. The following laboratory methods were used: clinical and biochemical blood analysis, coagulogram, blood gas analysis, cytomorphometry of lavage fluid and brush-biopsy. The area of burn wounds was determined using the rules "nines" and "palms". The depth of burn wounds was estimated by changes in pain, tactile sensitivity and vascular response. Frank index was used for objectivization of burn injury severity.

Data obtained from anamnesis collection, examination, clinical, laboratory, radiological examination of burnt persons with inhalation trauma can only be classified as indirect diagnostic signs of respiratory tract injury. It is possible to confirm its presence and estimate the degree of inhalation injury severity, as well as to predict the development of complications and outcome only using the endoscopic method of examination of the victim (Shpakov I.F. 1997). We performed a diagnostic fibrobronchoscopy in the first day after the injury. At that we used fibrobronchoscopes of LOMO and "Olympus" company (Japan). All diagnostic examinations were performed in the operating theatre of burn resuscitation equipped with breathing apparatus and centralized oxygen supply. Fibrobronchoscopy was performed under local anesthesia with spontaneous breathing or with TRS depending on the severity of respiratory failure. For local anesthesia of the respiratory tract 2% lidocaine solution in the amount of 10-15 ml (but not more than 400 mg per procedure) was used. The premedication included atropine (0.5 mg), droperidol (5.0 mg), prednisolone (30 mg). Fibrobronchoscope was administered either transnazially (with wide nasal passages) or transorally (with mouthpiece) if it was not possible to pass the endoscope through the nasal passages. In bronchoscopy under local anesthesia additional oxygen oxygenation with moistened oxygen was preliminary performed within 10-15 minutes. In case of respiratory insufficiency fibrobronchoscopy was performed through an intubation tube or a tracheostomic cannula against the background of a AV.

In order to study versatile disorders in the homeostasis system in patients with different severity of burn injury, the results of laboratory methods of investigation have been analyzed.

To determine the volume of blood loss we used a gravimetric method. Intraoperative blood loss is determined by the difference in mass of blood-soaked and dry wipes, tampons, balls, sheets, bathrobes. The obtained value is increased by 50% and summed up with the volume of blood in a can of electric aspirator. The error of the method is 10-12% (V.A. Koryachkin, V.I. Strashnova, 2002).

Intraoperative blood loss is the main reason limiting the possibility of early surgical treatment of deep burns. A new drug called Geprocele has been used as an implant. At the same time, the peculiarities of this type of injury were mandatorily taken into account, attaching special importance to careful control of hemodynamics, temperature response, breathing frequency, measuring of hourly and daily diuresis. The hematocrit value was also controlled in all investigated patients, at admission of patients to the hospital and on the following days of observation.

The state of hemodynamics was studied on the basis of blood pressure, heart rate, and CVP. Circulating blood volume (CBC) was determined to determine the degree of hemodynamic disorders during burn shock and their

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correction. The latter was investigated by the method of A.A. Froma and A.A. Lipets (1958) in modification of L.E. Manevich (1966). The study of circulatory blood pools was carried out on admission of the patient, before the beginning of infusion therapy and afterwards, every day for 5-7 days. OCC and its components in patients at admission to the hospital were determined by A.I. Gorbashko method (1974). For this purpose 6% polyglucinum official solution, 20% trichloroacetic acid solution and 96% ethanol were used. For determination of polyglucinum in plasma photocalorimeter FEK-56M was used, working with red light filter and ditches 10 mm thick. The presence of Systemic Inflammatory Response Syndrome (SICA) was determined by the presence of 2 and more listed features of R.Bone (1992). The presence of organ dysfunction was determined by J.C.Marshall (1995), the development of ПОН - by L.Doughty (1996).

Prothrombin index and fibrinogen according to R.G. Rutberg (1961), fibrinolytic activity according to time of euglobulin clot lysis by Kowalski et al (1959) were determined for determination of blood coagulation and fibrinolytic systems condition.

The following hemostasis parameters were studied: platelet count, RFMC (soluble fibrin, mg %); AT III (antithrombin III, %); disturbances in protein C system; prothrombin time (c) and Activated partial thromboplastin time (АПТВ) index - by V.N.Tugolukov method (1952); recalcification time - by W.Howell, E.Howell method (1959).Holt method (1916); plasma tolerance to heparin and thrombotest - enzymatic method; blood coagulation time (min) - by R.Lee, P.D.White method (1913); plasminogen content; hematocrit - by hematocrit scale; fibrinogen (g/l) and fibrinoplastic activity - enzymatic method (N.P. Medvedev, 1987).

Necrectomy operations were performed with IIIB-IV degree burns. In 1st degree IV burns, osteonectomy was also performed, and in 2 patients - shoulder disarticulation, hip amputation (1), upper third tibia (1), fingers and phalanges of the hand (5).

8 patients (I group - 6 patients, II group - 2 patients), with extensive deep burns (more than 40% of p.t.) and thermo-inhalation trauma due to the severity of the condition, who died of sepsis and polyorganic insufficiency from 3 to 15 days from the moment of trauma, were not operated on.

Autodermoplasty operations restored skin cover in 99 patients (I group) and 110 patients (II group), a total of 209 people with deep burns of III B-IV degree.

The statistical treatment was performed by calculating the arithmetic mean (M), its error (m), the square mean deviation (σ). The probability of p of the obtained data was determined by Excel functions: NORMSTRASP, STUDENTRASP, TEST

III. DISCUSSION

In victims with severe burns, hemostasis disturbances are manifested by disseminated intravascular clotting syndrome (ICS). At the same time, according to V.G. Lychev (1993), DVS-syndrome is either not recognized at all or is diagnosed at the stage of clinical manifestation, which is manifested by hemorrhage and/or organ dysfunction.

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Changes in laboratory data - a decrease in platelet count, an increase in fibrinogen concentration, the appearance of fibrin degradation products are often observed in the absence of clinical manifestations of coagulopathy (Zilber A.P., 1995).

Prevention and treatment of patients with ICS-syndrome is the elimination of factors that caused the activation of intravascular clotting (removal of necrosis foci that are the source of thromboplastin, elimination of intoxication, hypoxia, acidosis, correction of aqueous electrolyte disturbances, treatment of infectious complications). In the phase of hypercoagulation therapy begins with the introduction of heparin (400-500 units per hour). The greatest anticoagulant effect of heparin is shown against the high antithrombin III content. Deficiency of antithrombin III is replaced by transfusions of freshly frozen plasma. In the treatment of patients with DVS syndrome preference is given to low-molecular heparin (fraxyparin, kleksan), because, unlike the unfractionated forms, it does not activate platelet aggregation.

Disaggregants (curantile, pentoxyphylline), proteolytic inhibitors (pride, countercal) should be used to enhance the antithrombotic effect of heparin. Infusion therapy with crystals and colloidal solutions is mandatory. Of colloidal preparations, it is preferable to use amino starch derivatives, as they have a pronounced disaggregating effect and do not cause hypocoagulation. In the treatment of internal combustion engines at the stage of hypocoagulation antiproteases (gordox, contrikal) and transfusions of fresh frozen plasma up to 1500 ml per day are shown.

Transfusions of fresh (single daily) erythromass are carried out at the content of hemoglobin less than 60-80 g/l, and platelet mass if the number of platelets does not reach 40-60x109/l.

At admission to the hospital we differentiated 3 degrees of burn shock by the deficit of CBV. The majority (49 patients) had a deficit of PCK (plasma loss) from 20 to 30% of its initial importance, which corresponded to the II-step of burn shock. In contrast, 29 patients had I-step, 17 patients had III-rd degree of burn shock.

In addition to CBV deficiency, the Algoveran index, which had a direct dependence on the degree of plasma loss severity, was studied on admission to the hospital. According to the received data, for severe degree of plasma loss there was a characteristic increase of Algoverian index from 0.54 at 1 - degree to 1.45 in patients with 3 - degree of plasma loss. Consequently, these data indicate deeper changes in the homeostasis system in patients with severe burn shock.

In order to make an adequate judgment on the true changes and possibilities of corrective therapy, the data of CBV at admission of the patient to the hospital at the burn shock stage are analyzed. The results were assessed in comparative aspect with the results of the control group.

The study of the CBV and its components showed that the severity of changes is directly proportional to the degree of burn shock. At admission to the hospital in patients with deep burns there was statistically significant reduction of the total CBV index in 67.5±0.4 ml/kg to 53.9±0.4 ml/kg of I- and III-step shock, respectively. The CMP deficit also varied according to the severity of the burn shock, amounting to 10.9±0.4% in I-step, 22.0±0.3% in II- and 32.9±0.7% in III-step. Structural indices of CBV in patients with I-step shock did not significantly differ from those in the control group, although there is a statistical difference between them. These changes were most

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clearly expressed in the group of patients with medium and severe degree of shock. This is evidenced by the reduction of cerebral palsy and globular volume (GV) to 28.4±0.2 ml/kg and 26.5±0.3 ml/kg in patients with I-step shock, respectively. At the same time, there was a decrease in CBV from 3.3±0.1 g/l to 2.28±0.04 g/l (P<0.05).

It should be noted that after therapeutic tactics aimed at both correction of homeostasis disorders and complex anti-shock therapy, there were significant changes towards improvement of the circulatory system. Such a favorable tendency was the most typical patient with mild and medium degree of burn shock. There was a decrease in the deficit of CBV in patients with I- and II-step, respectively, to 4.3±0.1% and 10.2±0.3% (P<0.05). The positive trend was mainly based on the increase of CBV indices, which amounted to 38.3±0.2ml/kg and 33.7±0.3ml/kg at mild degree, 37.9±0.1ml/kg and 32.1±0.4ml/kg at medium degree of shock, respectively. However, despite the positive dynamics of indicators, the group of patients with severe degree of shock maintained the worst OCC even after the interventions. Thus, the deficit of CBV in this group of patients was 12.7±0.3% in the shock period. At the same time, statistically reliable low indices of PCS (34,7±0,2md/kg, P<0,05), ECG (8,9±0,04 g/l, P<0,05) and GV b (31,5±0,2 ml/kg, P<0,05) remained.

At admission to the clinic of patients with deep burns of 20-25% of the body surface there is a slight activation of the blood coagulation system, which is expressed in the lengthening of PI up to 92.3±1.5% (P < 0.05), CPV up to 82.1±2.9 sec. There is also a slight decrease of hematocrit index and suppression of fibrinolytic activity of blood from 15,4±0,6 to 10,7±0,27% (P<0,05) in the investigated group. In contrast, in patients with II degree of shock at admission to the clinic there was observed strengthening of blood coagulation system along with continuing suppression of fibrinolytic activity. This is evidenced by lengthening of PI index up to 94.6±3.8% (P<0.05) and decrease of plasma tolerance to heparin up to 256.3±11.8 sec (P<0.05). Fibrinolysis statistically reliably decreases to 8,09±0,42% (P<0,05), and hematocrit to 33,1±1,4 due to intensive loss of the blood form part and hemoconcentration.

The same changes were mainly observed at severe shock in patients with deep burns of more than 30% of the body surface. However, due to higher plasma loss volume, the changes were of deeper nature. There was a mild strengthening of the blood coagulation system (heparin tolerance was 253.4±21.3 sec, thrombosis - 4.06±0.2 degree), and PTI decreased to 87.6±3.1% (P<0.05). There was also a deep suppression of fibrinolytic activity, which made up 6.58±0.69% (P<0.05). The hematocrit indicator decreased critically to 19.1±2.1% (P<0.05).

Taking into account the aforesaid at admission to hospital all patients were carried out a complex of the antishock measures directed on improvement of water-salt balance, acid-base balance and homeostasis disorders.

IV. RESULTS

Treatment of patients with deep burns, which significantly reduces the time of treatment and provides better functional results in comparison with skin transplantation. Early excision of necrotic tissues proved to be particularly promising in the localization of burns in the area of large joints, hands and feet, as it allows them to maintain their optimal function. In these localizations, even minor scarring can lead to pronounced bending and extension contracts, which require further reconstructive and rehabilitation operations.

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Early necrectomy is accompanied by blood loss, this fact is the main reason limiting the possibility of early surgical treatment of burns.

Reduction of intraoperative blood loss can be achieved by pre-extrusion of tissues under the adrenaline solution dissected by the scab, or two days before the operation 30% ethyl alcohol is injected, which causes aseptic and thrombosis of blood vessels.

Increasing the volume of operations in burn units requires improving methods of perioperative preparation of patients with deep burns. Necrectomies and autodermoplasty are accompanied by blood loss amounting to 0.5-1.5 ml/cm2 of the wound surface. It is important to provide adequate infusion preparation and hemotransfusion support during all burn periods. At the same time, the volume of infusion and hemotransfusion is determined empirically, schematically.

The existing methods of necrectomy for burns are considered to be a stage of preparation for necrectomy and autodermoplasty, often accompanied by serious complications of blood loss, disorders of hemostasis and microcirculation, and the preparation of a cutaneous autograft requires taking a large area of the skin flap, which leads to increased blood loss.

In this regard, in case of deep burns it is still important to improve methods of preparation of burn wounds and patients for surgical intervention, to perform balanced infusion and hemotransfusion therapy, reduction and replenishment of blood loss and detoxification in autodermoplasty.

Morphological manifestations of ICE-syndrome were performed in internal organs in 19 patients who died in the acute stage of burn disease. All patients were diagnosed with ICE-syndrome by laboratory methods. Their age ranged from 18 to 81 years, the area of burns - from 25 to 90% of the body surface (64.6±4.8% on average), life expectancy after injury - from 1.5 to 12 days. The main causes of death were pneumonia, sepsis and burn shock. Internal organs: brain, heart, lungs, liver, kidneys, pancreas, etc. were subjected to histological examination.

The conducted research has shown that in the overwhelming majority (17 out of 19 dead) some kinds of fibrin blood clots in microvessels were found in internal organs. They were most commonly found in the brain, then in the lungs, liver and to a lesser extent in the kidneys and pancreas. It should be noted that micro clots were not often found in organs, their detection requires special search.

At microscopic examination in the internal organs hyaline micro clots were most often found which completely obstruct the lumen of the microvessel. They consist of homogeneous homogeneous eosinophilic mass resembling hyaline, in which fibrous structures were not seen. According to the literature, hyaline blood clots include, besides fibrin, also fibrinogen. We believe, however, that these are not purely protein structures, but clots, in the formation of which take part stazed, agglutinated and hemolyzed erythrocytes cemented with fibrin and fibrinogen. Except for hyaline clots, we often met in small veins and less often in capillaries spherical formations consisting, as well as hyaline blood clots, of homogeneous homogeneous eosinophilic material. These are so-called globular blood clots. They may have different diameters: the smallest were only slightly larger than the erythrocyte, the largest were still larger. Morphological manifestation of ICE syndrome, which develops due to thermal trauma, are non-specific

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manifestations in the form of mainly plasma coagulation and the formation of fibrin micro-thrombuses of various structures in the microcirculatory channel of internal organs. As for slag, this phenomenon was found in larger intraorganic vessels of almost all those who died from thermal trauma, so we do not consider it to be any typical manifestations of ICE syndrome.

V. CONCLUSION

In case of deep burns the overwhelming majority of patients have average degree of plasma loss that is manifested with deficit of CBV up to 30%, disturbance of the circulating plasma protein volume, decrease of the blood globular volume. At plasma loss in patients with extensive deep burns there is a violation of blood coagulation system indices and suppression of fibrinolytic activity, which correlates with the degree of burn shock.

Carrying out of adequate preoperative measures allows improving indices of both circulatory and coagulation systems in patients with mild and medium degree of plasmopoietic loss.

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