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A NEW APPROACH TO TREATMENT OF PATIENTS WITH SYNDROME DIABETIC FOOT WITH APPLICATION ABACTERIAL ENVIRONMENT

(Monograph)

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A new method of treating patients with critical ischemia of the lower extremities in diabetic foot syndrome. [Text]: monograph / B.B. SAFOEV,

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This monograph is devoted to the most modern method of treatment and diagnostics for assessing the condition of arterial vessels in patients with diabetes mellitus and critical lower extremity ischemia. It describes the anatomical and functional features of the pathogenesis of lower extremity ischemia in diabetic foot syndrome, as well as the etiological and pathogenetic factors in the development of lower extremity ischemia. Data from conservative and surgical treatment of diabetic foot syndrome and diagnostic methods for lower extremity ischemia are presented. The results of diagnosis and endovascular treatment of lower extremity ischemia in diabetic foot syndrome are analyzed in detail and scientifically substantiated. This book is intended for vascular surgeons and any specialists in their daily work providing medical care to patients with diabetic foot syndrome and lower extremity ischemia, as well as for clinical residents and master's degree students.

The monograph was discussed and approved by the Academic Council of the Bukhara State Medical Institute.

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 LIST OF ABBREVIATIONS

BA – balloon angioplasty

IIA – internal iliac artery

GB – hypertension

DFA – deep femoral artery

PNE – purulent-necrotic complications

GNPS - purulent-necrotic lesions of the foot

DPN – diabetic peripheral neuropathy

PTA – posterior tibial artery

PAD - peripheral arterial disease

IHD – ischemic heart disease

CILE – critical lower limb ischemia

CTA – computed tomography angiography ABP –

ankle blood pressure

LDF – laser Doppler flowmetry

ABI – ankle-brachial index

MSCT – multislice computed tomography

MDS - maximum systolic blood flow velocity

MRA – magnetic resonance angiography

MSS - maximum diastolic blood flow velocity

MCB - microcirculatory bed

NDA – neuropathic dysfunctional account

EIA – external iliac artery

OBA – common femoral artery

OCMV – acute cerebrovascular accident

CIA – common iliac artery

OPRS – Total vascular resistance

SFA – superficial femoral artery

ATA – anterior tibial artery

PCA – popliteal artery

PN – peripheral neuropathy

PPI - finger-brachial index

RCAG - X-ray contrast angiography

DM – diabetes mellitus type 2

DFS - diabetic foot syndrome

UZDS - ultrasound duplex scanning

UZAS – ultrasound angioscanning

HAN – chronic arterial insufficiency

CKD – Chronic kidney disease

CRF – chronic renal failure Color

Doppler mapping

IRF-Institute for the Development of

Finance EAR-electroactive solution

CLTI - Chronic lymphoarterial insufficiency

INTRODUCTION

Relevance and demand for the dissertation topic. In the world increases annually number of patients with new ulcers

"circulatory disorders lead to neuro- and microangiopathy, which play an important role in the pathogenesis of diabetic foot syndrome, which pose a direct threat to the development of ulcerative necrotic processes and gangrene of the foot"[1]The prevalence of diabetes continues to rise worldwide, and the International Diabetes Foundation estimates that "in 2021, 537 million adults aged 20 to 79 years worldwide are living with diabetes, with the prevalence of foot ulcers reaching 50%."[2]This situation leads to an increased incidence of foot complications, including infections. IRFs are associated with significant morbidity, requiring frequent doctor visits, daily wound care, antimicrobial therapy, surgical procedures, and high healthcare costs.

According to research conducted worldwide, diabetic foot ulcers are one of the most disabling complications of diabetes and can lead to amputation or even death. Treatment and management of diabetic foot ulcers are one of the most challenging tasks not only for patients and their families, but also for healthcare teams, requiring multimodal and multidisciplinary care. Numerous published studies highlight the relationship between diabetic foot ulcers, cardiovascular events, and increased mortality in patients with diabetes. Diabetic Foot

is considered a predictor of cardiovascular events and mortality, with possible common pathways.

Unsatisfactory results of lower limb amputations at the level of the upper third of the leg due to critical ischemia in the context of diabetes mellitus determine the relevance and social significance of studying the issues of preventing early

[1] Dedov I.I. Lesions of the lower extremities in diabetes mellitus: atlas for doctors. - M.: Institute of Healthcare Management Problems, 2013. - 56 p.

[2] Deev R.V. Remote results of the use of pl-VEGF165 in chronic lower limb ischemia due to obliterating atherosclerosis // Cardiology and cardiovascular surgery. - 2015. - 8 (4). – P. 43-49.

postoperative complications in lower limb amputations, which indicates the need to optimize the tactics of surgical treatment of these patients.

Currently, our healthcare system has undertaken large-scale, targeted measures to radically improve the quality and significantly expand the range of medical care provided to the population. The action strategy for five priority areas of development of the Republic of Uzbekistan for 2017-2021 sets the objectives of "developing and improving the system of medical and social assistance for vulnerable groups of the population to ensure their full life."[3]. In this area, in particular, in improving the quality of surgical treatment of patients with diabetes mellitus with critical lower limb ischemia, positive results have been achieved. In this area, in particular, in improving the quality of surgical treatment of patients with diabetes mellitus with critical lower limb ischemia, positive results have been achieved. At the same time, to improve the system of medical care, scientifically substantiated results are required to evaluate the effectiveness of new methods of surgical treatment of CLS with critical lower limb ischemia, which represent an important problem for specialists in this field. Unsatisfactory results of lower limb amputations due to critical ischemia in diabetes mellitus determine the relevance and social significance of studying the prevention of early postoperative complications in lower limb amputations.

limbs, which indicates the need to optimize the tactics of surgical treatment of these patients.

This dissertation research, to a certain extent, serves to fulfill the objectives approved by the Decree of the President of the Republic of Uzbekistan No. 4947 dated February 7, 2017 "On the strategy of actions for five priority areas of development of the Republic of Uzbekistan for 2017-2021" and the Resolution of the President of the Republic of Uzbekistan "On measures for the further development of specialized medical care to the population of the Republic of Uzbekistan for 2017-2021" No. PP-3071 dated June 20, 2017, as well as set out in other regulatory acts related to this activity.

Compliance of the research with the priority areas of development of science and technology of the republic. This dissertation The study was carried out in accordance with

[3] Decree of the President of the Republic of Uzbekistan dated February 7, 2017 No. UP-4947 "On the strategy of actions for the further development of the Republic of Uzbekistan." Collection of legislative acts.

the priority direction of development of science and technology of the Republic of VI. "Medicine and Pharmacology".

The degree to which the problem has been studied. According to research data, the risk The incidence of occlusive lesions of the main arteries of the lower extremities in diabetes mellitus increases with age and the duration of diabetes. The incidence of occlusive lesions of the main arteries of the lower extremities in diabetes mellitus ranges from 29 to 81% of all cases. The incidence of amputations due to diabetic gangrene is 83.1%, and 50 to 70% of all non-traumatic amputations occur in diabetics. However, hospital mortality rates remain dismal—up to 40%. Approximately 50% of patients who have undergone unilateral high amputation are only able to move around their apartment, and 51–73% develop purulent-necrotic changes in the foot of the remaining limb, which are often an indication for amputation (Malakhov Yu.S. et al., 2019).

Diabetic foot syndrome complicated by critical lower limb ischemia is characterized by high rates of disability and mortality. The most disabling factors for patients are high

Amputations at the level of the lower leg or thigh, which affect more than 25-30% of patients with critical lower limb ischemia (Voloshin V.N. et al., 2016). According to Udovichenko O.V., 1,500 to 2,000 amputations due to CLI are performed in Moscow annually, which is 15-20 people per 100,000 population. The mortality rate resulting from "high" lower limb amputations reaches 25-50% (Udovichenko O.V. et al., 2015).

According to international authors, the mortality rate in patients with diabetes and critical lower limb ischemia is 30% within 5 years. The incidence of patients with critical lower limb ischemia due to diabetes and non-reconstructable vascular bed in the peripheral limbs, according to various authors, can reach 80%. Such patients are forced to undergo limb amputations for life-saving reasons (Bokeria, L.A., et al., 2016).

Treating patients with critical ischemia due to lesions of the lower leg arteries is one of the most challenging areas of modern angiology. Vascular damage in diabetes mellitus resembles thromboangiitis, making bypass surgery less effective. Arterial calcification and stenosis, combined with the small caliber of the artery being revascularized, make it difficult to create a distal anastomosis during bypass surgery. Furthermore, microangiopathy leads to impaired outflow from the bypass graft, which in turn inevitably leads to thrombosis. Trophic disorders in the foot increase the risk of purulent-septic complications in this category of patients undergoing open bypass surgery. Minimal invasiveness, the possibility of repeat surgery, and the ability to restore blood flow through small-diameter arteries make endovascular procedures preferable for patients with critical ischemia. Chronic renal failure in this patient population requires a multidisciplinary approach to treatment. Determination of the sequence and timing of surgical treatment of SDS and

Limb revascularization, assessment of associated cardiovascular risks and complications, prescription of comprehensive conservative therapy, and individualized limb offloading are important components of the overall treatment strategy for ulcerative lesions in patients with diabetes and critical lower limb ischemia. The authors present a clinical case of a polymorbid patient with severe distal arterial disease in the lower limb. Multiple balloon angioplasty of the lower leg arteries was performed in this patient with critical ischemia of a single lower limb. Timely angioplasty alleviated the clinical symptoms of critical ischemia, promoted foot wound healing, and preserved the weight-bearing function of the limb, thereby prolonging the patient's active lifestyle without severe disability (Parfenov I.P. et al., 2022).

In Russia, 20 to 50% of all hospitalizations for patients with diabetes are related to foot problems. The risk of lower extremity amputations is also higher in this category of patients, with 50 to 80% of all nontraumatic amputations performed. Therefore, the development of modern, integrated approaches to treating patients with this pathology, aimed at performing organ-preserving surgeries and preventing postoperative complications, is urgently needed. Following lower extremity amputations, postoperative complications occur in 64% of patients, with average hospital stays ranging from 58.2 to 65.7 days. One of the most severe complications of diabetes mellitus (DM) is lower extremity damage, leading to the development of purulent necrotic processes in the foot in 6–15% of patients (M.D. Dibirov et al., 2021).

The question of the appropriate treatment method for purulent necrotic lesions in diabetic foot syndrome and complicated severe critical ischemia remains unresolved.

Also, there is currently little information in clinical practice regarding the role and application of abacterial environment using EAR in the prevention and treatment of purulent-necrotic lesions of the lower extremities in diabetic foot syndrome complicated by critical ischemia of the lower extremities.

The connection of the dissertation research with the plans of scientific research work of the higher educational or scientific research institution where the dissertation was completed.

The dissertation research was carried out within the framework of the research plan of the Bukhara State Institute number 02. 2022. PhD.148 on the topic: "Development of new approaches to early diagnosis, treatment and prevention of pathological conditions of the body affecting the health of residents of the Bukhara region after COVID 19" (2022-2026).

Purpose of the study:improving treatment outcomes for patients with SDS critical ischemia of the lower limb by using endovascular intervention and an abacterial environment.

Research objectives:

to study the results of traditional methods of treating patients with critical ischemia of the lower limb; to study the results of treatment of patients with SDS and critical ischemia of the lower limb, using endovascular intervention and abacteal environment;

to determine the effectiveness of using an abacterial environment in the treatment of diabetic foot syndrome;

Based on a comparative analysis of the results of the control and main groups of patients, develop a new, effective, improved method for treating diabetic foot syndrome.

The object of the studyshowed up104 patients with critical ischemia of the lower extremities in diabetic foot syndrome with a severe degree of damage, who received inpatient treatment at the clinical base of the Bukhara State Medical Institute of the Bukhara multidisciplinary regional medical center for the period 2010 to 2023.

Subject of the studyis the development of differentiated Surgical treatment tactics for patients with critical lower limb ischemia associated with diabetic foot syndrome and a study of the clinical, biochemical, and tactical and technical aspects. A study was conducted of various localizations of stenotic-occlusive processes in the arteries of the lower limb, the course and outcome with traditional treatment methods, as well as the effectiveness of using an abacterial environment..

Research methods. To carry out the dissertation The following examination methods were used for the research and solution of the set tasks: clinical, clinical laboratory, instrumental (ultrasound duplex angioscanning, angiography, PO2 tissue), bacteriological and statistical methods.

Scientific novelty of the study:

The shortcomings of the traditional method of treating patients with diabetic foot syndrome and critical ischemia of the lower extremities were studied;

The place and role of the abacterial environment in the treatment of patients with diabetic foot syndrome with critical ischemia of the lower extremities were studied;

The results of using a local abacterial method with a modern treatment method in the treatment of patients with diabetic foot syndrome with acute leg ischemia were studied;

An optimal method for treating patients with diabetic foot syndrome and critical ischemia of the lower extremities using a local abacterial environment has been developed.

Practical results of the study:

The shortcomings of the traditional method of treating patients with diabetic foot syndrome with critical ischemia of the lower extremities were studied;

The place and role of the use of an abacterial environment in the treatment of patients with purulent necrotic lesions against the background of diabetic foot syndrome and critical ischemia of the lower extremities were studied, taking into account the degree of damage and localization;

An optimal algorithm for treatment tactics for patients with SDS critical ischemia of the lower limb was developed based on a comparative analysis of the obtained research results..

Reliability of research results. Reliability of results is substantiated by the conformity of theoretical data with the obtained results and conclusions of research based on the principles of evidence-based medicine, the methodological conformity of the laboratory and instrumental research methods carried out, the sufficiency of the number of the examined contingent, and processing by statistical research methods.

Scientific and practical significance of the research results. The scientific significance of the study's results is determined by the theoretical significance of the findings and proposals, which significantly contribute to the study of the treatment of purulent necrotic wounds in patients with lower limb ischemia. The effectiveness of using an abacterial environment with EAR, which helps reduce the incidence of lower limb amputations and optimizes the choice of intervention when planning surgical interventions, has been studied and proven. Specific results from the study of the pathogenesis, clinical presentation, diagnosis, and surgical treatment of patients with lower limb ischemia have improved the structure and content of the manual and topics for students in undergraduate, residency, and master's programs.

The practical value of the work is that the tactics of managing patients with SDS with critical ischemia of the lower limb have been optimized using an abacterial environment with the use of EAR and taking into account the location and

The location and degree of vascular occlusion in the lower extremity are studied. The effectiveness of an abacterial environment using EAR is specifically noted, including accelerated wound cleansing and granulation tissue formation, and a reduction in the time it takes for edema and hyperemia to resolve. The timely use of an abacterial environment and endovascular interventions on lower extremity vessels is shown to reduce the number of amputations in this category of patients.

Implementation of research results. According to the conclusionNo. 7/108 of October 22, 2024 of the Scientific and Technical Council under the Ministry of Health of the Republic of Uzbekistan on the application of the results of scientific research in practice:

first scientific novelty:For the first time, the shortcomings of traditional treatment method for patients with diabetic foot syndrome and critical lower limb ischemia.Significance of scientific innovation:The obtained results have their own theoretical significance, which make a significant contribution to the study of the characteristics of the treatment of purulent necrotic wounds in patients with diabetic foot syndrome with critical ischemia of the lower extremities.Implementation into practice:The obtained scientific and practical data have been implemented into the practice of the Bukhara City Medical Association (order of 09.09.2024 No. 1651-2-42-TV/2024) and the Kagan City Medical Association (order of 18.09.2024 No. 3534-2-208-TV).Social efficiency:The use of these data made it possible to reduce the incidence of complications, improve the quality of treatment and reduce the likelihood of death in patients with purulent-necrotic lesions in diabetic foot syndrome. Cost-effectiveness:

reduction in average life expectancy A 6-day hospital stay reduced hospitalization costs by 630,000 soums per patient and decreased medication costs, which averaged 120,000 soums per day.Conclusion: study of the shortcomings of the traditional method of treating patients with diabetic foot syndrome with critical lower limb ischemia has significantly reduced complications and mortality, improved treatment outcomes, and provided significant positive effects in both medical and economic terms.

the second scientific novelty:The place and role of the abacterial environment in treatment of patients with diabetic foot syndrome with critical ischemia of the lower extremities.Significance of scientific innovation:studying the effectiveness of using an abacterial environment with the use of EARA, which helps to reduce the number of lower limb amputations, thereby allowing for the optimization of the choice of intervention method when planning surgical intervention.Implementation in practice:The obtained data were implemented into the practice of the Bukhara city medical association (order dated 09.09.2024 No. 1651-2-42-TV/2024) and Kagan city medical association (order dated 18.09.2024 No. 3534-2-208-TV).Social efficiency:The use of the results made it possible to reduce the risk of complications, improving the quality of prevention and treatment of patients.Cost-effectiveness: Reducing the average length of a patient's hospital stay by 6 days reduced hospitalization costs by 630,000 soums and reduced medication costs, which averaged 120,000 soums per day. Conclusion:treatment of patients with diabetic foot syndrome with critical ischemia of the lower limb, the use of an abacterial environment with ERA-A in the first phase of the wound process helps to improve the treatment results for this category of patients.

third scientific novelty:the results of local application were studied abacterial method with a modern treatment method in the treatment of patients with diabetic foot syndrome with critical ischemia of the lower extremities.Significance of scientific innovation:The study of the results of the use of abacterial medium using EAR-A specifically indicated the effectiveness of abacterial medium using EAR-A in
in the form of: accelerating the time of wound cleansing and formation of granulation tissue, reducing the time it takes for edema and hyperemia to resolve.Implementation into practice: The obtained data were implemented into the practice of the Bukhara City Medical Association (order of 09.09.2024 No. 1651-2-42-TV/2024) and the Kagan City Medical Association (order of 18.09.2024 No. 3534-2-208-TV).Social efficiency: Studying the results of using an abacterial environment with EAR-A allows us to improve the quality of diagnosis and treatment, as well as reduce the risk of complications.Cost-effectiveness:A study of the results of using an abacterial medium with the use of EAR-A made it possible to reduce treatment costs, decreasing expenses by 630,000 soums per patient from budgetary funds and 120,000 soums from extra-budgetary funds.

Conclusion:use of a special device for carrying out abacterial The use of EAR-A by means of long-term lavage of the affected limb helps to reduce amputations at the level of the lower leg from 19.2% to 6.2%, high amputations from 1.7% to zero, foot amputations from 25.0% to 12.5%, and reamputations from 5.3% to zero.

the fourth scientific novelty:an optimal treatment method has been developed patients with diabetic foot syndrome and critical ischemia of the lower extremities using a local abacterial environment, it was also confirmed that the timely use of an abacterial environment and endovascular interventions on the vessels of the lower extremities helps to reduce the number of amputations in this category of patients.Significance scientific innovation:developed method of applying local Application of an abacterial environment to the affected limb by prolonged lavage for 6 hours with ERA-A solution twice a day in combination with a water-soluble ointment + ERA-A under a bandage is a more effective method of treating patients with severe critical ischemia of the lower extremities in diabetic foot syndrome. Implementation into practice: the developed method was introduced into the practice of the Bukhara city medical association (order dated 09.09.2024 No. 1651-2-42-TV/2024) and Kagan city medical association (order dated 18.09.2024 No. 3534-2-208TV).Social efficiencyThe developed method made it possible to significantly reduce the incidence of complications, improve the quality of treatment and accelerate the recovery of patients.Economic efficiency:reduction in the average length of hospital stay by 6 days allowed saving 630,000 soums of budgetary funds and 510,000 soums of extra-budgetary funds per patient due to the reduction of costs for hospitalization and medications.Conclusion:The implementation of the developed method of using an abacterial medium by prolonged lavage for 6 hours with ERA-A solution twice a day in combination with a watersoluble ointment + ERA-A under a bandage is a more effective method of treating patients with severe critical ischemia of the lower limbs in diabetic foot syndrome, which can be recommended for widespread use in clinical practice in this category of patients and provide a significant economic advantage.

Testing the research results. Results this The research was presented and reported at 5 international and two national scientific and practical conferences and congresses.

Publication of research results. On the topic of the dissertation 17 scientific papers were published, of which 10 were journal articles, including 4 in national and 6 in foreign journals recommended by the Higher Attestation Commission of the Republic of Uzbekistan for the publication of the main scientific results of the dissertation.

Structure and scope of the dissertation. The dissertation consists of an introduction, Four chapters, a conclusion, findings, practical recommendations, a list of references, and an appendix. The dissertation is 146 pages long.

CHAPTER I. MODERN CONCEPTS OF THE PROBLEM OF DIABETIC FOOT SYNDROME. (LITERATURE REVIEW).

1.1 Modern concepts of diabetic foot syndrome pathogenesis, etiology, classification

A long-term consequence of diabetes mellitus is the syndrome Diabetic foot ulcer (DFU), the prevalence of which is rapidly increasing. It includes all foot changes resulting from diabetic polyneuropathy, as well as micro- and macroangiopathic (peripheral arterial disease, PAD) changes. The number of patients with new diabetic foot ulcers increases annually. They often become chronic wounds. DFU is a collective term for pathological changes in the foot of people with diabetes mellitus. DFU is a common, complex, expensive and sometimes life-threatening complication. Ulcers or necrosis are caused by local pressure overload with limited pain sensitivity resulting from diabetic polyneuropathy.

Deformities of the foot and toes often occur simultaneously. In more than 50% of cases, corresponding peripheral arterial disease of the pelvic arteries and arteries of the lower extremities in the sense of critical limb ischemia (CLI) is added, which complicates wound healing and a large number of amputations are required [144; pp. 81-94]. Most patients develop foot ulcers after age 40, and the risk increases with age [156; p. 573-583].

The prevalence of diabetes continues to rise worldwide, and the International Diabetes Foundation estimates that 537 million adults aged 20 to 79 years worldwide were living with diabetes in 2021. [98; p. 62] This situation leads to an increase in the incidence of foot complications, including infections. IRFs are associated with significant morbidity, requiring frequent physician visits, daily wound care, antimicrobial therapy, surgical procedures, and high healthcare costs. Of particular importance is that IRFs remain

The most frequent complications associated with diabetes requiring hospitalization and the most common precipitating events leading to lower limb amputation. The most severe diabetic foot syndromes are associated with impaired blood supply to organs and tissues due to the involvement of both main and small peripheral arteries. Circulatory disorders lead to diabetic retinopathy, which underlies the development of blindness in individuals of working age; to diabetic nephropathy, which is one of the main factors in the development of end-stage renal disease; and to diabetic neuro- and microangiopathy, which play an important role in the pathogenesis of diabetic foot syndrome [13; pp. 69-78].

Diabetic foot ulcers are one of the most disabling complications of diabetes and can lead to amputation or even death. Treatment and management of diabetic foot ulcers are one of the most challenging tasks not only for patients and their families but also for healthcare teams, requiring multimodal and multidisciplinary care. Numerous published studies highlight the relationship between diabetic foot ulcers, cardiovascular events, and increased mortality in patients with diabetes. Diabetic foot ulcers are considered a predictor of cardiovascular events and mortality, with possible common pathways [140; pp. 98-100].

German scientists [140; pp. 98-100] cite data that patients with diabetes and diabetic foot syndrome have a mortality rate more than twice that of non-ulcerated diabetics. Furthermore, the 5-year mortality rate after amputation is estimated at 39-68%, which is comparable to the life expectancy in aggressive types of cancer or progressive congestive heart failure. Most patients with diabetic foot ulcers also have insulin resistance, central obesity, dyslipidemia, and arterial hypertension, which characterize metabolic syndrome.

Which, in turn, is associated with an increased risk of serious cardiovascular events. Sensory neuropathy is the underlying cause of over 60% of diabetic foot ulcers. Diabetic peripheral neuropathy is a microvascular complication of diabetes mellitus. In type 2 diabetes mellitus, not only hyperglycemia but also other metabolic changes and persistent inflammation due to obesity play a significant role in axonal damage. Elevated triglyceride levels have been shown to be an independent risk factor for lower extremity amputation in patients with diabetes. Furthermore, toxic obesity, oxidative stress, mitochondrial dysfunction, activation of the polyol pathway, accumulation of advanced glycation end products (AGEs), and elevated inflammatory markers are also associated with diabetic vascular disease and neuropathy. In patients with diabetes, a strong correlation was observed between cardiovascular mortality, diabetic foot ulcer severity, and an inflammatory marker, as well as kidney function (elevated cystatin C). This reflects multiorgan and multisystem damage caused by neuropathy, vascular damage, and inflammation. The association between DFU and renal failure supports the idea that this relationship represents the interrelated evolution of chronic complications, both vascular and neuropathic, and chronic inflammation.

Excess body weight and metabolic disorders, including insulin resistance, type 2 diabetes, and cardiovascular complications, together constitute metabolic syndrome. [143; p. 183-193] The pathogenesis of metabolic syndrome involves many factors. However, a number of studies indicate that oxidative stress, along with chronic inflammation, paves the way for the development of metabolic diseases. Oxidative stress, a state of loss of balance between the oxidative and antioxidant systems of cells and tissues, leads to excessive production of oxidative free radicals and Reactive oxygen species (ROS). Excessive amounts of generated ROS can attack cellular proteins, lipids, and nucleic acids, leading to cellular dysfunction, including loss of energy metabolism, altered cellular signaling and cell cycle control, genetic mutations, altered cellular transport mechanisms, a general decrease in biological activity, immune activation, and inflammation. Furthermore, nutritional stress caused by a high-fat, high-carbohydrate diet also contributes to oxidative stress, manifested by an increase in lipid peroxidation products, protein carbonylation, a decrease in the antioxidant system, and decreased glutathione (GSH) levels. These changes lead to a pathogenic environment and the development of a number of chronic diseases. Research shows that in obese individuals, oxidative stress and chronic inflammation are important underlying factors that lead to the development of pathologies such as carcinogenesis, obesity, diabetes, and cardiovascular disease through altered cellular and nuclear mechanisms, including impaired DNA damage repair and cell cycle regulation. In this article, we discuss aspects of oxidative stress caused by metabolic disorders in major pathological conditions and strategies for their prevention and treatment.

Noninvasive measurements of small arteries in the lower extremities are closely associated with foot complications in people with diabetes, as proven in the work [119; pp. 589-593]. A relationship was shown between a history of foot complications (ulceration or amputation) and noninvasive vascular assessment in people with diabetes. Bilateral ankle-brachial index (ABI), toe brachial index (TBI) and continuous wave Doppler ultrasonography

(CWD) were performed in 127 adults with diabetes mellitus (97% type 2; age 66.08±11.4 years; 55% men; diabetes duration 8.8±7.6 years; 28% on insulin therapy; 31% with a history of foot complications). Correlations were made between known risk factors for foot complications and

documented confirmed anamnesis complications feet. Regression analysis was used to determine the impact of TBI on the odds of a prior foot complication. By logistic regression, the odds of a history of foot complications were highest in patients with a TBI <0.6 (OR=7.74, p=0.001), followed by longer diabetes duration (OR=1.06, p=0.05). HbA1c did not predict a history of foot complications (OR=1.10, p=0.356). The odds of a prior foot complication in this population were ~8-fold higher when TBI was <0.6. This clinical risk profiling has not been demonstrated by other noninvasive methods. Prioritizing TBI as an indicator of lower extremity vascular disease may be useful for prospectively identifying those at risk for diabetic foot complications.

Most studies indicate that the pathogenesis of diabetic foot involves several factors, two of which can be considered primary: two key mechanisms—neuropathy and vascular disorders (angiopathy and ischemia)—are directly linked to hyperglycemia, which suppresses the production and activation of endothelial nitric oxide synthase. Furthermore, hyperglycemia leads to increased protein glycosylation. High glucose levels, dyslipidemia, insulin resistance, and oxidative stress can lead to cellular damage, endothelial dysfunction, and various diabetes-related complications. Hyperglycemia inhibits nitric oxide production by blocking the activation of endothelial nitric oxide synthase, leading to the formation of reactive oxygen species (superoxide). Superoxide dismutase converts hydrogen peroxide into hydrogen peroxide, which, in the presence of iron and copper ions, transforms into a highly reactive and damaging hydroxyl radical. Moreover, superoxide itself is capable of directly binding to nitric oxide (a powerful vasodilator), thus reducing the bioavailability of the latter, which leads to a limitation

vasodilatory effect. Dysfunction of the endothelium leads not only to vasoconstriction, but also to platelet aggregation, abnormal growth of the intima, inflammation, and the development of atherothrombosis. Ultimately, these processes, occurring in the small vessels that supply the nerves, lead to neuropathy [86; p. 1,101; pp. 55-59].

In diabetes mellitus, the risk of developing foot infections is 25%, and it is the most common cause of hospitalization in this category of patients. Moreover, the development of a purulent-necrotic process in the foot is often accompanied by a fairly serious infection with multiple pathogenic factors. Under the influence of this flora, pathological thrombus formation occurs in the microcirculation, decreased permeability of the vascular basement membrane and endothelial cells, decreased venous outflow and venous wall tone. If this process is complicated by the presence of occlusive lesions of the peripheral arteries, leading to ischemia and impaired tissue metabolism, then the first stage of the wound process (tissue destruction, exudation, inflammatory infiltration) is more active and severe compared to patients with patent arteries. This leads to the progression of necrosis, its spread throughout the foot, and the formation of secondary necrosis both on the foot itself and on the lower leg. Repeated necrectomy surgeries become necessary, and in some cases, lower limb amputation is necessary.

— due to the local spread of the purulent-necrotic process [33; pp. 25-36]. The basis of the metabolic syndrome in the pathogenesis of the development of purulent-necrotic processes on the feet in patients with diabetes mellitus is hypercoagulation, impaired viscosity and plasticity of the blood. This leads to pathological thrombus formation in the microcirculatory bed. As a consequence, peripheral circulation worsens, the purulent-necrotic process progresses, which leads to the formation of secondary necrosis, its spread in area and depth [134; pp. 82-90]. Despite all efforts to treat the syndrome

In diabetic foot ulcers, wound healing rates remain poor and have not improved over the past 30 years. The chronic inflammatory state present in diabetes leads to an imbalance between pro- and anti-inflammatory cytokines in the wound. Macrophages play a key role in this imbalance. During normal wound healing, activated macrophages (M1) are initially recruited and secrete several pro-inflammatory cytokines, including those with antimicrobial properties. In the next phase, macrophages are activated, secreting anti-inflammatory cytokines and promoting tissue repair (M2). There is evidence that in patients with diabetes, this second phase, mediated by M2, is impaired, leading to an imbalance of pro- and anti-inflammatory cytokines and delayed healing. Thus, the wound remains open and serves as a gateway for infection, which, associated with impaired leukocyte function, also caused by hyperglycemia, can lead to sepsis and/or amputation of the limb [26; p. 1-144].

The International Working Group on Diabetic Foot (IWGDF) notes that the most important factors underlying the development of foot ulcers are peripheral neuropathy, peripheral arterial disease, foot deformities associated with motor neuropathy, and minor foot injuries. These factors expose the patient to the risk of skin ulceration, which makes the foot susceptible to infection, a medical emergency. Only two-thirds of diabetes-related foot ulcers ultimately heal, and up to 28% may result in some form of lower limb amputation. Each year, more than 1 million people with diabetes lose at least part of a leg due to diabetes-related foot disease. This means that every 20 seconds, somewhere in the world, a lower limb is lost due to diabetes [154; pp. 19-31]. In a prospective study [139; p.16-19], outcomes in patients with infected diabetes-related foot ulcer (DRFU) were suboptimal: after 1

Over the course of a year, ulcers healed in only 46% of patients (and later recurred in 10% of them), while 15% died, and 17% required lower limb amputation. The main complications are diabetic foot ulcers (DFUs), skeletal foot deformities (Charcot foot), and amputations. According to the International Working Group on Diabetic Foot (IWGDF), DFUs are wounds that penetrate the dermis and are located below the ankle in patients with diabetes. DFUs cause significant suffering to the patient and their family and also pose a significant burden to society and healthcare institutions.

The International Working Group on Diabetic Foot (IWGDF) has identified 28 classification systems proposed by experts using the GRADE methodology. The experts identified classification systems considered potentially appropriate for use in clinical settings by synthesizing judgments about diagnostic tests, focusing on each system's usability, accuracy, and reliability for predicting ulcer-related complications, as well as resource use. They also determined which of the proposed schemes should be used in specific clinical scenarios. Following this process, the IWGDF recommends that for a person with diabetes and a foot ulcer:

(a) - for communication between healthcare professionals: use the SINBAD (location, ischaemia, bacterial infection, area and depth) system (first option) or consider using the WIfI (wound, ischaemia, foot infection) system (alternative option where the necessary equipment and level of expertise are available and this is considered feasible) and in each case the individual variables that make up the system should be described rather than an overall assessment;

(b) - to predict the outcome of an ulcer in a specific individual: no existing system can be recommended;

(c) - to characterize a person with an infected ulcer: use the IDSA/ IWGDF classification (first option) or consideration of the possibility of using the WIfI system (an alternative option where the necessary equipment and level of expertise are available and this is considered feasible);

(d) - to characterize a person with peripheral arterial disease: consider using the WIfI system as a means of stratifying the likelihood of recovery and the risk of amputation;

(e) - for the audit of the results (outcomes) of the population: use SINBAD scales. [131; p.32-73]

1.2. Modern methods of diagnosing the syndrome diabetic foot

The rapid development of new technologies and devices in the last decade has contributed to the growth of minimally invasive methods in both treatment and diagnostic approaches.

Modern imaging techniques, namely standard AP and lateral radiography, computed tomography, and magnetic resonance imaging, make it possible to detect this complication in the early stages of its development and promptly provide the necessary medical care. Determining the standard for diagnosing diabetic foot syndrome begins with a visual examination of the skin and a neurological examination.

Physical examination includes assessing the pulse of the legs, searching for PNP, examining the wounds, and assessing the foot for favorable deformities. The following questions should be asked: Why is the wound present? However, in some cases, clinicians and radiologist fail to establish a correct diagnosis in the early stages of the disease's progression, and patients seek medical care only in the later stages of diabetic foot development with deep wound defects and bone lesions. As a result, the only correct solution remains resection of the infected segment or complete amputation of the foot. In order to avoid surgical intervention and

To ensure a timely and accurate diagnosis in patients with diabetes, specialists use a number of radiological diagnostic methods. These include standard radiography in frontal and lateral projections, computed tomography, magnetic resonance imaging, and radionuclide diagnostic methods. These methods allow for an assessment of the extent of the pathological process and its stage [84; pp. 87-90].

Mexican scientists have proposed a terahertz imaging method for early screening of diabetic foot syndrome [106; pp. 45-49]. Terahertz imaging is a noninvasive method that does not expose patients to risk and has the advantage of directly assessing skin hydration, unlike monofilament or Doppler tests, which assess nerve or vascular deterioration, respectively. However, terahertz imaging remains a relatively expensive method. The authors proposed terahertz reflectance imaging as a potential method for early screening of foot deterioration in patients with diabetes. They also designed and implemented the appropriate equipment for obtaining images of the soles of the feet. Furthermore, they obtained images of 12 diabetics and 21 non-diabetics, giving us a very optimistic idea of the method's potential. Based on these results, the scientists are planning a clinical trial of the screening method, which is expected to be completed in the coming months or years. However, the researchers emphasize that, provided the observations are confirmed in a larger, more rigorous clinical trial, this method could fundamentally change the approach to foot care for patients with diabetes, as well as the development of new treatments for this condition.

Ultrasound is a non-invasive and versatile technology that has gained recognition in recent years in virtually all medical specialties, with diagnostic and interventional applications. In diabetic foot syndrome, ultrasound has revealed specific indications are mainly in screening, quantification and follow-up of the vascular component of the pathology, as well as in the study of deformities and structural modifications caused by neuropathy, as well as in the diagnosis and surgical treatment of infections, especially those causing anatomical changes, such as abscesses and fasciitis [141; pp. 315-333] in the article summarized all these applications of ultrasound, paying special attention to the vascular aspects, as well as the predominant role that ultrasound has recently acquired in determining the indications for revascularization, a new standardized approach to the study of the arterial tree of the limb and foot, the so-called duplex ultrasound mapping of the arteries, which has significantly increased the use of ultrasound for planning revascularization in this complex pathology. Beyond vascular areas, the discussion covers the diagnosis of neuropathy and infection, as well as the intraoperative use of ultrasound in the surgical treatment of abscesses and fasciitis. The final section focuses on new and exciting applications of ultrasound in the treatment of DFUs, a field that is still evolving, offering new opportunities for healthcare professionals involved in the treatment of these chronic wounds. The diversity of applications in both diagnostic and surgical areas makes ultrasound a highly versatile technology and tool that should hold a special place among those available to specialists treating DFUs.

Revascularization, either surgical or endovascular, is the cornerstone of treatment [93; pp. 148–151]. Indeed, it is performed to ensure adequate blood flow to the extremities in at least 50% and up to 90% of patients with CLI in some tertiary referral centers, while minor and major amputations are performed when all previous treatments cannot be used or have failed. In patients with diabetes mellitus, the indications for revascularization are more complex and take into account foot perfusion, wound severity, and infection, assessed using toe pressure.

Leg pressure, ankle pressure, ankle-brachial index (ABI), and transcutaneous oxygen tension (TcPO2) are used as first-line diagnostic methods. However, secondary vascular imaging remains essential for confirming the diagnosis, indications, and planning revascularization strategies.

Digital subtraction angiography remains the gold standard for assessing inflow and outflow arteries prior to revascularization, although it is burdened by local and systemic complications [152; pp. 224–233]. In this context, Doppler ultrasound (DUS) has become a recognized primary noninvasive tool for patients with PAD. In fact, DUS is harmless, welltolerated by patients, significantly less expensive than DSA, and provides anatomical and hemodynamic information.

Studies have shown that Doppler ultrasound and contrast-enhanced magnetic resonance angiography (CE-MRA) appear to be superior to DSA in predicting distal outflow tract, especially with very low flow [110; pp. 287-292]. Doppler ultrasound can accurately assess the status of the entire vascular tree and foot drainage and provides sufficient information about the target vessels to guide the revascularization strategy. Furthermore, it appears to be able to replace conventional second-level diagnostic imaging when performed by skilled operators within a multidisciplinary evaluation with the ability to guarantee high technical success rates and satisfactory short- and medium-term outcomes. However, the high operator dependence of DUS compared to DSA still limits its widespread use as the only preoperative imaging modality for planning the revascularization strategy in patients with chronic limb threatening ischemia.

Sharing experiences successful multiple endovascular revascularization of the arteries of a single lower limb in a patient with diabetic foot syndrome [54; pp. 67-72]. The treatment of patients with critical ischemia caused by damage to the arteries of the lower leg is one of the most complex tasks of modern angiology. Damage to the vascular wall of the arteries in diabetes mellitus is similar to thromboangiitis, which makes bypass operations less effective. Calcification and stenosis of the artery in combination with the small caliber of the artery subject to revascularization makes it difficult to create a distal anastomosis during bypass operations. In addition, the presence of microangiopathy leads to a violation of the outflow from the bypass, which in turn will inevitably lead to thrombosis. The presence of trophic disorders in the foot increases the risk of purulent-septic complications in this category of patients during open bypass operations. Minimal invasiveness, the possibility of repeated performance, the possibility of restoring blood flow through the arteries small diameter makes Endovascular procedures are preferable in patients with diabetic foot ulcers. The presence of chronic renal failure in this category of patients requires a multidisciplinary approach to treatment. Determining the sequence and timing of surgical treatment of diabetic foot ulcers and limb revascularization, assessing associated cardiovascular risks and complications of the disease, prescribing comprehensive conservative therapy, and individual limb unloading are important components of the overall treatment strategy for ulcerative lesions in patients with diabetes and critical lower limb ischemia. The authors present a clinical case of a polymorbid patient with severe distal arterial disease in the lower limb. Multiple balloon angioplasty of the crural arteries was performed in a patient with critical ischemia of a single lower limb. Timely angioplasty relieved the clinical symptoms of critical ischemia, promoted foot wound healing, and preserved the weight-bearing function of the limb, thereby prolonging the patient's active lifestyle without severe disability.

The leading method for correcting the patency of major vessels today is endovascular balloon angioplasty. Advantages angiosomal-oriented endovascular The following are the revascularization methods: reduction of the duration of the intervention, reduction of the volume of the administered contrast agent, and targeted restoration of blood flow in the artery supplying the affected segment of the limb.

Belarusian scientists [76; pp. 635-637] The choice of primary surgery aimed at limb revascularization should be based on the degree of peripheral circulatory impairment, the number of affected arteries, the condition of the inflow and outflow tracts in the distal bed, the severity of bone and soft tissue pathology of the feet, and the presence of infection. Surgical and X-ray endovascular revascularization methods are reliable and highly effective, achieving improvement in more than 78% of cases. Surgical treatment is highly effective, with significant results achieved immediately after surgery. Complete or partial restoration of blood flow in the affected limb has led to an increase in minor amputations (at the foot level) due to a decrease in high ones (lower leg and thigh), promoting wound healing and a reduction in hospital stay from 19.3 to 14.2.

A new work by Belarusian authors [78; pp. 68-70] presents the experience of 25 cases of using posthumous donor vascular grafts in 24 patients during revascularization of the lower extremities with critical ischemia. All patients were divided into 2 groups: the first group included 13 with the neuroischemic form of diabetic foot syndrome, and the second with obliterating atherosclerosis of the vessels (arteries) of the lower extremities - 11. Positive results were noted in 20 patients (83.3%). In the immediate and late periods after revascularization with a donor graft (1 - artery, 3 - vein), high amputations were performed in 4 cases (16.7%), all patients had diabetes mellitus. Indications for
The procedure for limb revascularization in patients of both groups was determined based on the type and extent of the lesion, the condition of the outflow tract, and the general somatic status. In each case, the indications were determined individually and could be adjusted during the operation. In the presence of indications and conditions for open revascularization, as well as in the absence of the possibility of using an autovein, reconstruction was performed with donor venous or arterial (6; 24%) grafts: femoropopliteal bypass - 9 (including two cases with an artery); femoral-anteriorbtibial bypass – 4 (including two cases with an artery); femoral-posterior-tibial bypass – 4; femoral-femoral bypass – 2 (both with an artery); crossed femoral-femoral bypass – 2; femoralinterosseous bypass – 1; deep femoral-posterior-tibial bypass – 1; femoralfoot bypass – 1; popliteal-foot bypass – 1; popliteal-posterior-tibial

– 1. One patient underwent removal of a femorofemoral synthetic graft due to suppuration and bleeding. Bypass grafting was performed with a donor allograft. In patients with critical lower extremity ischemia and the absence of autologous graft material, the use of donor venous and arterial grafts proved to be an effective method of direct open revascularization in the presence of critical ischemia and purulentnecrotic tissue changes, avoiding major amputation in 83.3% of cases.

Application of X-ray endovascular methods revascularization The use of intraoperative methods for determining the significance of lower extremity arterial stenosis allows for the determination of the extent of balloon angioplasty and confirmation of the completeness of revascularization. Contrast-enhanced angiography and computed tomography (CT) assessment methods do not allow for the specific location of stenosis leading to limb ischemia, and in the case of multiple lesions, more selective balloon angioplasty is not possible.

Scientists from Bashkortostan [19; pp. 300-306] have proposed a new method for assessing stenosis. The method is implemented as follows: during angiography in the main group, invasive pressure in the arteries of the lower extremities is additionally measured. Using a catheter with an attached invasive pressure sensor, measurements were taken before and after stenosis. Stenoses were considered significant if they had a systolic pressure gradient >20 mmHg or a mean gradient >10 mmHg in combination with a decrease in limb blood flow reserve (LBR) below 1.0, which is defined as the ratio of the pressure behind the stenosis against a background of hyperemia and the pressure at an unchanged site before the stenosis. Before the use of the proposed method, the success of balloon angioplasty of the arteries of the lower extremities was considered to be obtaining a positive X-ray surgical result, visualized on control images. When using the developed method, it was mandatory to compare repeated measurements of invasive pressure in the corrected artery after balloon angioplasty in order to monitor the success of the treatment.

1.3. Critical ischemia of the lower extremities in syndrome diabetic foot, clinical manifestations.

Critical lower limb ischemia is symptoms associated with end-stage atherosclerotic peripheral arterial disease, characterized by rest pain and tissue loss. It is associated with an increased risk of limb amputation and cardiovascular-related mortality. Research projects that the prevalence of the disease will increase with both the aging population and the continued impact of smoking and diabetes [122; p, 125-130]. Treatment includes measures to reduce cardiovascular risk and preserve limb viability. Despite the growing popularity of endovascular techniques, revascularization with surgical bypass or endovascular Intervention is the cornerstone of therapy. Currently, there is a lack of adequate level I data to guide decisions on optimal treatment strategies for critical lower extremity ischemia, particularly in patients who are candidates for both open and percutaneous approaches.

A study by Chinese scientists [124; pp. 988-992] from Sichuan University demonstrated the experience of treating chronic lower limb ischemia complicated by diabetes mellitus. Patients with CLTI should undergo preoperative evaluation for revascularization. Surgery may be delayed in patients with mild pain, acceptable walking distance, and limb ischemia that has little impact on quality of life. In patients with significant tissue loss and severe limb necrosis, especially in patients with severe stage IV infection, the benefit of revascularization may be less, and prolonged absorption of leg infection may lead to life-threatening systemic infection, therefore amputation must be performed immediately。 Patients who revascularization is required after the initial examination, the trilogy of risk assessment - lesion stage - vascular anatomy should be followed for further assessment of the feasibility of surgery and choice of surgical

Method. Preoperatively, surgical risk and life expectancy are comprehensively assessed based on the patient's physical examination and assessment. Comorbidities are comprehensively assessed, and for patients with high surgical risk and short life expectancy, a more conservative treatment plan is typically adopted. "Wound" is the assessment of the size and distribution of ulcers and gangrene in the affected limb, "ischemia" primarily refers to the dorsal leg artery pulse and ankle-brachial index (ABI), and "infection" primarily refers to the local manifestations of ulcers in the patient and whether they are associated with osteomyelitis. Vascular anatomy is divided into

Segmental assessment of the femoropopliteal artery and inferior genicular artery, primarily based on the location and length of stenosis and occluded artery, and the patency of the distal outflow tract. The higher the GLASS stage, the higher the risk of intraoperative surgical failure and postoperative restenosis. Preoperative anatomical assessment of the lower extremity arteries relies primarily on ancillary studies, including color ultrasound of the lower extremity arteries and 3D CT vessel reconstruction. Ultrasound is indicated as the preferred study due to its convenience, reliability, and economy。 The decision to undergo surgery must based on patient preferences, economic factors, surgical risks, and WIfI and GLASS stages.

For patients with chronic lower limb ischemia, the main surgical methods are endovascular angioplasty and bypass [108. p. 96-98]. Currently, there is still no high-quality study comparing the effect and prognosis of endovascular therapy and bypass, but practical experience shows that patients who have the opportunity for endovascular treatment can give priority to endovascular angioplasty, endovascular treatment has the advantages of less trauma, lower perioperative risk and can avoid general anesthesia, especially suitable for patients with high perioperative risk and poor general condition at preoperative assessment, but patients with a higher stage of WIfI have

higher risk of postoperative re-intervention。

Bypass grafting has a high long-term patency rate, and for patients with a long life expectancy, good surgical tolerance, and vascular anatomy, bypass grafting can be directly attempted. For patients with obvious inferior genicular artery lesions, the primary treatment option at the center is endoluminal angioplasty.

The procedure includes balloon dilation alone and balloon dilation plus stent implantation, with the decision to place a stent primarily based on the patient's angiography results after balloon dilation. The goal of the surgery is to restore blood flow to the main trunk of the inferior genicular artery. Some patients experience severe distal arterial occlusion that is difficult to identify. Distal occlusion of the anterior tibial artery is the primary reason why the dorsalis pedis artery cannot be palpated in some patients after surgery.

The article examines the evaluation of the technical feasibility of endovascular revascularization of lower extremity arteries in the development of critical lower extremity ischemia (chronic ischemia threatening limb loss), including diabetic foot syndrome [59; pp. 38-43]. Two clinical cases of endovascular revascularization of lower extremity arteries in the development of chronic ischemia threatening limb loss, as well as diabetic foot syndrome, were analyzed. The median age was 61 (60-62) years; there was 1 male (50%). At hospitalization, the risk of limb loss according to the

WIfi classification was assessed as high in one case and as moderate in the other. The effectiveness of revascularization was 100%. In 1 case (50%), re-intervention was required. Freedom from high amputation after surgery during the subsequent year of observation was 100%. The surgery lasts 120-150 minutes. The survival rate within a year of follow-up after surgery was 100%. Clinical observation demonstrates that even with proper patient selection, stratification of risk factors for both possible limb loss and surgical risk, and the correctness of the chosen tactics for revascularization of the central nervous system, only with an increase in the number of procedures performed, the development of routing, and the creation of specialized centers is it possible to achieve satisfactory results in the treatment of this problem, which, as demonstrated by global

This trend will worsen as the incidence of diabetes increases and the population ages.

Polish authors demonstrate two-stage gene therapy (VEGF, HGF, and ANG1 plasmids) as an adjunctive therapy in the treatment of critical lower limb ischemia in diabetic foot syndrome [92; pp. 36–38]. Gene therapy that stimulates angiogenesis improves not only blood flow from the proximal limb but also blood redistribution within individual angiosomes. Due to the encouraging results of sequential treatment consisting of intramuscular injections of bicistronic VEGF/HGF plasmids followed by monthly administration of ANG1 plasmids, we decided to use the described method for the treatment of critical lower limb ischemia in diabetes mellitus, and in particular, in diabetic foot syndrome. The study included 24 patients who met the inclusion criteria. They were randomly divided into two equal groups. The first group of patients underwent gene therapy, receiving intramuscular injections of pIRES/VEGF165/HGF plasmids and ANG-1 plasmids for 1 month. The remaining patients constituted the control group. Gene therapy was well tolerated by most patients. In group 1, wounds healed significantly better. The minimum ABI value significantly increased in group 1 from 0.44 ± 0.14 (± standard deviation) to 0.47 ± 0.12 (at $p = 0.028$) at the end of the study. No significant differences were found in the control group. In the gene therapy group, $PtcO_2$ increased significantly (from 28.71 ± 10.89 mmHg to 33.9 ± 6.33 mmHg at $p = 0.001$), while no statistically significant changes were found in group 2. Observed pain at rest significantly decreased in both groups (group 1 decreased from 6.80 ± 1.48 to 2.10 ± 1.10; p <

0.001; the control group decreased from 7.44 ± 1.42 to 3.78 ± 1.64 with $p < 0.001$). In this study, the authors evaluated the effectiveness of gene therapy with the above-described growth factors in

patients with CLI with complicated diabetes. The therapy proved effective with minimal side effects. No serious complications were observed.

1.4. Modern methods of treatment of diabetic syndrome feet.

German scientists note that after the implementation of the minimum The application of minimally invasive surgery as an adjustment to the multidisciplinary approach to treating patients with diabetic foot syndrome has shown a tendency to decrease both minor and major amputation rates [87; p. 54-58]. The introduction of minimally invasive surgery into the instrumentation of regional hospitals can significantly contribute to improving the health of patients. Various methods were used to cover the wound. For example, plastic flap covering, mesh graft, and kerecis fish skin. To support the secondary wound healing process, vacuum therapy (negative pressure wound therapy) was used in both groups. Group 2 consisted of platelet-rich plasma therapy and biochemical surgery. Orthoses and bandages were used as external relief. In addition, in case of circulatory disorders, revascularization therapy, directed in accordance with the angiosomal concept in the lower leg area, was used. This study was conducted retrospectively.

The most common cause of SDS is high mechanical stress on the foot tissues of people with diabetes and the loss of protective sensation. This loss of protective sensation is a result of peripheral neuropathy and affects approximately half of all people with diabetes. Mechanical stress on the tissues is caused by plantar pressure and shear, accumulated during repeated loading cycles. Peripheral neuropathy can also lead to further gait changes, foot deformities, and soft tissue deformities, which can further increase mechanical stress on the tissues. Once SDS develops, healing is difficult.

chronically delayed unless the area is effectively relieved [118; p.91-105].

Effective treatment of SDS typically requires multiple interventions, including local wound care, treatment of any infection and peripheral arterial disease, and off-loading.[130;p.36-48].

This requires a team approach, based on collaboration between on representatives of different disciplines, and an engaged and empowered patient. The first three of these interventions are described in other parts of the International Working Group on Diabetic Foot (IWGDF) Guidelines. In people with neuropathic diabetic foot syndromes, offloading has been found to be perhaps the most important of these interventions for effective healing. There is a long clinical tradition of using various offloading devices, footwear, surgery, and other offloading interventions to treat diabetic foot syndromes.[99; pp. 507-512]

Previous IWGDF guidelines found that there is sufficient evidence to support the use of fixed knee-high offloading devices for the treatment of plantar forefoot ulcers compared with all other offloading interventions. It also determined that additional high-quality studies are needed to confirm the promising effects of other offloading interventions for the treatment of SUDs to better inform practitioners about effective treatment methods. Fixed knee-high offloading devices are devices that extend up the leg to just below the knee and cannot be easily removed by the patient, such as total contact casts (TCCs) and fixed walkers. They should also include a foot device interface, which helps reduce peak pressure at the ulcer site. For TCCs, foot device interfaces are typically adapted to the TCC method by hand-molding the TCC to the shape of the plantar forefoot.

surfaces to redistribute pressure on the foot. For walkers, foot-device interfaces typically consist of prefabricated (which may have a modifiable modular design) or custom-made insoles. Additionally, felt foam can be added around the ulcer perimeter as part of the foot-device interface to further reduce pressure and promote ulcer healing. Finally, MonteiroSoares M recommends the use of walking aids if stability is impaired by wearing the device and there is a high risk of falls [89; pp. 105-118].

Over the past four years, a number of new studies on offloading have been conducted, expanding the evidence base for the treatment of people with DFUs. Ulcer healing continues to be recognized as a key, critical outcome for people with DFUs. However, other outcomes important for people with DFUs are attracting more attention and also require careful consideration when developing recommendations in new offloading guidelines, such as the impact on plantar pressure, weight-bearing capacity, treatment adherence, adverse effects, quality of life, and costs. The new 2023 guidelines aim to update the previous 2019 IWGDF guidelines on offloading of DFUs in accordance with the GRADE best practice approach for guideline development, taking into account all new evidence and important findings, and providing current, evidence-based international recommendations and rationale for offloading of DFUs. This guideline is part of a series of new IWGDF 2023 recommendations, including recommendations on ulcer classification, peripheral arterial disease, infection, wound healing, prophylaxis, and Charcot foot.
[65;p.144-146]

1.5. Application of controlled electroactivated solution

in the treatment of wounds.

The cause of the formation of chronic wounds of the lower extremities is chronic venous insufficiency of the lower extremities, both alone and in combination with neuropathy and chronic arterial insufficiency of the lower extremities, which leads to the formation of ulcers of mixed etiology [66; pp. 427-429]. At the emergency stage, a set of measures was carried out to diagnose and surgically treat the purulentinflammatory process, relieve intoxication and administer antiinflammatory drug therapy. Of the 92 patients examined, 68 were men and 24 women, aged from 42 to 75 years (mean age 54.3 ± 3.8 years). 15% of the total number of patients were in the compensation stage, 68% of the total number of patients were in the subcompensation stage, the remaining patients were admitted with decompensated diabetes mellitus, which significantly complicated the surgical treatment of these patients. For the comparative evaluation of treatment effectiveness, the patients were divided into two groups: The main group of 46 patients received general and local treatment with ECA of anolyte and catholyte solutions in the postoperative period (pH 7.3, redox potential +1100 mV; Ph> 9, ORP -300 - 500 mV). Signs of wound inflammation and their changes during treatment differed significantly in the main and control groups. When using hydropressive anolyte debridement in the first phase of purulent inflammation followed by applications of catholyte solution, inflammation indices were relieved twice as fast as in the control group with the traditional treatment method. Thus, signs of wound inflammation and their changes during treatment differed significantly in the main and control groups. When using anolyte, inflammation indices (purulent discharge and tissue infiltration) were relieved 2 times faster than in the control group with traditional treatment methods. Faster elimination of purulent inflammation reduces the risk of developing purulent-septic complications, contributes to the early stabilization of the general condition of the body.[67; p.102-108]

Successful experience in treating purulent soft tissue wounds in inpatient and outpatient settings is demonstrated in the authors' work [62; pp. 111-120, 57; pp. 366-374]. The use of electroactivated solutions of EAR-A and EAR-K in outpatient settings in patients with purulent soft tissue diseases revealed the following features of the wound healing process: the use of EAR for local treatment of purulent wounds leads to complete wound cleansing and normalization of clinical and laboratory biochemical parameters. As scientists note, this is a simple method that allows for treatment in both inpatient and outpatient settings.[56; pp. 36-45].

1.6. Use of a controlled antibacterial environment in treatment of diabetic foot syndrome.

Diabetic foot syndrome and diabetes mellitus are significantly increase the risk of developing generalized forms of infection. The steadily decreasing sensitivity of microorganisms to modern anti-infective drugs requires research to select adequate antibiotic therapy. In addition, the study of the structure of microflora and its sensitivity is necessary for economic forecasting and rational organization of medical care. The study of the influence of an abacterial environment on the quality of treatment of generalized forms of soft tissue infection against the background of diabetes mellitus is one of the important tasks of modern medicine, allowing to find the most rational methods of treating this pathology [10; pp. 44-48] notes that the use of conditions of an abacterial environment makes it possible to prevent the generalization of the process, relieve existing symptoms of a systemic inflammatory reaction in a short time, preventing the development of sepsis clinical symptoms. Treatment under aseptic conditions is accompanied by rapid dynamics of local and general inflammatory phenomena, allows reduce the time of elimination of pathogenic flora from wound discharge and shorten the period of inpatient treatment of patients by 1.3-1.4 times.

This paper examines several pathogenetic aspects of treating purulent-necrotic lesions of the feet in diabetes mellitus—a combination of basic therapy and wound treatment using controlled vacuum therapy, a fibrinolytic agent, an angioprotector, an antithrombotic agent, and a vasodilator. The article details the main stages and outcomes of inpatient treatment, the mechanisms of action on the pathological process, and the options for implementing controlled vacuum therapy [39; pp. 77-84].

The issues of subsequent treatment at the outpatient stage are also considered. Due to peripheral neuropathy, peripheral vascular disease, hyperglycemic environment, inflammatory disorders and other factors, the healing of DFU is impaired or delayed, leading to the formation of diabetic chronic refractory ulcer [138; p. 110-112]. Due to these pathological abnormalities, it may be difficult to accelerate wound healing in DFU with traditional treatments or antibiotics, while platelet-rich plasma (PRP) can promote wound healing by releasing various bioactive molecules stored in platelets, making it more promising than traditional antibiotics.[141; p. 315-333].

In recent years, relevant research has shown that the use of stem cells or growth factors could form the basis of new treatments that could restore the body's normal healing process. Among these, platelet-rich plasma is of particular interest, as platelets contain various growth factors essential for tissue repair and regeneration, and also possess antibacterial properties in traumatic injuries. PRP is a plasma preparation rich in these factors.
platelets at a higher concentration than whole blood [121; p.530-531].

The platelet concentration in its plasma is higher than the baseline level and ranges from 150 x 103/dL to 400 x 103/dL (22), which is 4-5 times higher than in whole

blood. The classical method of preparing PRP consists of two steps. The first step is centrifugation to separate the blood components into three layers: a layer of red blood cells, a light-colored coating layer (which contains the most platelets and leukocytes) and lowquality platelet-rich plasma. The second step is collecting the concentrated platelets in a small volume of plasma, called PRP. The role of PRP in wound healing is mainly due to the release of various bioactive molecules stored in platelets. In recent years, many studies have analyzed the effectiveness of PRP in the treatment of DFU, but they are limited to only a few indicators, and there are still conflicting conclusions, such as: Tasmania et al. concluded that the use of PRP in DFU promoted wound healing, reduced ulcer volume, shortened the time to complete wound healing, and decreased the incidence of adverse events without any difference in the likelihood of wound complications. This is consistent with previous findings (27–31). However, Ajay et al. concluded that PRP did not have a significant effect on ulcer healing (32). As one of the most important and common complications in patients with diabetes mellitus, DFU has a profound impact on the prognosis, amputation, and even death of patients. As a new treatment option for DFU, the efficacy of PRP in DFU deserves further study. Therefore, the main objective of this review is to review the results of various studies on the efficacy of PRP in the treatment of DFU. The use of antioxidants in the treatment of purulentnecrotic complications of diabetic foot syndrome has been shown. [33; p.
164-175]

It is currently believed that factors that slow down the wound process and contribute to the recurrence of the purulent-necrotic process in

The main factors affecting the progression of wound healing in patients with diabetic foot syndrome include chronic ischemia, neurotrophic disorders, and a reduced immune response. Another important factor influencing the course of wound healing is oxidative stress. The inflammatory stage is characterized by impaired microcirculatory function, leading to wound hypoxia and phagocyte activation and chemotaxis. Subsequently, reactive oxygen species are formed, slowing the sequential transition of the wound healing process from one stage to another. The inclusion of antioxidants and antihypoxants in therapy to correct oxidative stress promotes faster wound cleansing from necrotic tissue and accelerated epithelialization. The author analyzed the results of treating purulent-necrotic wounds in 52 patients with the neuroischemic form of diabetic foot syndrome complicated by the development of a purulent-necrotic process. The average age of the patients was 58±1.7 years. All patients underwent surgical debridement of the necrotic lesion upon admission. Conservative treatment included glycemic control, unloading the affected foot, antibacterial, anticoagulant, and antiplatelet therapy. The author concludes that the use of antioxidants in the complex treatment of diabetic foot syndrome can reduce the time it takes for wounds to clear necrotic tissue, the development of granulation tissue, and promotes shorter epithelialization times.[18; pp. 39-46]

Care for patients with diabetic foot syndrome (DFS) requires interdisciplinary collaboration, which is why there are interdisciplinary guidelines focused on the diagnosis, treatment, and prevention of DFS. These guidelines are also necessary because DFS has its own specific characteristics that influence its diagnosis, treatment, and patient prognosis. These include, for example, the varying course of infection and PAD in patients with diabetes, the diagnosis of Charcot's neuropathic osteoarthropathy, and its frequent association with end-stage disease.

Kidney disease, which worsens the course of diabetic foot syndrome and increases the risk of its development. Last but not least, amputations are a characteristic of diabetic foot syndrome, with a significantly worse prognosis than in people without diabetes. The creation of a multidisciplinary team in foot clinics that provides comprehensive care to patients with diabetic foot syndrome according to recommended guidelines has been associated with an improved prognosis for patients with diabetic foot syndrome, particularly a reduction in the number of amputations.

Conclusion of the literature review

An analysis of the literature shows that scientists and practicing surgeons are constantly searching for solutions to the problem of diagnosing and treating foot lesions at various stages of the disease's progression. A current area of vascular surgery is the introduction of new, effective methods for the surgical treatment of multilevel occlusivestenotic lesions of peripheral arteries in patients with diabetes. The incidence of obliterating atherosclerosis of the lower extremity arteries among patients with diabetes mellitus (DM) and the specific characteristics of vascular lesions in this patient population necessitate the search for optimal surgical treatment strategies to preserve the limb during critical ischemia.

The conducted literature review presents publications for the period from 2015-2022 posted in the following databases: EBSCOhost, Springernature, Googlescholar, eLibrary, etc.

Chapter II. MATERIAL AND METHODS OF RESEARCH §

2.1. Clinical characteristics of patients

The work is based on the data of examination and treatment of 104 patients with critical ischemia of the lower extremities in diabetic foot syndrome with a severe degree of damage (III-V according to Wagner, 1979) who received inpatient treatment at the clinical base of the Bukhara State Medical Institute for the period 2010 to 2023..

In accordance with the objectives of the study, all patients were conditionally divided into 2 groups:The first comparison group included 56 (53.8%) patients with critical ischemia of the lower extremities in diabetic foot syndrome, who underwent a traditional method of local treatment, which included: angiographic examination and endovascular intervention, as well as local surgical treatment and wound treatment with antiseptic drugs.

Table 2.1

Distribution of patients depending on the type therapeutic measures (n=104)

Groups sick	Treatment methods	Number of patients
I	Comparison group Traditional treatment method: - Treatment tactics: the use of angiographic examination in traditional local treatment.	n = 56
II	Main group - Treatment tactics: angiographic diagnostics using endovascular intervention + local abacterial WEDNESDAY	n = 48

When determining purulent-necrotic lesions in the examined patients, the Wagner classification (1979) was used (Table 2.2).

Table 2.2

Wagner Classification 1979

Degree	Definition	Description

0	Risk to the foot	There is no wound defect, but there is dry skin, dry calluses, and deformation of the joints of the fingers and/or feet.
1	Superficial ulcer	Complete destruction of the skin
2	Deep ulcer	A wound defect affecting the skin, subcutaneous fat fiber, tendons, but without damaging the bone
3	Abscess	A wound defect affecting the skin, subcutaneous fat fiber, tendons and bone
4	Limited gangrene	Necrosis at the level of the toes or foot
5	Extensive gangrene	Foot necrosis with systemic signs of inflammation

Taking into account the characteristics of the angiographic study, localization and degree of damage to the vessels of the lower extremities, the following types of endovascular minimally invasive interventions were determined: balloon angioplasty (vascular dilation), stenting of stenotic vessels, recanalization of occluded vessels.

Active surgical interventions such as amputation of the lower leg, toes, and atypical foot resection were performed on the first day of treatment, and later, 4-5 days after angiographic intervention after eliminating blood flow to the affected portion of the limb vessels. The effectiveness of endovascular intervention was also taken into account. The choice of this tactic facilitated the most economical use of the amputating surgery with minimal removal of the lower limb, which made it possible to completely preserve the limb with the limitations of a necrotomy. Unlike the control group, patients in Group II underwent local treatment of lower limb wounds using a special device developed by us (patent for utility model).

No. FAP 20240005 fromJanuary 5, 2024) electroactivated solution-A (ERA-A). Abacterial environment was carried out in combination with the use of an aseptic dressing with 25% dimethyl sulfoxide solution and water-soluble Levomekol ointment under the dressing for 6 hours twice daily. On the day of presentation, patients in Group II underwent emergency surgery to open the purulent focus and debride the purulent cavity with an antiseptic 3% hydrogen peroxide solution. After drying, debridement was performed with a chemical solution of 25% dimethyl sulfoxide, followed by an abacterial environment using wound lavage with ERA-A solution (the technique is described in detail below in a separate subchapter).

During the second phase of wound healing, the abacterial medium was discontinued, the wound was debridement with electroactivated catholyte solution (EAR-K), Levomekol ointment was applied, and the wound was treated with wipes soaked in anolyte in combination with 25% dimethyl sulfoxide. The dressings were changed once daily.

In both groups of patients, prior to the use of antiseptics, wound fluid samples were collected from the wound using sterile pellets for microbiological analysis. Antibiotic therapy was administered based on the sensitivity of the wound microflora.

Method of preparation and application of electroactivated

aqueous solution.

To prepare the electroactivated aqueous solution, we used the Espero-1 apparatus developed in 1998 by S.A. Alekhin, an employee of the Tashkent Institute of Gas and the Central Asian Research Institute of Natural Resources. Espero-type bioelectroactivators are approved by the Pharmaceutical Committee of the Republic of Uzbekistan for the production of drugs used in clinical practice and have been widely used by staff at the V.V.

Vakhidov Research Institute and the clinics of Tashkent State Medical Institute No. 2 (Figs.

2.1, 2.2).

Bioelectroactivator ESPERO 1-is a medical portable submersible diaphragm electrolyzer.

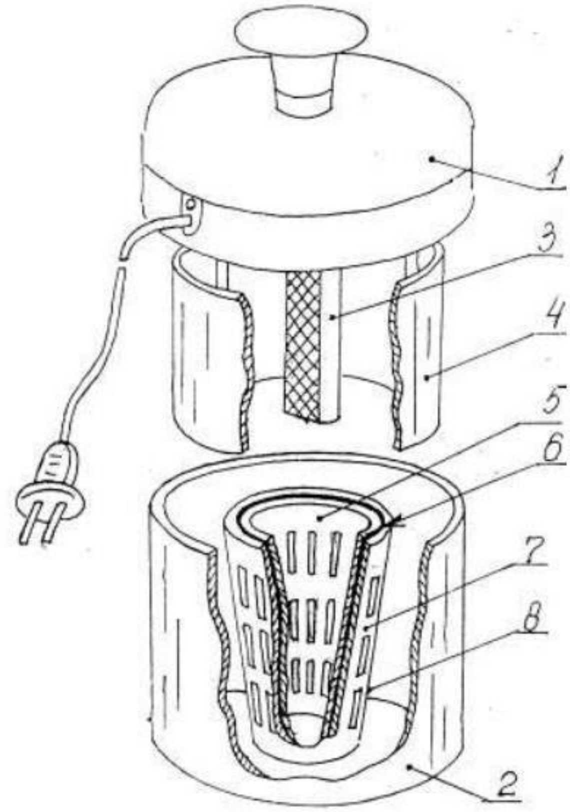

Fig. 2.1. Schematic representation of the Espero-1 apparatus

DEVICE DESIGN

"ESPERO-1" consists of a cover 1 with a built-in power supply unit, a container 2 for catholyte, in which the electrodes (anode 3 and cathode 4) are placed, and a container 8 for anolyte, consisting of two glasses 5 and 7, separated by a diaphragm 6. Base and body PSM-115 GOST 20282-86. Sleeve and insert - polyethylene ND GOST 16338-77. Diaphragm - natural tracing paper GOST 892-70. Anode 3 is made of high-quality chemically inert graphite MPG-7 TU 48-20-86-81. Cathode 4 is made of stainless steel 12X18N10T GOST 5632-72. A tracing paper wound three layers around the inner cup serves as a diaphragm, and cups 5 and 7 rotate until the slots align. The power supply consists of a limit switch that disconnects the device from the power supply when lid 1 is lifted, a paper capacitor, a rectifier, and a signal lamp. The positive terminal of the rectifier is connected to anode 3, and the negative terminal is connected to cathode 4..

WORK ORDER

To obtain EVR-K and EVR-A, lift lid 1 and fill containers 2 and 8 with tap water. Tap water can be preheated to 25-30ABOUTC. Pour and stir up to 9 grams of table salt into container 8. Close the device with lid 1 and connect to the power supply for the required time. The required time is selected from the table in the appendix.

EVR-K and EIVR-K are formed in tank 2, EVR-A in tank 8. After the time required for activating EVR has elapsed, the device is disconnected from the power supply, cover 1 is lifted, tank 8 is removed, in which EVR-A has formed, and EVR-K or EIVR-K remains in tank 2.

To obtain EIVR-K, other inorganic salts, such as calcium chloride, potassium chloride, and magnesium chloride, are added to container 8 instead of table salt.

Fig. 2.2 of the Espero-1 apparatus

The Espero-1 device will prepare 3 types of biologically active substances drugs:

1. Electroactivated solution – anolyte (EVR-A) is formed in the zone anode (graphite), the pH of which is from 7 to 1; ORP 0 +1200 mV

EVR-A (anolyte) has pronounced antimicrobial activity, antiinflammatory, antipruritic, anti-allergic action, antibacterial, drying, inhibitory properties, slowing down biological processes.

EVR-A (anolyte) is used to treat purulent processes, whitlows, paraproctitis, mastitis, purulent wounds, and postoperative abscesses, as well as to treat postoperative wounds to prevent infection. Anolyte is nontoxic and environmentally friendly.

2. Electroactivated solution – catholyte (EVR-K) is formed in the zone Cathode (stainless steel), pH from 7 to 12.8; ORP 0-960 mV. EVR-K is a powerful biological stimulator of reparative regeneration processes. It is used as irrigation, lotions, and rinses. EVR-K is non-toxic and harmless.

3. Electroactivated ionized solution - catholyte. (EIRS-

K) (electro-activated solution of inorganic salts) is obtained in the cathode zone of a bioelectroactivator, has pH parameters from 7 units to 10.5 units; ORP parameters from 0 to -400 mV. In medical practice, it is used for internal use.

Electroactivated ionized solution catholyte (EIVR-K) is an effective immunomodulatory agent with increased absorption and absorption activity. Electroactivated ionized solution catholyte is non-toxic and has no side effects.

TECHNICAL CHARACTERISTICS

Bioelectroactivator Espero 1

Productivity, l/h: pocatolite - 10.0

for anolyte - 1.8

Salt consumption per filling, g - up to 9.0

Hydrogen ion index, pH: for catholyte - 7-11.5

for anolyte - 7-2.54.

Oxidation-reduction potential, mV: for catholyte - up to -800

for anolyte - up to +1180

The amount of "active" chlorine, mg/l not less than

- 30.0 Current, A - 0.6 Voltage, V - 40 Power, W - 24

Table 2.3

Change in pH and ORP, "AX" from the time of electrical treatment of EVR-A,

in the bioelectroactivator Espero 1

No	Initial data	Indicator / Time electrical processing (minutes)	10	20	30	40	50	60
1	EVR-A Volume processed 30 liters of liquid, with concentration NaCl 1g/l in buffer zone 50 g/l Na2CO3 J=6A	pH, units	6.0	5.3	3.1	2.5	2.4	2.5
		ORP, mV	+ 800	+ 920	+ 1100	+ 1140	+ 1150	+ 1150
		"AH" mg/l	9.0	20.4	35.4	52.6	64.7	69.8

Table 2.4

Change in pH and ORP from the time of electrical treatment of EVR-K,

In the bioelectroactivator Espero 1

	Initial data	Indicator / Time electrical processing (minutes)	10	20	30	40	50	60
1	EVR-K Volume processed 30 liters of liquid, with a concentration NaCl 1g/l in buffer zone 50 g/l Na2CO3 J=6A	pH units	8.0	8.8	9.0	9.2	9.35	10.3
		ORP, mV	+ 100	- 100	- 400	- 720	- 730	- 800

To determine the pH of wound discharge, an indicator method with litmus was used.

Control parameters. Control for alkalinity Electroactivated aqueous catholyte solution (EVR-K) and electroactivated anolyte solution (EVR-A) were measured using a potentiometric method— an ion meter (pH meter) with a glass electrode with hydrogen function. The activity of the electroactivated solution can be monitored by measuring the oxidation-reduction potential (ORP) using instruments. Since not every patient has an expensive ion meter, the equipment is not available.

The ESPERO-1 is calibrated so that the parameters required for treatment are controlled by the water activation time specified in each specific instruction. The oxidation-reduction potential (ORP) of the electroactivated aqueous solution catholyte (EVR-K) system has a minus (-) sign, while the oxidation-reduction potential (ORP) of the electroactivated aqueous solution anolyte (EVR-A) system has a plus (+) sign.

Furthermore, to treat certain diseases with anolyte, it is necessary to measure the amount of "active" chlorine (hypochloride) using a standard method. The electroactivated anolyte solution (EVR-A) retains its properties for 15-20 days. The electroactivated aqueous catholyte solution (EVR-K) in an open container begins to lose its properties after 2-3 hours and completely loses them within 24 hours.

To prepare the electroactivated solution, instead of water, we used a sterile solution of 0.9% sodium chloride.

The device and method of using an abacterial environment. To solve the set problems, we used a device we invented for the treatment of purulent-necrotic wounds of the limbs.controlled abacterial environment Patent of invention No. FAP 20240005 fromJanuary 5, 2024

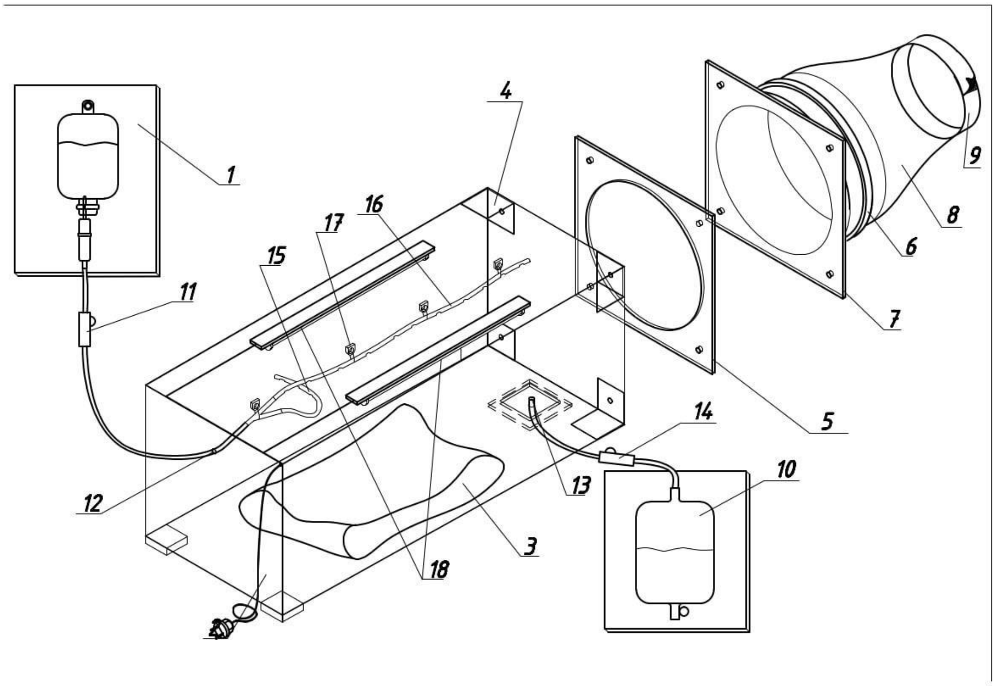

Fig. 2.3. Device for the treatment of purulent-necrotic wounds limbs in a controlled abacterial environment.

A device for treating purulent-necrotic wounds of the limb in an abacterial environment, where: 1 - a treatment chamber made of plexiglass 5 mm thick for holding an abacterial environment, 2 - trapezoidal chamber walls, 3 - a rear wall of the chamber measuring 250 x 250 x 5 mm_3, 4 - the front wall of the chamber; 5 - a through hole for fixing the elements; 6 - a rubber gasket; 7 - a ring-clamp made of stainless steel; 8 - a cover in the form of a truncated cone with an inlet and outlet holes made of artificial leather based on polyvinyl chloride; 9 - a rubber clamp for fixing on the limb; 10 - a corner made of plexiglass 5 mm thick with a through hole; 11 - a square stand; 12 - drain; 13 - a special container with a volume of 200 ml with a solution for performing lavage; 14 - a regulator of the flow rate of medicinal substances; 15 - a drainage tube with holes for distribution of medicinal substances; 16 - a drainage tube retainer in the form of a loop with a ring; 17 - a drainage tube for draining waste fluid; 18 - a tap for monitoring the draining of waste fluid;

19 - a receiving bag for collecting waste fluid; 20 - source (lamp) ultraviolet rays; 21 - 220 V power source; 22 - silicone cushion for the limb; 23 - tee for drainage tubes.

Method of using the device. Fig. 2.4

After observing the basic principles of treating purulent wounds, such as opening the purulent focus, revision and sanitation of the purulent cavity with antiseptic solutions, and, if necessary, performing necrectomy as a local treatment for the purulent-necrotic affected limb, proceed to the next stage of treatment using the proposed device (Fig. 2.4). For this purpose, in the patient's room, ultraviolet ray sources (lamps) (20), installed on the assembled and pre-treated with medical solutions device, are connected for 3 minutes using a 220 V power source to create an abacterial environment in the chamber (1). The patient is placed on his back, and his affected limb is immersed through a cover (8) made of artificial leather based on polyvinyl chloride, made in the form of a truncated cone with inlet and outlet openings, into the chamber (1) of the device onto a special silicone pad (22). The limb is hermetically fixed in the thigh area with a rubber clamp (9) made on the cover (8), which is fixed with a clamp ring (7) made of stainless steel (7) through the through holes (5) of the front wall (4) of the chamber (1) and the rubber gasket (6) on the four corners (10) installed on the inner corners of the side walls (2). Using a 220 V power source (21), ultraviolet ray sources (20) are turned on in the chamber with the immersed limb to create an abacterial environment in it. From a special container (13), through a tee (23) along the drainage tubes (15) of the system, using a flow rate regulator (14), the medicinal substance is supplied to the affected areas of the limb (uniform lavage) for 6 hours. In parallel, using a tap (18) through a drainage tube (17) of the system, installed in an opening (5) of a recess (12) on the lower wall (2) of the chamber (1), the waste liquid is collected into a receiving bag (19). After 6 hours, the flow rate regulator (14) and the tap (18) for discharging the medication are closed. The used fluid is disposed of. The limb is released from the device, and an aseptic dressing is applied to the wounds. The device is used until signs of healing appear.

After each use of the device, its removable parts are disassembled and subjected to sanitization with disinfectants consisting of 1 part 5% sodium hypochlorite (disinfectant) diluted in 9 parts deionized water, and also, after drying, with ultraviolet rays of its own lamps for 30 minutes.

All patients were distributed by sex and age according to the classification of age groups adopted at the regional seminar of the World Health Organization (Kyiv, 1963)

Table 2.5

Characteristics by gender and age

Groups	**Age**								**All**
	20-44		**45-59**		**60-75**		**75 years and older**		
	Husband.	**Female**	**Husband.**	**Female**	**Husband.**	**Female**	**Husband.**	**Female**	
Comparisons	7 (12.5%)	4 (7.1%)	11 (19.6%)	8 (14.3%)	11 (19.6%)	6 (10.7%)	7 (12.5%)	2 (3.6%)	56
Main	6 (12.5%)	4 (8.3%)	7 (14.6%)	5 (10.4%)	12 (25%)	9 (18.7%)	4 (8.3%)	1 (2.1%)	48
Total	13 (12.5%)	8 (7.7%)	18 (17.3%)	13 (12.5%)	23 (22.1%)	15 (14.4%)	11 (10.6%)	3 (2.9%)	104

As can be seen from Table 2.5, in Group I there were 36 (64.3%) men and 20 (35.7%) women aged 29 to 78 years (mean age was 56.6-5.2 years). In

Group II, there were 29 (60.4%) men and 19 (39.6%) aged 28 to 79 years (mean age was 52.4-4.6 years). The majority of patients (66.3%) were of prime working age (from 38 to 60 years).

Upon admission, signs of general intoxication were prevalent: elevated body temperature or persistent subfebrile fever, pallor, reduced mobility, tachycardia with a weak pulse, elevated ESR, leukocytosis, and a leftward shift in the blood count. Along with the general symptoms, local manifestations of the disease were also present: hyperemia, swelling, and tissue infiltration in the affected area of the limb. During treatment, these signs of intoxication and the inflammatory response to the infection gradually returned to normal.

A detailed analysis of the obtained research results for each group of patients will be presented in the relevant chapters of the dissertation.

§ 2.2. Clinical and instrumental research methods

The examination utilized standard clinical, laboratory, and instrumental methods. Upon admission, careful attention was paid to collecting the patient's medical history. Information was obtained regarding pain, the duration of intermittent claudication, and the nature of the condition.

The pain was assessed based on the localization of pain while walking, the distance traveled without pain, pain at rest, its intensity, and whether it increased or decreased in a horizontal position and when lowering the leg from the bed. During examination, the skin color and the presence of visible trophic disorders were visually assessed: thinning of the skin, roughness and porosity of the nail plates, and the presence of trophic ulcers or necrosis. An objective examination included palpation of the lower extremity arterial pulsation at typical points and auscultation of the aorta, iliac, and femoral arteries. All patients in the control group underwent duplex angioscanning. Forty-five patients in the study group underwent angiographic endovascular diagnostics. The ankle-brachial index was calculated to determine critical limb ischemia. To determine endogenous intoxication, the leukocyte intoxication index was calculated (V.K. Ostrovsky (1983)).

All patients had multilevel occlusive-stenotic lesions in the arterial system of the extremity, including the femoral (general, superficial, and deep), popliteal, and crural arteries (anterior and posterior tibial, and interosseous). Based on clinical examination, further treatment was determined based on the vascularity.

Laboratory examination

Clinical blood test.

A complete blood count included determination of red blood cell count, hemoglobin content, and platelet count as screening tests; white blood cell count was determined using a Celloskop device. A white blood cell count was calculated using a visual microscopic examination of stained smears, which revealed the presence of a regenerative leukocyte shift, as evidenced by an increase in the ratio of band neutrophils to the total white blood cell count of more than 6%.

The leukocyte intoxication index (LII) was calculated using the formula of Ya.Ya. Kalf-Kalifu (1927):

$$LII- \frac{(4We-3Yu-2P-WITH)(Pl-1)}{(L-Mo)(E-1)}$$

where LII is the leukocyte intoxication index; Mi are myelocytes; Yu are young; P are band neutrophils; S are segmented neutrophils; Pl are Turk's plasma cells; L are lymphocytes; Mo are monocytes; E are eosinophils.

Bacteriological examination was carried out from two sources by collecting secretions from the soleus muscle, as well as from the wound bed tissue during surgery with qualitative and quantitative determination of wound microflora and its sensitivity to antibiotics.

To isolate anaerobic bacteria, we used the method proposed by V.I. Kocherovets et al. (1996) [65; pp. 144-146]. The starting material for microbiological studies was exudate from purulent wounds and washings from the stump during surgery. Part of it was immediately injected into a sterile transport bottle containing a mixture of a three-component gas: nitrogen (80%), carbon dioxide (10%), and hydrogen (10%). Part of the material was analyzed for aerobic content using the well method. Strict aseptic technique was followed during collection of research material.

The transport flask was delivered to the bacteriological laboratory. The fluorescent properties of anaerobes were studied under ultraviolet rays and sowing began immediately. To isolate pure cultures and quantitatively characterize the anaerobic microflora of the native material, sowing was performed on prereduced (kept for at least 1 day in a microanaerobic jar) dishes with anaerobic hemagar according to the method of T.S. Gould (1965) [130; pp. 36-48]. For this purpose, using a bacteriological loop with a diameter of 3 mm, the test material was inoculated onto the first sector of the Petri dish (30-40 streaks). After this, the loop was burned and 4 streak sowings were performed from the 1st sector to the 2nd, similarly from the 2nd to the 3rd, from the 3rd to the 4th-, burning the loop after reseeding each sector. The results were calculated using a special table. Kanamycin and nevigramon were added to the nutrient media to suppress enterobacteria and select for certain bacteroides. The culture dishes were placed in a domestically produced MK-752 microanaerobic jar, which was filled with a three-component gas mixture (nitrogen – 80%, carbon dioxide – 10%, and hydrogen – 10%) by purging the jar three times and evacuating the air with a vacuum pump to 1 atm.

To control anaerobiosis, a sterility control medium was placed in the microanaerobic jar, to which 2–3 drops of a 1% aqueous solution of methylene blue were added. Under anaerobic conditions, the medium becomes colorless. Upon contact with atmospheric oxygen, the upper layer of the medium acquires a greenish-bluish color. Trace amounts of oxygen and moisture in the microanaerobic jar were removed using silica gel. The microanaerobic jar was then placed in a thermostat for 48–72 h. After isolating a pure culture, facultative anaerobes were identified using the generally accepted method of M.O. Birger (1982) [21; p. 182], as well as using the Eterotest I and II system (Czechoslovakia), and obligate anaerobes were identified using anaerodisks and studying their biochemical activity.

The sensitivity of aerobic bacteria was determined by the diffusion method from standard disks on a dense nutrient medium, and that of anaerobic microbes was determined by the diffusion method in agar using wells with antiseptics.

The degree of endogenous intoxication was assessed by medium volume molecular weight peptides (MMWP) using spectrophotometry at a wavelength of 210 nm.

To assess the condition of the arterial bed in patients, ultrasound duplex and triplex angioscanning was used using the VIVIDE60 (USA) system. 2-3.5 MHz transducers were used to visualize the arteries of the iliofemoral segment, and a transducer was used for arteries located below the level of the inguinal ligament. 5-10 MHz. The advantage of this method is the ability to non-invasively obtain a real-time image of a vessel with recording of the Doppler curve in a selected section of the vessel in any plane. This method allows one to determine the vessel diameter and wall thickness, the level and extent of occlusion, as well as assess the condition of the collateral vascular bed and hemodynamic parameters—linear and volumetric blood flow velocities, and resistance indices [68; pp. 128-130].

Fig. 2.5. VIVIDE60 view

The most informative and screening indicator is the ankle

- brachial index (ABI). ABI is calculated as the ratio arterial systolic pressure in the anterior or posterior tibial artery to this indicator in the brachial artery. Normally, the ABI is 1.0. For inclusion in the study, the ABI values of 0.3 and below were used [112; p. 53]. Amputation is recommended where systolic pressure is higher than 30 mm Hg, and the regional systolic pressure index is 0.3 [34; pp. 164-175]. One of the objective indicators for assessing the degree of ischemia is

the value of the resistance index (RI) - the Pourcelot index. The lower the RI value, the more severe the CAD 2004 [5; pp. 45-49].

Angiographic examination

Rice. 2.6. View PHILIPS Allura Centron

Contrast-enhanced angiography remains the gold standard for diagnosing occlusive arteries. It allows for the precise determination of the location, extent, degree, and nature of stenosis, as well as the multiplicity of occlusive lesions in the main arteries of the lower extremities, and the assessment of the collateral circulation. The study was performed using the PHILIPS Allura Centron system (Netherlands), Fig. 2.6, via Seldinger catheterization of the femoral or brachial artery.

The essence of the technique for performing catheterization through the brachial artery was as follows.

Technique of brachial artery catheterization:

Indications for brachial access include: occlusion or severe lesion of the aortofemoral segment, planned surgical procedures interventions on the femoral arteries, pseudoaneurysm or hematoma of the femoral artery, infection or wound in the groin area, operator preference, especially in operations on visceral arteries or during stent graft placement, when several approaches are required simultaneously. Contraindications: occlusion or severe lesion of the brachial or axillary artery, the presence of diseases of the aortic arch and its branches. Another contraindication is the inability to reach the target vessel due to the length of the instrument - lesions located below the level of the popliteal artery. The most significant advantage of the brachial approach is its convenience during interventions on visceral arteries, which are most often oriented caudally [129]. Stages. The patient's arm is extended and placed on the table in a position of full supination. The cubital fossa is prepared and covered. Before the intervention, the pulse in the radial and brachial arteries, as well as the blood pressure in both arms, are measured and recorded. The brachial artery is punctured a few centimeters above the elbow at the point of highest pulsation, as this allows the artery to be compressed against the humerus, which is important for hemostasis.

Anesthesia is administered with 3-5 ml of 1%-2% lidocaine. After a small incision with a scalpel and gentle dilation, the anterior wall of the artery is punctured at 18-21G and a guidewire is inserted. This procedure is best performed under direct ultrasound guidance, which allows for monitoring of the guidewire's free passage within the arterial lumen and avoiding nerve damage during puncture [48]. An introducer sheath is then inserted along the guidewire.

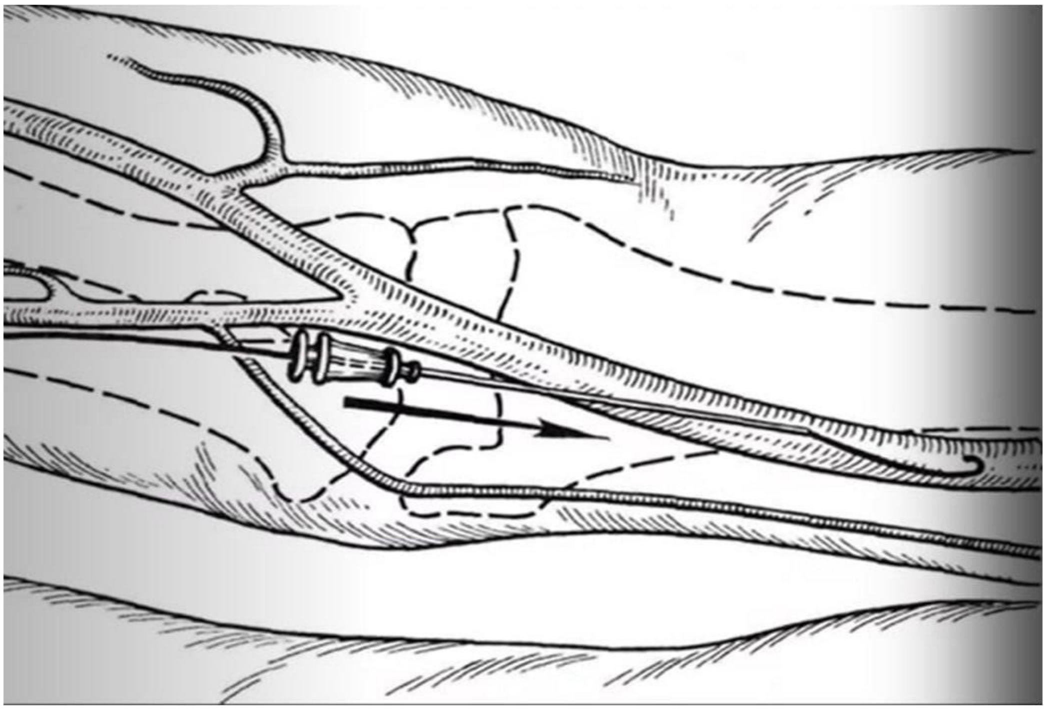

Fig. 2.7 Technique for performing a BA puncture

The technique of catheterization through the femoral artery was as follows.

The first step involves identifying a preliminary puncture site located at the intersection of the BA pulse line and the inguinal skin fold. This site is marked with a radiopaque instrument (puncture needle, clamp) (Fig. 2.7). Under fluoroscopic control (one frame is sufficient), the preliminary puncture site and the mid-BA level are determined. The second step involves adjusting the puncture site, attempting to position it at the midBA level. It should be noted that, as a rule, a cranial shift of 1–2 cm is required. The new puncture site position is also verified fluoroscopically. In most cases, these two steps are sufficient to determine the puncture site on the skin, at the mid-BA level. Puncture at the selected point allows catheterization at the level of the BA.

The femoral vein is punctured at the inguinal ligament. A large 1.2 mm diameter needle is used. For ease of manipulation, the needle is attached to a syringe. The middle and index fingers of the left hand are used to feel the pulsation of the vessel wall. The needle is inserted between the fingers, bevel down.

"The needle is directed at a slight angle toward the skin, avoiding puncturing the opposite wall. As soon as the needle penetrates the artery, blood is forced into the syringe under high pressure. After this, the syringe is disconnected and further necessary procedures (transfusion, catheterization) begin."

Introducers are designed for percutaneous insertion into a vessel to provide access and facilitate invasive interventions. Characteristics:

• TiF: optimal conical tip shape, smooth shaft-dilator transition, ensures smooth introducer insertion

• Three-way hemostatic valve ensures hemostasis, preventing bleeding and air aspiration
• Thin radiopaque shaft wall with anti-kinking sleeve provides excellent catheter manipulation
• A special design of the dilator attachment with a latch prevents the dilator from shifting during insertion and allows the dilator to be manipulated with one hand.

PTCA Guidewire 0.014", 0.010" Conical Tip (2cm), (conical part 3 cm), (SION TECC core) –

- Stainless steel core + Composite core (rope
ACT ONE coil, round core)
- spring coil 16 cm

- COATING: 17 cm hydrophilic coating (SLIP-COAT) - COVER: polymer shell 17 cm.
- TIP LOAD: 1.0g (regular older Fielder

XT 0.8 g)

- X-RAY SEGMENT: 16 cm

Available in 190 and 300 cm, straight tip, green shaft color PTFE coating

- PTCA Guide 0.014" Stainless Steel DURASTEEL, core to tip construction, parabolic technology core grinding
- COATING: Hydrophilic coating
- COATING: Full hydrophilic polymer coating
- TIP LOAD: 4.1 g
- X-RAY SEGMENT:
- radiopaque segment 3 cm, gold marker located at 4.5 cm from the tip

Available in 190 and 300 cm, straight and with a J-shaped tip The following drugs were used as a contrast agent:

Unigexol "350." The study results were stored both as X-ray films and digitally. The study allowed us to determine the anatomical features of the arteries in the extremities and the localization of occlusion zones.

§ 2.4. Statistical processing of material

Statistical processing of the quantitative study data was performed using parametric and nonparametric analysis methods. Microsoft Office Excel 2010 spreadsheets were used to collect the database and organize the information, as well as adjust it if necessary. IBM SPSS Statistics v.23 (IBM Corporation) was used for statistical analysis. Differences in qualitative indicators between the compared groups were determined using χ2 tests. When analyzing four-field tables, the χ2 test was used if the expected values in each cell were 5 or more.

In cases where the expected phenomenon was observed less frequently in one cell 5, Fisher's exact test was used for analysis. Differences were considered statistically significant at $p < 0.05$.

Quantitative indicators were assessed for sample distribution normality using the Shapiro-Wilk test (for $n < 50$) and the KolmogorovSmirnov test (for $n > 50$). After assessing the sample distribution normality for describing quantitative indicators, variation series were generated from the data, which were used to determine the mean (δ), standard deviation (s), and standard error (m), with a 95% confidence interval.

To compare the mean values of selected series of independent sets of quantitative data, Student's t-test was calculated. The obtained result was evaluated by comparing it with critical values. If the significance level calculations were calculated at $p < 0.05$, the differences in the indicators were considered statistically significant. In the absence of evidence of normal distribution of the sample data, the Mann-Whitney U-test was used for comparative analysis.

Comparison was made between critical values and the Mann-Whitney U-test at a given significance level. If the obtained U-value was≤ critical, then in this case the statistical significance of the differences was recognized.

CHAPTER III. EVALUATION OF THE EFFECTIVENESS OF TRADITIONAL TREATMENT OF DIABETIC FOOT SYNDROME IN PATIENTS WITH CRITICAL ISCHEMIA OF THE LOWER EXTREMITIES (Group I) n=56)

When determining the tactics of surgical treatment of patients in the first control group, we focused mainly on the severity of the purulent necrotic process, relying on the Wagner classification (see Chapter II).

The results of treatment of 56 patients with diabetic foot with critical ischemia of the lower extremities were analyzed. Angiographic studies and local treatment without the use of an abacterial environment were used to determine the diagnosis and treatment tactics..

The general condition of the patients in most cases upon admission was moderate to severe: they all complained of constant pain at rest, trophic ulcers, gangrene of the fingers or feet, numbness, general weakness, malaise, thirst, and an increase in body temperature to 39o From and above. All patients had pronounced signs of general

intoxication: high hyperthermia, increased heart rate (tachycardia) up to 110 beats per minute and higher, dry tongue and skin (signs of hypovolemia), and constipation in most patients. Impaired sensitivity in the affected limb was noted: 35 (62.5%) patients with affected areas of the foot experienced complete loss of sensitivity and local hypothermia of the limb, hyperemia, and swelling of the skin tissue around the ulcerativenecrotic skin defect..Duplex angioscanning of the vessels of the affected lower extremities in most cases revealed: in the a. poplitea, the patency of the vessels with a critical decrease due to stenosis. a. tibialis posterior, a. tibialis anterior, a. dorsalis pedis.

As noted in Chapter II, when assessing purulent-necrotic lesions of the limb, we followed the classification proposed

Wagner (1979) The distribution of patients in the control group according to this classification is given below.

Table 3.1

Distribution of patients by degree of damage according to Wagner

Group sick	0	I	II	III	IV	V	Total
I.gr comparisons	-	-	-	14 (25.0%)	20 (35.7%)	22 (39.2%)	56

As can be seen from Table 3.1, most patients had grade IV-V limb damage (Wagner). Treatment of patients with purulent-necrotic limb lesions involved a team of specialists: a purulent surgeon, a vascular surgeon, an endocrinologist, a general practitioner, and an anesthesiologist-resuscitator.

An analysis of the duration of purulent-necrotic foot lesions (PNFL) before admission to the clinic in the comparison group revealed that of 56 patients (100%), 26 (46.4%) were admitted 30 days or later after disease onset. Thirty-one (55.3%) patients presented to our clinic from other medical institutions due to treatment failure. Most patients with grades IV-V limb lesions showed signs of intoxication upon late admission (Figure 3.1).

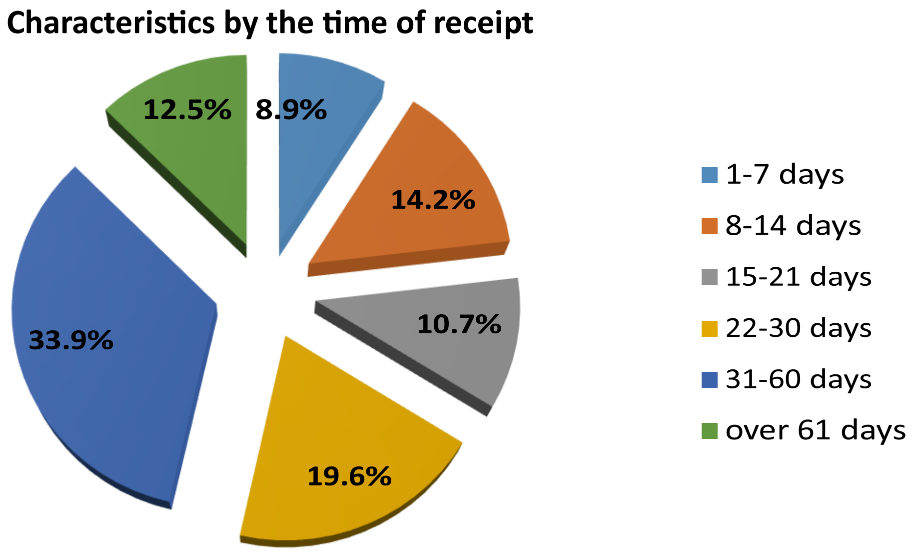

Fig. 3.1. Characteristics of patients in the comparison group by time period receipts

When assessing purulent-necrotic lesions of the limb in patients of the control group, it was revealed: in most cases, patients had lesions of the first finger 5 (8.9%), I-II fingers 6 (10.7%), sole 10 (17.8%), foot 11 (19.6%) and shin 5 (8.9%). In the remaining 19 (33.9%) patients, lesions were observed of the second finger - 3 (5.3%), third finger - 5 (8.9%), IV finger - 4 (7.1%), V finger - 7 (12.5%) fingers of the limb..

Preparation for surgery began with an assessment of metabolic and electrolyte disturbances and their correction.

All patients, regardless of diabetes mellitus type (DM), were switched to short-acting insulin using the "intensive insulin therapy" principle. Intensive insulin therapy included frequent (more than 3 times daily), subcutaneous or intravenous administration of small doses (8-10 units) of short-acting insulin with careful glycemic monitoring throughout the day. In severe cases, combined insulin administration (intravenous and subcutaneous) was used. Alpha-lipoic acid preparations formed the basis of pathogenetic therapy.

In the absence of contraindications, all patients were prescribed intravenous heparin drip up to 50-60 thousand units per day.

Symptomatic treatment included:

- non-steroidal anti-inflammatory drugs - clodifen (under monitoring of kidney function);
- tricyclic antidepressants for effective reduction painful manifestations;

- medications containing B vitamins. Antibacterial therapy was prescribed for soft tissue infections of the foot. The choice of medication for antibacterial therapy was based on the following factors: microflora sensitivity, safety, and availability. Antibiotic therapy was administered using stepwise therapy.

The complex of conservative measures also included treatment of concomitant diseases and correction of blood rheology disorders. Indications for emergency surgical interventions were primarily wet gangrene of the toes and feet, cellulitis of the foot, cellulitis of the foot with inflammation extending to the lower leg, and severe intoxication posing a threat to the patient's life. In such cases, surgery was usually performed with the aim of saving the patient's life.

Indications for urgent surgical interventions were: purulent-necrotic wounds that do not have adequate drainage - deep abscesses of the foot with distant septic metastatic foci, newly formed abscesses and poorly drained purulent leaks.

When choosing a general anesthesia method, it was essential to achieve the most complete blockade possible of the body's stress response, which leads to the release of counter-regulatory hormones and increased blood glucose levels. Intubation anesthesia was used in patients with severe multiple organ failure. Lower limb surgeries were performed under regional anesthesia according to A. Yu. Pashuk (1987) or conduction epidural anesthesia.

The results of a study of patients in the control group by localization of the purulent-necrotic process showed that the pathological process in the area of the first toe was characterized by a more malignant course, especially when it was affected in combination with other toes, than when other toes or their combinations were affected. This is due to the topographic and anatomical features of the first toe.

The diabetic anamnesis revealed that among 56 patients in the comparison group, diabetes mellitus was diagnosed for the first time in 5 (8.9%).These patients learned about their illness only after being admitted to our clinic due to diabetic gangrene of the lower limb (Table 3.2).

Table 3.2 Duration of diabetic history

Duration diseases (diabetes mellitus)	Absolute number	%

First identified	5	8.9
up to 1 year	9	16.1
1-3 years	8	14.2
4-5 years	12	21.4
6-10 years	13	23.3
10 years or more	9	16.1
Total	**56**	**100%**

As Table 3.2 shows, in most patients the duration of diabetes mellitus before admission ranged from 4 to 10 years.

A study of the microflora of purulent necrotic wounds in patients in the control group revealed the following: as shown in Table 3.3, 64 strains of aerobic microflora were detected in the 56 patients examined in the comparison group. Staph. aureus (45.3%) and Proteus spp. (26.5%) were isolated in most cases. The prevalence of Streptococcus and E. coli was 18.7% and 10.2%, respectively.

Table 3.3

Species composition of the aerobic microbial association from the wound group comparison, patients n=56

Aerobes	Number of strains	IN %
S. aureus	29	45.3
Proteus spp.	17	26.5
Streptococcus spp.	12	18.7
E. coli	6	9.3
Total	**64**	**100%**

It should be noted that in order to maintain synchronicity of the different groups in our study, patients with anaerobic infections were not included in the studies.

The next criteria for assessing the patients' condition were indicators of general intoxication. Their dynamics are reflected in Table 3.4.

Table 3.4

Dynamics of changes in intoxication indicators in patients of the group comparisons (n=56)

Show tel	Nor Ma	Day				
		The first ones day	3 days By	Day 7 By	Day 9 By	Day 12 By
t₀bodies	36.6	39.5±0.04	39.2±0.04***	37.9±0.04***	37.2±0.04***	36.7±0.04***
Lblood	6.0	10.8±0.23	10.5±0.12***	9.6±0.14***	8.6±0.06***	6.7±0.03***

MSM	0.120	0.317±0.009	0.288±0.004***	, 187±0.006***	0.136±0.004***	0.111±0.003***
LII	1.2	3.6±0.05	2.9±0.05***	2.4±0.06***	1.9±0.04***	1.2±0.02***
ESR	10	52.5±1.66	44.5±1.2***	30.8±0.92***	18.4±0.89***	14.1±0.13***

Note: * - differences relative to the indicators of the previous day of treatment are significant (*** - P<0.001).

On the first day of treatment, the body temperature of patients was on average 39.5±0.04$_0$C. The white blood cell count was equal on average 10.8±0.23·10$_9$/L. The average volume of medium-sized molecules was 0.317±0.009 units. Similarly, an increase in LII and ESR was noted to 3.6±0.05 and 52.5±1.66, respectively. Elevated levels of MSM, L, LII, and ESR indicated severe endotoxicosis in this category of patients.

On the third day of treatment, a slight decrease in body temperature data was noted from 39.5±0.04$_0$From up to the level of 39.2±0.05$_0$With the number of leukocytes in the blood decreased, on average, to 10.5±0.12·10$_9$/l. The blood MSM content decreased to 0.288±0.004 units. Changes in LII indicators by the 3rd day of treatment also tended to decrease from 3.6±0.05 to 2.9±0.05 units. At the same time, ESR decreased, on average, to 44.5±1.2 mm/g.

By the seventh day of treatment, the examined patients in the comparison group with GNSS continued to have a slight subfebrile temperature (37.9±0.04$_0$C). At the same time, according to the indicators of intoxication of the body: L, MSM, LII and ESR of the blood, a further decrease was noted, that is, there was a tendency towards normalization - 9.6 ± 0.14, 0.187 ± 0.006, 2.4 ± 0.06, 30.8 ± 0.92, respectively.

It should be noted that during the treatment process, with the normalization of all other indicators of intoxication, the ESR of the blood tended to slowly normalize.

In parallel with the above indicators, we studied clinical and biochemical tests when assessing the effectiveness of the therapy.

A study of blood sugar levels showed that at the time of admission to the clinic, on average, it was 13.8±2.3 mmol/l.

Elimination of the purulent-necrotic focus and intensive therapy carried out in the postoperative period contributed to a decrease in blood sugar levels to the upper limit of normal only by the 14th-15th day of treatment.

The functional state of the vessels was studied using duplex angio scanning, by determining regional MCC and MDS. Examination of the popliteal and posterior tibialis vessels was performed on the day of admission. showed that MCC and MDS were significantly below the norm – 30.5-1.2 and 2.2-0.16, respectively.

To determine the surgical treatment strategy for the control group of patients, endovascular X-ray contrast imaging of the leg and foot vessels was performed. Based on the angiographic findings, the method of choice for endovascular minimally invasive surgical intervention to eliminate blood flow to the affected vessel was determined. In this case, we took into account the anatomy of the leg and foot vessels and their lumen at various levels of the foot. To differentiate the approach to endovascular surgical interventions based on vessel size, we followed the principle of dividing the vessels of the foot into three levels, proposed to our clinic by Nazarov Zh.R. (2022)

Level I –**top level**From the middle segment of the femoral artery to the level of the popliteal artery. The lumen of the vessels is up to 4.0-4.5 mm.

(number of patients)

Level II –**average level**foot. (Peroneal, anterior and posterior tibial arteries). The lumen of the vessels is up to 2.5-3.0 mm.(number of patients)

Level III –**distal level**feet. The lumen of the vessels is up to 1.5-2.0 mm. Arcuate, dorsal, metatarsal arteries, medial and lateral plantar arteries of the foot.

The primary diagnostic method for assessing vascular condition was X-ray contrast angiography. Angiographic studies were performed after appropriate preparation under local anesthesia in the angiography room. A detailed methodology is provided in Chapter II.

In the absence of contraindications, all patients were prescribed intravenous heparin drip up to 15-20 thousand units per day or other anticoagulants (Clexane 0.6, 0.8, Enoxaparin 0.6, 0.8, Fraxiparin 0.6, 0.8.
subcutaneously)

All surgical operations were performed on an emergency basis, after appropriate preoperative preparation.

The distal calf arteries were examined with the patient lying supine with the knees slightly bent and the legs slightly apart. To visualize the distal calf arteries, the transducer was positioned along the lower third of the leg and slightly posterior to the medial malleolus. The distal calf arteries were located along the lower third of the leg along the anterior surface, along the projection of the extension of an imaginary line drawn between the first and second toes of the dorsum of the foot.

The diagram of the sensor location during the examination of the distal sections of the tibial arteries (A) and the ultrasound image of the posterior tibial artery (B) are shown in Fig. 3.2

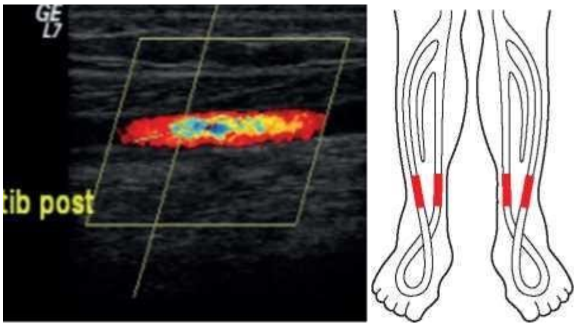

Fig. 3.2. Diagram of the sensor location during ultrasound examination.

Examination and measurement of blood flow parameters of the peroneal artery (PA) become relevant in the presence of chronic ischemia of the lower extremities or stenotic lesions of the tibial arteries in the patient. When visualizing, the MBA was performed along the medial surface in the middle third of the leg.

When ultrasound signs of lower limb ischemia were detected in a patient, the ankle-brachial index (ABI) was measured.

Measurement of ABI is a reliable and effective method for quantitative assessment of the blood supply to the limb calculated using the formula:

ABI = systolic tibial artery blood pressure/brachial artery systolic blood pressure.

Systolic pressure was determined using a tonometer with a pneumatic cuff and a linear ultrasound transducer placed at the location of the SBMA and PBA. If the latter was occluded or could not be clearly located due to damage, the SBMA or MBA were used.

Measurements were taken symmetrically on both arms and legs. The sensor was placed alternately at the locations of the indicated arteries, and pressure was applied to the cuff until the Doppler signal in the vessel disappeared. Upon slow cuff decompression, the first beat of restored blood flow corresponded to the systolic blood pressure in the vessel.

It was taken into account that a normal difference of up to 12-15 mmHg in blood pressure between the arms is acceptable. If the blood pressure readings differ significantly between the arms, a stenotic lesion of the subclavian or axillary artery on the side with the lower blood pressure reading should be suspected. In this case, the blood pressure reading from the arm with the higher reading is used to calculate the ABI.

Typically, ankle pressure is 10-15 mmHg higher than brachial pressure, and the normal ABI systolic pressure is greater than 1.0. ABI values below 0.9 are considered abnormal. The index correlates with the stage of the lesion and the clinical presentation of lower extremity ischemia:

Results of X-ray angiographic interventions.

Contrast angiographic examination revealed vascular lesions in the subgenicular artery and level I foot vessels in 29 (51.7%) patients of Group I (peroneal, anterior and posterior tibial arteries). Stenosis and occlusion at level II foot vessels (dorsal, medial plantar artery of the foot) were observed in 13 patients (23.2%). Vascular lesions in the form of stenosis and occlusion up to level III foot vessels were observed in 14 (25.0%) patients..(Fig. 3.3, 3.4, 3.5)


Fig. 3.3


Fig. 3.4


Fig. 3.5

A-first level, B-second level, C-third level, occlusions

The method of angiographic diagnostics and endovascular interventions was carried out according to the principle described in detail in Chapter II.

Of the 29 patients with level I lesions of the foot, 14 (48.2%) patients underwent stenting of the vessels of the middle segment of the femoral artery to the level of the popliteal artery..The indication for stenting of these vessels was: the occurrence of residual stenosis of vessels up to 45-50% (after) transluminal balloon angioplasty (Fig. No. 3.6).

Fig. 3.6 Angiography. Patient S. SDS with critical ischemia of the lower limb, 90% stenosisvessels of the middle segment of the femur arteries to the level of the popliteal artery.

Methodology for stenting of lower extremity vessels. Stenting of the affected vessels of the foot was performed using self-expanding With stents, which are more flexible than balloon-expandable stents. Stenting is not a standalone angioplasty technique and is used in cases of residual stenosis of up to 45-50% after balloon dilation or to correct complications of percutaneous transluminal balloon angioplasty (PTBA) such as intimal dissection.

The essence of stenting of the vessels of the lower extremities: after the first stage of the angiographic examination, the second stage of recanalization of the artery of the lower extremities is carried out. A conductor is inserted through the conductor

A stent is inserted into the narrowed area of the artery. To ensure better adhesion, the stents are inflated with a balloon after insertion.

Self-expanding stents are preferred for extended lesions, tortuous vessels, and areas of expected external impact, such as flexures and twisting. They are ideal for femoropopliteal lesions but have high compliance. These stents are made of shape-memory metal and, when deployed, occupy the free lumen. Abbott's self-expanding Supera stent is highly resistant to kinking and adapts to knee joint movements and natural deformations. A disadvantage of this device is difficult-to-control delivery and, potentially, significant trauma to the intima. The nonrandomized SUPERB study evaluating the use of Supera stents yielded promising results, but the advantage of these types of stents over conventional nitinol stents needs to be confirmed in additional large randomized trials. Correct (adequate) stent positioning in the proximal and distal popliteal artery determines early and long-term patency. When performing angiography with the limb straightened, the result can be excellent, however, when the limb is flexed, the stent can cause excessive kinking of the artery, which leads to trauma to the intima and rapid progression of restenosis. The proximal end of the stent should reach the adductor canal, the distal end - 2-3 cm above the level of origin of the anterior tibial artery or, optimally, go into it or the tibioperoneal trunk. To control the position of the stent, it is recommended to perform angiography with the limb flexed at the knee joint. Performing isolated angioplasty of the popliteal artery can ensure its short-term patency, and with severe calcification, fragmentation of the atheroma often occurs and subsequently, when the limb is flexed, it may

Stenosis, embolism, and arterial occlusion may develop. Therefore, TLBAP without subsequent stenting is only acceptable for discrete stenoses without significant arterial calcification. The results of TLBAP should also be assessed using dynamic angiography.

Taking into account all the above-mentioned features of well-known stents, we prefer the MagicTouch stent with drug-eluting Sirolimus, developed by Tavimedical (2020, India), which is free of the abovementioned disadvantages and, in our opinion, is more optimal for stenting of foot vessels.

Of the 29 patients with level I vascular lesions in the foot, 15 (51.7%) underwent balloon angioplasty followed by stenting of the affected vessels due to chronic lower extremity ischemia caused by occlusivestenotic lesions of the arteries of the foot. Balloon angioplasty was performed to perform the procedure. Subsequently, stenting of the affected areas was performed using the above-mentioned technique.

Methodology for performing balloon angioplasty (dilation) of vessels of the lower extremities.

Balloon angioplasty of stenotic vessels of the lower extremities was performed using a 5th generation drug-eluting balloon angioplasty device, Sirolimus.

Characteristics of drug-eluting balloon angioplasty— This is the world's first sirolimus-coated balloon using unique nanotechnology. Submicron sirolimus particles encapsulated in phospholipid are sprayed onto the balloon with low inflation, then refolded and re-inflated, ensuring 100% coverage of the balloon surface with the phospholipidcontaining sirolimus. When injected into an artery, this phospholipid is transported into the artery, and as the body's pH changes, the phospholipid releases the submicron sirolimus particle, which, after 7 days, penetrates the deepest layer of the artery, down to the adventitia.

The essence of the balloon angioplasty technique is as follows: After the first stage of angiographic examination, under fluoroscopy and angiographic control, guidewires are inserted through narrowed and occluded areas of the arteries of the lower extremities to the affected area in the foot. Balloon catheters (tubes with a polyethylene balloon at the end) are inserted through the guidewire under high pressure to expand the arteries in areas of occlusion and stenosis. A catheter with a small balloon at the end is inserted into the narrowed area and inflated under a certain pressure, achieving arterial patency. If this is not achieved, a metal frame—a stent—can be placed in the narrowed area to maintain arterial patency (Figs. 3.7, 3.8, 3.9).

Fig. 3.7.Before recanalization

Fig. 3.8.During recanalization

Fig. 3.9. After recanalization

As noted above, 13 (23.2%) of the 56 patients underwent stenting of the affected vessels, including 5 (38.4%). Eight (61.5%) patients underwent vascular recanalization with balloon angioplasty, as indicated. For this purpose, recanalization was performed after determining the level and extent of the vascular lesion (Figs. 3.10, 3.11).

Fig. 3.10.Balloon angioplasty **Fig. 3.11.After balloon angioplasty**

Fig. 3.12(before endovasculatory intervention) Fig. 3.13(after endovasculatory intervention)

Reconalization of vessels living limbs carried out in by the following method:

Stage 1 After that, as a patient

The patient was taken to the angiography room, and the doctor treated the site of the proposed vessel puncture with an antiseptic solution based on iodine or ethyl alcohol. Under local anesthesia, a percutaneous vessel puncture (antegrade and contralateral) was performed. The doctor warned the patient in advance about any allergic reactions to iodine, chlorhexidine, ethyl alcohol, or local anesthetics.(novocaine, lidocaine)or other medications.

Stage 2. Catheterization of the orifice of the contralateral SFA was performed in In each individual case, different special catheters were used. For a bifurcation angle of 90 degrees, a Cobra catheter was used. For an acute bifurcation angle, a Hook catheter was most convenient. For tortuosity of the aorta and iliac vessels, an Omni or Shepherd-Hook catheter was used. A special 5F catheter (Cobra, Hook, Omni, Shepherd-Hook) was inserted into the bifurcation zone. Then, into the opposite common iliacsh A guidewire was advanced through the common femoral artery, followed by a catheter or long introducer. Catheterization of the contralateral SFA was performed with particular care to avoid damaging the atherosclerotic plaque. A 0.035" hydrophilic guidewire, 190 cm long (Terumo, Japan) or a soft guidewire was advanced distally to the common femoral artery. The diagnostic catheter was advanced to the lesion. Then the guidewire

The sheath was replaced with an ultra-rigid 0.035" sheath (Amplatz "Boston Scientific", SupraCore "Guidant", USA), which provides good support during axial insertion of the guide sheath and avoids artery damage. After positioning the sheath over the stenosis area, control angiography was performed.

Stage 3. The introducer guide was advanced until it reached the middle segment of the SFA on the opposite side. During recanalization distal sections of the arteries of the leg were used conductors with a diameter of 0.014 inches "Pilot". The conductor is not passable on its own. occlusive part of the artery. Support is required to pass the guidewire. which is carried out by a cylinder (Mozec 2.0x20.0mm). For restoration cross-country ability arterial riverbeds, patients performed transluminal balloon

diameter 2.0, cylinders (MagicTouch. ConceptMedical) with a length from 30 to 210 mm, 2.5, 3.0 mm depending on the detected extent of the narrowing (in the main group). The diameter of the balloon corresponded to the diameter of the operated section of the artery.

Ten patients with level III vascular lesions of the foot (arcuate, dorsal, and metatarsal arteries) underwent reconalization with balloon angioplasty in four (40%) patients. In six (60%) patients, due to severe chronic lower extremity ischemia caused by occlusive-stenotic lesions of level III arteries, reconalization of the affected vessels was limited.

Fig. 3.13, 3.14 Before reconstruction Balloon angioplasty

Fig. 3.15 During reconalization Fig. 3.16 After balloon angioplasty

Before After (Fig. 3.17, 3.18)

Analysis of the treatment results of the control group of patients revealed the following statistical data: Table 3.4.

Of the 56 patients examined in Group I, amputation at the level of the lower leg was performed in 1 (1.7%) patient. In this patient, the primary reasons for the amputation were severe (Wagner grade V) lesions of the lower leg and foot tissues prior to admission. Despite the elimination of blood flow to the occlusive vessels of the lower leg and foot, due to failure to restore limb tissue viability, amputation at the level of the upper third of the lower leg (Mitisch method) was performed within 3-5 days of treatment.

Table 3.4

Evaluation of the results of surgical treatment in patients of group I

No.	Indicators	Number of patients	%

	Amputation at the hip level	1	1.7%
1.	Amputation at the level of the leg	11	19.6%
2.	Atypical foot resection	14	25.0%
3.	Finger amputation	19	33.9%
4.	Necrectomy	11	19.6%
5.	Reamputation	3	5.3%
6.	Suppuration of the postoperative stump	9	10.7%
7.	Mortality	3	5.3%
8.	Average bed day	9.8 :1.1	

Fatal outcomes were observed in three patients admitted late in the disease with Wagner grade V lesions. Two of these patients were elderly (64 and 68 years old). One had a history of myocardial infarction a year earlier. Despite comprehensive detoxification and specific treatment, they died by day five due to severe intoxication and multiple organ failure.

Taking into account the degree of damage, level and localization, data from objective, subjective studies, as well as the results of duplex angioscanning according to indications, out of 56 examined patients of the control group, amputation at the level of the lower leg was performed in 11

(19.6%), atypical resection of the foot in 14 (25.0%), amputation of the fingers in

19 (33.9%), necrectomy in 11 (19.6%) patients (Fig. 3.19, 3.20, 3.21, 3.22)

Fig. 3.19 Amputation at the level of the shin

Fig. 3.20 Atypical resection of the left foot

Fig. 3.21. Amputation of the toes

Fig. 3.22. Necrectomy

So, V ours research were observed, next unsatisfactory results; suppuration of the postoperative wound in 9 (10.7%) patients, of which 3 (5.3%) resulted in forced reamputation of the leg.

The average duration of treatment for patients in group I was 9.8±1.1 days.

Clinical example. Patient A.K.1978, case history number 852/95, hospitalized on August 24, 2033. Complaints upon admission of severe pain, swelling, hyperemia of the left foot, the presence of blackening of all fingers and feet, increased $t_0$body up to 38.9_0With, general weakness, dry mouth, decreased appetite. According to the patient, he has been ill for the last 12 days, the disease is associated with diabetes mellitus, which he has been suffering from for 10 years. After examination, the diagnosis was: Obliterating atherosclerosis of the extremities, occlusion of the femoropopliteal and tibial segments, stage III CAF, gangrene of the toes and foot on the left. Concomitant: Diabetes mellitus type 2, severe course. Objectively: muffled heart sounds, blood pressure 140/85 mmHg, pulse 95 beats per minute. Weakened vesicular breathing in the lungs, respiratory rate - 21 times per minute, tongue not sufficiently wet, abdomen enlarged due to pronounced subcutaneous fat. On examination; the left foot is edematous to the lower third of the leg, hyperemic, toes and foot are black. Pulse in the peripheral arteries a. femoralis is weakened, a. poplitea and a. dorsalispedis are not determined. From the tests: HB - 95 g / l, Erythrocytes - 3.1 x 10_9

l., LII – 10.2 10_9l, ESR - 36 mm/h, blood sugar - 16.0 mmol/l, platelets – 295 thousand/ml, urea - 8.0 mmol/l. On the ECG - left ventricular myocardial hypertrophy with dystrophic changes. ABI on the left is 0.3, on the right - 0.7;

Ultrasound imaging (USA) revealed an occlusive lesion of the poplitealtibial segment upon admission. Blood flow through the subclavian artery and lower leg arteries was not detectable in visually accessible locations. Direct angiography confirmed the lesion in the popliteal-tibial segment identified by the ultrasound imaging. Critical ischemia of the right lower limb (grade 5 according to the Wagner classification).

The patient was prescribed the following treatment: Levofloxacin 500 mg x 1 time per day intravenously by drip, Metronidazole 500 mg x 3 times per day intravenously by drip, Ceftriaxone 1.0 g x 3 times per day intramuscularly, NSAID diclofenac 3.0 g intramuscularly x 2 times; Fluconazole 200 mg x 2 times per day intravenously by drip; Thiotriozolin 2.0 x 2 times per day intravenously; Heparin 10 thousand units x 4 times per day,

Rheopolyglucin 400 ml intravenously by drip; infusion and detoxification therapy. The right lower limb was amputated at the level of the second third of the tibia.

In the postoperative period, antibacterial, infusion, and anticoagulant therapy were continued; despite the treatment, an increase in body temperature to 38 was noted on the 3rd day.$_0$C, manifestation of intoxication. Local: edema, redness, local wound temperature, marginal skin necrosis. On the same day, surgical debridement of the wound with necrosectomy was performed, the wound sutures were removed, and approximately 10.0 ml of foul-smelling pus was released. Transcutaneous oximetry of the distal part of the stump wound revealed a tpcO2 value of 2.5 cm.$_2$was below 30 mmHg (18-21 mmHg). A study of the degree of contamination of wounds with aerobes and anaerobes showed that at the time of surgery it was 8.13±0.32 and 7.1±0.28 lg CFU/ml, respectively. Taking these indicators into account, reamputation was performed at the level of the upper third of the tibia by 7 knocks, taking into account the tpcO indicator.$_2$In the postoperative period, on days 3-5, the patient again developed clinical signs of intoxication, deterioration of laboratory parameters, hemodynamic instability, decreased diuresis, and an increase in t$_0$bodies up to 38$_0$C and above, an increase in leukocytosis to 16-19 with a shift in the leukocyte formula to the left. Upon examination, the stump tissue is edematous, the edema extends to the knee joint. The identified clinical picture allowed us to conclude that the patient is developing sepsis with renal failure. Due to the spread of the purulent process in the proximal direction. Under general anesthesia, the sutures were dissolved, the edges were separated, a moderate amount of purulent-hemorrhagic discharge was detected. The discharge was sent for bacteriological examination. An association of aerobic and anaerobic microorganisms was detected. Upon examination of the deep tissues, ischemic tissue fragments were detected. In order to preserve the knee joint, a decision was made to perform a reamputation at the level of the second third of the tibia. The postoperative wound is to be kept under tampons with levamekol ointment for 3-4 days for 5-7 days, and

Then, with 25% dimethyl sulfoxide, also for 4-5 days under the cover of antimicrobial and antifungal therapy. On the 10th day, all signs of the purulent-inflammatory process disappeared, which allowed for the postoperative wound to be treated with 25% dimethyl sulfoxide and a drainage and irrigation system to be installed. Early secondary sutures were applied. The postoperative period was uneventful, and the drainage system and sutures were removed on the 15th day. The patient was discharged in satisfactory condition on the 18th day.

Thus, an analysis of the study results for patients in the control group showed that, in severe forms of critical lower limb ischemia, the use of known methods of modern endovascular interventions and local wound treatment for diabetic foot syndrome is effective, but has several drawbacks in the form of complications that require improvements in treatment methods. In our opinion, the results obtained in treating patients with diabetic foot syndrome using known treatment methods require improvements in local treatment of purulent wounds, thereby improving treatment outcomes for this category of patients.. All of the above became the basis for the development of a new treatment approach that contributes to improving treatment results by reducing the number of complications, mortality and accelerating the wound healing process of limb amputations and postoperative complications with the use of minimally invasive surgeries..

We decided to improve treatment methods by using a local abacterial environment in the comprehensive treatment of patients with diabetic foot syndrome. This is the focus of our subsequent research.

CHAPTER IV. EVALUATION OF THE EFFECTIVENESS OF LOCAL APPLICATION ABACTERIAL ENVIRONMENT IN THE TREATMENT OF PATIENTS DIABETIC FOOT SYNDROME.

The second main group included 48 patients with diabetic foot syndrome and critical ischemia of the lower extremities..

When determining the comprehensive treatment strategy for patients in the second main group, unlike patients in the control group, on the day of presentation, an emergency surgical procedure was performed to incise the purulent lesion and debride the purulent cavity with antiseptic solutions, including 3% hydrogen peroxide. After drying, the wound was debridement with electroactivated solution-A (ERA-A), followed by a bacterial culture using ERA-A solution using a device specially developed by us, which is described in detail in Chapter II.

Methodology for conducting an abacterial environment.

The technique for creating an abacterial environment was as follows: On the first day of treatment, the wound was treated with a 3% hydrogen peroxide solution, then dried. Necrotomy was performed if necessary. Afterwards, an abacterial environment was created in the affected area of the leg and foot using the device we developed. For this, the patient was in a supine position. The affected limb was inserted into the device through the entry port and comfortably placed on the device cushion (Fig. (No. 4.1)). Using a rubber clamp (Fig. (No. 4.2) the entry port was hermetically secured to the patient's limb. Through inlet tubes with holes for distributing medicinal substances, A - for the leg; B-for the foot (No. 4.3) A prolonged lavage of the affected limb was performed using the drip method, using EAR-A up to one liter over 6 hours in the first phase; EAR-K was used in the second phase of the wound process. After the abacterial environment session, the wound was dried with sterile wipes and treated with water-soluble ointments.

An aseptic dressing with moistened wipes was applied to the EAR-A. The procedure was repeated every 6 hours, and an abacterial lavage was performed twice daily on the limb for 6 hours each time, and the affected limb was kept under a dressing twice for 6 hours each time.FIG. No.

Fig. 4.1 installation begotten limb

Fig. 4.2 inclusion

Ural Federal District

Fig. 4.3 Conducting

lavage in the affected area horse bones

It should be noted that on the day of admission of patients, before the first procedure, material was taken from the wound wall (using a sterile ball) or from the wound discharge (wound exudate) for bacteriological examination to conduct a targeted Antibiotic therapy. With improvement, the patient conditions per day procedure was stopped before discharge. abacterial environment. All recovered patients were discharged in the second phase of the early process.

When assessing the severity of the purulent necrotic process in this group of patients, Wagner's classification was also used (see Chapter II).

Table 4.1

Distribution of patients by degree of damage according to Wagner

Group sick	0	I	II	III	IV	V	Total
Main	-	-	-	11 (22.9%)	17 (35.4%)	20 (41.7%)	48

As can be seen from Table 4.1, the majority of patients had grade IV-V limb damage (Wagner). Treatment of patients with purulent-necrotic limb lesions involved a team of specialists: a purulent department surgeon, a vascular surgeon and angiographer, an endocrinologist, a general practitioner, and an anesthesiologist-resuscitator.

The general condition of the patients in the main group, like that of the control group, was moderate to severe in most cases upon admission: they all complained of constant pain at rest, trophic ulcers, gangrene of the fingers or feet, numbness, general weakness, malaise, thirst, and an increase in body temperature to 39_0C and above. All patients had pronounced signs of general intoxication: high hyperthermia, increased heart rate (tachycardia) up to 110 beats per minute and higher, dry tongue and skin (signs of hypovolemia), and constipation in most patients. Impaired sensitivity in the affected limb was noted: 29 (61.7%) patients with affected areas of the foot had a neuropathic form of diabetic foot syndrome, complete loss of sensitivity and local hypothermia of the limb, hyperemia and edema of the skin tissue around the ulcerativenecrotic skin defect.

Analysis of the duration of purulent-necrotic lesion of the foot (PNLF) before admission to the clinic of patients in the comparison group revealed that out of 48 (100%), 26 (54.1%) were admitted to the clinic 30 days or later after the onset of the disease. Most patients with grade IV-V limb damage showed signs of intoxication and anemia upon late admission..

Characteristics by the time of receipt

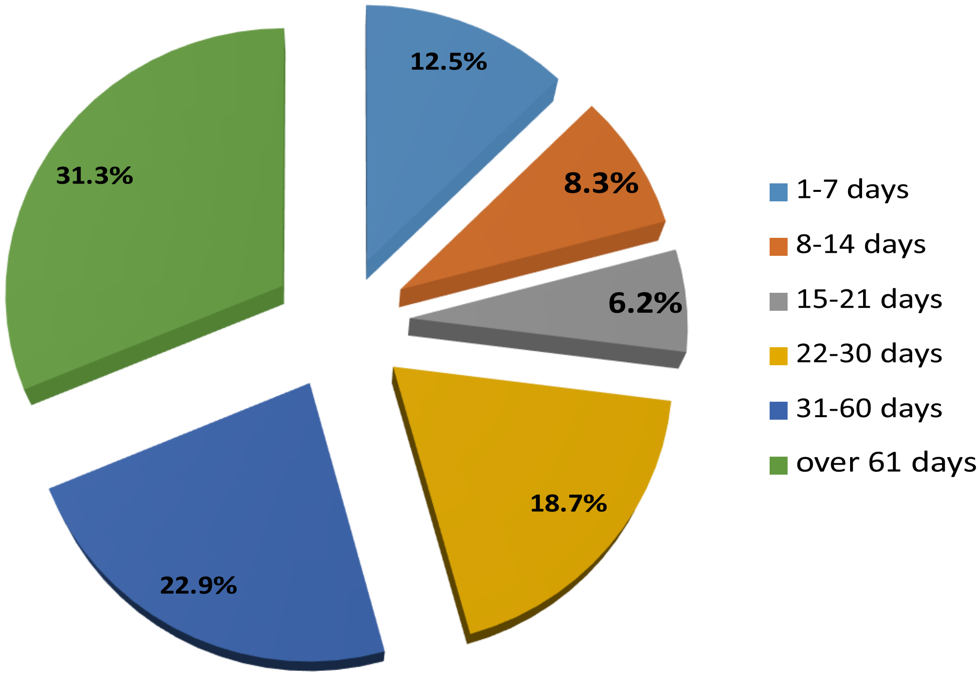

Fig. 4.4. Characteristics of patients in the control group by time period receipts

When assessing purulent-necrotic lesions of the limb in patients of the main group, it was revealed:lesions of the first finger 2 (4.1%), I-II fingers 3 (6.1%), sole 9 (18.7%), foot 10 (20.8%), shins 5 (10.4) foot and shin 11 (22.9%). The remaining 8 (16.6%) patients had lesions of the second finger 4 (8.3%), third finger 2 (4.1%), fourth finger 1 (2.0%), fifth finger 1 (2.0%),

Fig. 4.5. Lesions of the first finger

Fig. 4.6 Lesions of the second fingers

Fig. 4.7. Lesions of the sole

Fig. 4.8. Lesions of the foot and lower leg

All these patients, regardless of their diabetes mellitus (DM) type, were also switched to short-acting insulin using the "intensive insulin therapy" principle. Intensive insulin therapy included frequent (more than
3 times daily), subcutaneous or intravenous administration of small doses (8-10 units) of short-acting insulin with careful glycemic monitoring throughout the day, following the endocrinologist's recommendations. In severe cases, combined insulin administration (intravenous and subcutaneous) was used. Alpha-lipoic acid drugs formed the basis of pathogenetic therapy..

In the absence of contraindications, all patients were prescribed intravenous drip heparin up to 15-20 thousand units per day or other anticoagulants (Clexane 0.6, 0.8, Enoxaparin 0.6, 0.8, Fraxiparin 0.6, 0.8. subcutaneously)

The use of vasodilators, symptomatic treatment and antibiotic therapy were similar to those in the control group..

The complex of conservative measures included, as in the control group, treatment of concomitant diseases and correction of disturbances in the rheological properties of the blood.

All surgical operations were performed on an emergency basis, after appropriate preoperative preparation.

The diabetic anamnesis revealed that among the 48 patients in the comparison group, diabetes mellitus was diagnosed for the first time in 5 (10.4%). These patients

They learned about their illness only after being admitted to our clinic due to diabetic gangrene of the lower limb. (Table 4.2).

Table 4.2 **Duration of diabetic history**

Duration diseases (diabetes mellitus)	Absolute number	%
First identified	5	10.4
up to 1 year	8	16.6
1-3 years	9	18.8
4-5 years	11	22.9
6-10 years	6	12.5
10 years or more	9	18.8
Total	**48**	**100%**

As Table 4.2 shows, in most patients the duration of diabetes mellitus before admission also ranged from 4 to 10 years.

A study of the microflora of purulent necrotic wounds in patients in the control group revealed the following: as can be seen from Table 3.3, 59 strains of aerobic microflora were identified in 48 patients examined in the main group. Most cases were culturedStaph.aureus(49.2%),Proteus spp. (32.2%). Percentage of occurrence of microfloraStreptococcusAndE. coli amounted to 11.9% and 6.7%, respectively (Table 4.3).

Table 4.3

Species composition of the aerobic microbial association from the wound group comparison, patients n=48

Aerobes	Number of strains	IN %
S. aureus	29	49.2
Proteus spp.	19	32.2
Streptococcus spp.	7	11.9
E. coli	4	6.7
Total	**59**	**100**

The next criteria for assessing the patients' condition were indicators of general intoxication. Their dynamics are reflected in Table 4.4.

Table 4.4 Dynamics of changes in intoxication indicators in the main group patients (n=48)

Show li	Normal A	Day				
		The first ones day	3 days p/o	7th day p/o	9th day p/o	12th day p/o
$t_0$bodies	36.6	39.9±0.04	37.6±0.04***	36.7±0.04***	36.6±0.04***	36.6±0.04***
L-blood	6.0	12.8±0.25	7.2±0.48***	6.4±0.11***	6.4±0.54***	6.2±0.22***
* MSM	0.120	0.341±0.05 1	, 178±0.009***	, 112±0.009**	, 104±0.009**	*, 102±0.008**
LII	1.2	3.9±0.08	2.1±0.04***	1.1±0.03***	1.1±0.03***	1.0±0.03***
ESR	10	59±1.65	28.2±1.23***	23.8±0.78***	10.3±0.27***	10.0±0.07***

Note: * - differences relative to the indicators of the previous day of treatment are significant (*** - P<0.001).

On the first day of treatment, the body temperature of patients was on average 39.9±0.04$_0$C. The white blood cell count was equal on average 12.8±0.25·10$_9$/L. The average volume of medium-sized molecules was 0.341±0.005 units. Similarly, an increase in the LII and ESR indicators was noted to 3.9±0.08 and 59±1.65, respectively. Elevated levels of MSM, L, LII, as well as ESR, indicated severe endotoxicosis in this category of patients.

On the third day of treatment, a slight decrease in body temperature data was noted from 39.9±0.04$_0$From up to the level of 37.6±0.04$_0$With the number of leukocytes in the blood decreased, on average, to 7.2±0.48·10$_9$/l. The blood MSM content decreased to 0.178±0.009 units. Changes in LII indicators by the 3rd day of treatment also tended to decrease from 3.9±0.08 to 2.1±0.04 units. At the same time, ESR decreased, on average, to 38.6±0.56 mm/g.

By the seventh day of treatment, the examined patients in the comparison group with GNSS continued to have a slight subfebrile temperature (36.7±0.04$_0$C). In this case, according to the indicators of intoxication of the body: L, MSM, LII and ESR of the blood

a further decrease was noted, that is, there was a tendency towards normalization – 6.4±0.11, 0.112±0.009, 1.1±0.03, 23.8±0.78, respectively.

It should be noted that during the treatment process, with the normalization of all other indicators of intoxication, the ESR of the blood tended to slowly normalize.

In parallel with the above indicators, we studied clinical and biochemical tests when assessing the effectiveness of the therapy.

Blood sugar levels were measured at an average of 14.2±2.1 mmol/L upon admission to the clinic. Combined with comprehensive conservative and surgical treatment, postoperative removal of the purulent-necrotic lesion helped reduce blood sugar levels in the second group of patients to the upper limit of normal by 6-7 days of treatment.

The functional state of the vessels was studied using duplex angioscanning, determining regional MCC and MDS. Examination of vesselsa.Poplitea, a. tibialisposterioron the day of admission

showed that MCC and MDS were significantly below the norm – 30.5-1.2 and 2.2-0.16, respectively.

Endovascular diagnostic and treatment tactics in the second group of patients were carried out according to the principle described in detail in Chapters II-III.

Results of X-ray angiographic interventions in group II patients.

During the X-ray contrast angiographic study of the second group of patients, lesions of the vessels under the genicular artery and level I vessels of the foot were revealed in 26 (54.1%) patients of the second group (peroneal, anterior and posterior tibial arteries). In 12 (25.0%) patients, stenosis and occlusion at level II of the vessels of the foot (dorsal,

medial plantar artery of the foot). Ten (20.8%) patients had vascular lesions in the form of stenosis and occlusion up to level III of the vessels of the foot..

Of the 26 patients with level I lesions of the foot, 11 (42.3%) patients underwent stenting of the vessels of the middle segment of the femoral artery to the level of the popliteal artery.

Of the 26 patients with level I lesions of the vessels of the foot, balloon angioplasty with subsequent reversal of the affected vessels was performed in 15 (57.6%) patients due to chronic ischemia of the lower extremities caused by occlusive-stenotic lesions of the arteries of the vessels of the foot..

As noted above, out of 48 patients, 10 (20.8%) patients had stenosis or occlusion of level III of the vessels of the foot (dorsal, medial plantar artery of the foot).Of these, 3 (33.3%) underwent stenting of the affected vessels. In 16 (61.5%) patients, recanalization of vessels with balloon angioplasty was performed according to indications.. For this purpose, after establishing the level and extent of vascular damage, vascular recanalization was performed.

The use of angioendovascular diagnostics and a differential approach to endovascular surgical intervention with local application of abacterial medium according to our developed method in the complex treatment of diabetic foot syndrome has improved the indicators of postoperative complications and research results compared to the control group.,Table 4.5.

Table 4.5

Comparative evaluation of the results of surgical treatment in patients I-II groups

No.	Indicators	Group I (n=56)	Group II (n=48)
	Amputation at the hip level	1(1.7%)	-
1.	Amputation at the level of the leg	11(19.6%)	3 (6.2%)
2.	Atypical foot resection	14 (25.0%)	5(12.5%)

3.	Finger amputation	19(33.9%)	14(29.1%)
4.	Necrectomy	11(19.6%)	25(52.0%)
5.	Reamputation	3 (5.3%)	-
6.	Suppuration of the postoperative stump	9 (10.7%)	-
7.	Mortality	3 (5.3%)	1(2.0%)
8.	average bed day	9.8±1.1	7.4±1.2

It should be noted that out of 48 examined patients in Group II, amputation at the level of the lower leg was performed in 3 (6.2%) patients.. In these patients, the primary reasons for leg amputation were severe (Wagner grade V) lesions in the leg and foot prior to admission. Despite cessation of occlusive vessel flow in the leg and foot due to failure to restore limb tissue viability, amputation at the upper third of the leg (Mitisch) was performed 3-5 days after treatment. All these patients had high-grade vascular occlusion in the leg, with levels 1-2 of the foot vessels. A fatal outcome was observed in one elderly patient (69 years old), who presented late in the disease with Wagner grade V lesions. The patient's medical history included a myocardial infarction two years earlier. According to indications, balloon angioplasty and stenting of the first and second levels of the foot vessels (posterior tibial artery and dorsal artery) were performed on the second day of treatment. Despite the implementation of complex detoxification and specific treatment, by the 5th day, against the background of severe intoxication and multiple organ failure, a fatal outcome was observed.

Clinical example. Patient S.Ya.,Born in 1964, IB No. 11/4, hospitalized on January 2, 2023.

Complaints: pain, swelling, hyperemia of the right foot, blackening of all toes and foot, increased temperature$_0$body up to 39.4$_0$C, general weakness, dry mouth, decreased appetite.

Main diagnosis: Diabetic foot syndrome, obliterating atherosclerosis of the extremities, occlusion of the femoropopliteal and tibial segments, stage III diabetic foot disease, gangrene of the toes and feet.

Concomitant diagnosis: type 2 diabetes mellitus, severe. On examination: the left foot is edematous to the lower third of the leg, hyperemic, and the toes and foot are black. Pulse: weakened in the peripheral arteries (femoral artery), weak filling of the popliteal and dorsal arteries.

From the tests: HB - 90 g/l, Erythrocytes - $3.0*10_9$l., LII – $9.4*10_9$l, ESR – 26 mm/h, blood sugar - 17.0 mmol/l, platelets - 280 thousand/ml, urea - 7.0 mmol/L.

ECG: left ventricular myocardial hypertrophy with dystrophic changes, ABI: left - 0.3, right - 0.7.

Ultrasound examination: occlusive lesion of the popliteal-tibial segment, blood flow through the subcutaneous artery and arteries of the leg in places accessible for visualization is not located,

RCA: lesion of the popliteal-tibial segment, critical ischemia of the left lower limb (stage V according to the Wagner classification).

Prescription: Levofloxacin 500 mg x 1 time per day, intramuscularly; Metronidazole 500 mg x 3 times per day, intravenously, by drip; Ceftriaxone 1.0 g x 3 times per day, intramuscularly; Diclofenac 3.0 ml x 2 times per day, intramuscularly, Fluconazole 200 mg x 2 times per day, intravenously, by drip; Thiotriozolin 2.0 ml x 2 times per day, intravenously, by drip; Heparin 10 thousand IU x 4 times per day, subcutaneously; Rheopolyglucin 400 ml intravenously, by drip.

The patient underwent debridement and revision of the purulent-necrotic wound. Necrectomy was performed under local anesthesia. A daily course of lavage in an abacterial medium with EAP-A solution was prescribed for 6 hours twice daily using a device for abacterial medium transfer. On the twelfth day, signs of wound cleansing and healing were noted. The patient was discharged for outpatient treatment on January 14, 2023, in satisfactory condition.

Thus, an analysis of the study results for patients in the control group showed that, for severe forms of critical lower limb ischemia, the use of known methods of modern endovascular interventions and local wound treatment for diabetic foot syndrome is effective, but has several drawbacks in the form of complications that require improvements in treatment methods. In our opinion, the obtained results in treating patients with diabetic foot syndrome with known treatment methods require improvements in local treatment of purulent wounds, thereby achieving better treatment outcomes for this category of patients..All of the above formed the basis for the development of a new treatment approach that improves treatment outcomes by reducing complications and mortality and accelerating wound healing. This approach also reduces the incidence of limb amputations and postoperative complications through the use of minimally invasive procedures..

We decided to improve treatment methods by using a local, abacterial environment in the comprehensive treatment of patients with diabetic foot syndrome. This is the focus of the next chapter of our dissertation.

Thus, the results of our study showed that in the treatment of patients with SDS with critical ischemia of the lower limb, the use of a differential approach to surgical tactics taking into account X-ray endovascular diagnostics and the use of a local abacterial environment according to the method we developed helps improve the treatment results for this category of patients..In this case, the rate of amputation at the level of the lower leg is reduced from 19.6% to 6.2%, high amputation by 1.7%, amputation of the foot from 25.0% to 12.5%, reamputation by 5.3%, suppuration of the postoperative stump is reduced by 10.7%. It should be noted that amputations at the level of the thigh, suppuration of the stump after surgery, reamputation in the main group of patients were not observed.

Due to the reduction in major traumatic operations,
In cases where disability is the primary cause, the number of minimally invasive surgeries such as necrotectomy increased to 52% of patients. The average length of hospital stay decreased from 9.8±1.1 to 7.4±1.2 days. Mortality rate ranged from 5.3% to 2.0%..All this indicates a fairly high economic efficiency of the proposed method of differential treatment of patients with diabetic foot syndrome with critical ischemia of the lower extremities using an abacterial environment according to the method we developed.

All of the above allows us to recommend the widespread use of an abacterial-free environment in clinical practice for surgical treatment of patients with SDS. To create a permanent abacterial environment and lavage, it is necessary to use EAR-A solution in the first phase of foot and leg wounds, and EAR-K solution in the second phase..If only the foot area (level III) of the limb is affected, an ablative environment can be created by administering EAR-A through one chamber of the lavage chamber (B) at the tapi level. If the foot and lower leg are affected, the medicinal EAR-A solution must be administered through chambers A and B. All this allows us to recommend the method we have developed for wide application in clinical practice as a modern new treatment method with clinical and economic effectiveness.

CONCLUSION

According to research, the risk of developing diabetic foot syndrome increases with age and the duration of diabetes. The incidence of occlusive lesions of the main arteries of the lower extremities in diabetes ranges from 29% to 81% of all cases. The amputation rate for diabetic gangrene is 83.1%, and 50% to 70% of all non-traumatic amputations occur in diabetics. However, hospital mortality rates remain dismal – up to 40%. Approximately 50% of patients who have undergone unilateral high amputation are only able to move around their apartment, and 51–73% develop purulent-necrotic changes in the foot of the remaining limb, which are often an indication for amputation (Malakhov Yu.S. et al., 2019).

Diabetic foot syndrome complicated by critical lower limb ischemia is characterized by high rates of disability and mortality. The most disabling amputations for patients are high amputations at the level of the leg or thigh, which affect more than 25-30% of patients with critical lower limb ischemia (Voloshin V.N. et al., 2016). According to Udovichenko O.V., 1,500 to 2,000 amputations due to diabetic foot syndrome are performed in Moscow annually, which is 15-20 people per 100,000 population. The mortality rate resulting from high amputations of the lower limbs reaches 25-50% (Udovichenko O.V. et al., 2015).

According to international authors, the mortality rate in patients with diabetes and critical lower limb ischemia is 30% within 5 years. The incidence of patients with critical lower limb ischemia due to diabetes and non-reconstructable vascular bed in the peripheral limbs, according to various authors, can reach 80%. Such patients are forced to undergo limb amputations for life-saving reasons (Bokeria, L.A., et al., 2016).

Treating patients with critical ischemia due to lesions of the lower leg arteries is one of the most challenging areas of modern angiology. Vascular wall damage in diabetes mellitus resembles thromboangiitis, making bypass surgeries less effective. Arterial calcification and stenosis, combined with the small caliber of the artery being revascularized, make it difficult to create a distal anastomosis during bypass surgeries. Furthermore, the presence of microangiopathy leads to impaired outflow from the bypass graft, which in turn will inevitably lead to thrombosis. Trophic disorders in the foot increase the risk of purulent-septic complications in this category of patients undergoing open bypass surgeries. Minimally invasive, the possibility of repeat surgery, and the ability to restore blood flow through small-diameter arteries make endovascular procedures preferable for patients with diabetic foot syndrome. The presence of chronic renal failure in this category of patients requires a multidisciplinary approach to treatment. Determining the sequence and timing of surgical treatment for diabetic foot ulcers and limb revascularization, assessing associated cardiovascular risks and complications, prescribing comprehensive conservative therapy, and individualized limb unloading are important components of the overall treatment strategy for ulcerative lesions in patients with diabetes and critical lower limb ischemia. The authors present a clinical case of a polymorbid patient with severe distal arterial disease in the lower limb. Multiple balloon angioplasty of the lower leg arteries was performed in a patient with critical ischemia of a single lower limb. Timely angioplasty alleviated the clinical symptoms of critical ischemia, promoted foot wound healing, and preserved the weight-bearing function of the limb, thereby prolonging the patient's active lifestyle without severe disability (Parfenov I.P. et al., 2022).

In Russia, 20 to 50% of all hospitalizations for patients with diabetes are related to foot problems. The risk of lower extremity amputations is also higher in this category of patients, with 50 to 80% of all nontraumatic amputations performed. Therefore, the development of modern, integrated approaches to treating patients with this pathology, aimed at performing organ-preserving surgeries and preventing postoperative complications, is urgently needed. Following lower extremity amputations, postoperative complications occur in 64% of patients, with average hospital stays ranging from 58.2 to 65.7 days. One of the most severe complications of diabetes mellitus (DM) is lower extremity damage, leading to the development of purulent necrotic processes in the foot in 6–15% of patients (M.D. Dibirov et al., 2021).

The choice of treatment method for purulent necrotic lesions in diabetic foot syndrome complicated by severe critical ischemia remains unresolved. Furthermore, there is currently little information in clinical practice regarding the role and application of an abacterial environment using EAR in the prevention and treatment of purulent necrotic lesions of the lower extremities in diabetic foot syndrome complicated by critical lower extremity ischemia.

Diabetic foot syndrome and diabetes mellitus significantly increase the risk of developing generalized infections. The steadily decreasing sensitivity of microorganisms to modern anti-infective drugs requires research to select appropriate antibiotic therapy. Furthermore, studying the structure of microflora and its sensitivity is essential for economic forecasting and the rational organization of medical care. Studying the impact of abacterial environment on the quality of treatment

The treatment of generalized forms of soft tissue infection in diabetes mellitus is one of the important tasks of modern medicine, allowing for the identification of the most rational methods of treating this pathology [10; pp. 44-48] notes that the use of abacterial environments helps prevent the generalization of the process, quickly relieve existing symptoms of a systemic inflammatory response, and prevent the development of sepsis. Treatment under aseptic conditions is accompanied by rapid dynamics of local and general inflammatory phenomena, reduces the time of elimination of pathogenic flora from wound discharge, and reduces the period of inpatient treatment by 1.3-1.4 times.

This article examines some pathogenetic aspects of treating purulent-necrotic lesions of the feet in diabetes mellitus—a combination of basic therapy and wound treatment using controlled vacuum therapy, a fibrinolytic, angioprotective, an antithrombotic, and a vasodilator. The article details the main stages and outcomes of inpatient treatment, the mechanisms of action on the pathological process, and the implementation options for controlled vacuum therapy. Issues of subsequent outpatient treatment are also discussed [39; pp. 77–84].

Due to peripheral neuropathy, peripheral vascular disease, hyperglycemic environment, inflammatory disorders, and other factors, DFU healing is impaired or delayed, leading to the formation of diabetic chronic refractory ulcer. Due to these pathological abnormalities, wound healing in DFU may be difficult to accelerate with traditional treatments or antibiotics, while platelet-rich plasma (PRP) can promote wound healing by releasing various bioactive molecules stored in platelets, making it more promising than traditional antibiotics [138; p.110-112].

In recent years, relevant studies have shown that the use of stem cells or growth factors may form the basis of new treatments that can restore the body's normal healing process. Of these, platelet-rich plasma is of great interest because platelets contain various growth factors that are necessary for tissue repair and regeneration, and also have antibacterial properties in traumatic injuries. PRP is a plasma preparation rich in platelets with a higher concentration than whole blood [121; p. 530-531. The platelet concentration in its plasma is higher than the baseline level and ranges from 150 x 103/dL to 400 x 103/dL (22), which is 4-5 times higher than in whole blood. The classic method of PRP preparation consists of two steps. The first step is centrifugation to separate the blood components into three layers: a red blood cell layer, a light-colored coating layer (which contains the most platelets and white blood cells), and low-quality platelet-rich plasma. The second step is to collect the concentrated platelets in a small volume of plasma, called PRP. The role of PRP in wound healing is mainly due to the release of various bioactive molecules stored in platelets. In recent years, many studies have analyzed the effectiveness of PRP in the treatment of DFU, but they are limited to only a few indicators, and there are still different conclusions, such as: Tasmania et al. concluded that the use of PRP in DFU promoted wound healing, reduced ulcer volume, shortened the time to complete wound healing, and reduced the incidence of adverse events without any difference in the likelihood of wound complications. This is consistent with previous findings (27-31). However, Ajay et al. concluded that PRP does not have a significant effect on ulcer healing (32). As one of the most important and common complications in patients with diabetes, DFU has a profound impact on the prognosis, amputation, and even death of patients.

As a new treatment option for DFU, the effectiveness of PRP in DFU deserves further study. Therefore, the primary objective of this review is to summarize the results of various studies on the effectiveness of PRP in the treatment of DFU.

Application antioxidants V treatment purulent-necrotic Complications of diabetic foot syndrome. It is currently believed that factors that slow wound healing and contribute to the recurrence of purulent-necrotic processes in patients with diabetic foot syndrome include chronic ischemia, the presence of neurotrophic disorders, and a reduced immune response. Another important factor influencing the course of wound healing is oxidative stress. It is known that the inflammatory stage is characterized by impaired microcirculatory function, leading to hypoxia in the wound, activation, and chemotaxis of phagocytes. Subsequently, reactive oxygen species are formed, slowing the sequential transition of wound healing from one stage to the next. The inclusion of antioxidants and antihypoxants in therapy to correct oxidative stress promotes faster wound cleansing of necrotic tissue and accelerated epithelialization. The author analyzed the results of treatment of purulent-necrotic wounds in 52 patients with the neuroischemic form of diabetic foot syndrome complicated by the development of a purulentnecrotic process. The average age of patients was 58±1.7 years. All patients underwent surgical debridement of the necrotic focus upon admission. Conservative treatment included glycemic control, unloading of the affected foot, antibacterial, anticoagulant, and antiplatelet therapy. The author states that the use of antioxidants in the complex therapy of diabetic foot syndrome allows to reduce the time of wound cleansing from necrotic tissue, the appearance of granulation and contributes to a reduction in the time of epithelialization [33; pp. 164-175].

Care for patients with diabetic foot syndrome (DFS) requires interdisciplinary collaboration, which is why there are interdisciplinary guidelines focused on the diagnosis, treatment, and prevention of DFS. These guidelines are also necessary because DFS has its own specific characteristics that impact its diagnosis, therapy, and patient prognosis. These include, for example, the variable course of infection and PAD in patients with diabetes, the diagnosis of Charcot neuropathic osteoarthropathy, and the frequent association with end-stage renal disease, which worsens the course of DFS and increases the risk of its development. Last but not least, DFS is characterized by the issue of amputations, which have a significantly worse prognosis than in patients without diabetes. The creation of an interdisciplinary team in foot clinics that provides comprehensive care to patients with DFS according to recommended guidelines is associated with an improved prognosis for patients with DFS, particularly a reduction in amputations.

The work is based on the data of examination and treatment of 104 patients with critical ischemia of the lower extremities in diabetic foot syndrome with a severe degree of damage (III-V according to Wagner, 1979) who received inpatient treatment at the clinical base of the Bukhara State Medical Institute for the period 2010 to 2023..

In accordance with the objectives of the study, all patients were conditionally divided into 2 groups:The first comparison group included 56 (53.8%) patients with critical ischemia of the lower extremities in diabetic foot syndrome, who underwent a traditional method of local treatment, which included: angiographic examination and endovascular intervention, as well as local surgical treatment and wound treatment with antiseptic drugs.

Taking into account the characteristics of the angiographic study, localization and degree of damage to the vessels of the lower extremities, the following types of endovascular minimally invasive procedures were determined: balloon angioplasty (vascular dilation), stenting of stenotic vessels, reconalization of occluded vessels.

Active surgical interventions such as amputation of the lower leg, toes, and atypical foot resection were not performed on the first day of treatment, but rather deferred until days 4-5 after angiographic intervention, after blood flow to the affected portion of the limb's vessels had been restored. The effectiveness of endovascular intervention was also considered. This approach facilitated the most cost-effective organremoving surgery with minimal removal of the lower limb or allowed for complete limb preservation with limited necrotomy. Unlike the control group, patients in Group II received local treatment of lower extremity wounds using an abacterial environment using Electro-Activated SolutionA (ERA-A). Given the antibacterial properties of ERA-A, the abacterial environment was created by immersing the affected limb in ERA-A. An abacterial environment was achieved using an aseptic dressing with 25% dimethyl sulfoxide solution and water-soluble Levomekol ointment under the dressing for 6 hours twice daily. On the day of presentation, patients in Group II underwent emergency incision of the purulent lesion and debridement of the purulent cavity with an antiseptic 3% hydrogen peroxide solution. After drying, debridement was performed with a chemical solution of 25% dimethyl sulfoxide, followed by an abacterial environment using EAR-A solution. For this purpose, the affected limb was immersed in a special polyethylene bag containing EAR-A solution. The lumen of the bag was filled with EAR-A solution up to the middle third of the affected leg. The upper part of the bag was hermetically secured to the upper third of the leg using fixing material.

In the second phase of the wound course, the use of the abactirial medium was stopped, the wound was sanitized with an electroactivated solution of catholyte (EAR-K), Levomekol ointment was applied on top of the wound, and the wound was applied wipes soaked in anolyte in combination with 25% dimethyl sulfoxide. The dressings were changed once a day.

Before using antiseptics, wound fluid was collected from both subgroups of patients on sterile pads for microbiological analysis. Antibiotic therapy was administered based on the sensitivity of the wound microflora.

All patients were distributed by gender and age according to the classification of age groups.

Upon admission, signs of general intoxication were prevalent: elevated body temperature or persistent subfebrile fever, pallor, reduced mobility, tachycardia with a weak pulse, elevated ESR, leukocytosis, and a leftward shift in the blood count. Along with the general symptoms, local manifestations of the disease were also present: hyperemia, swelling, and tissue infiltration in the affected area of the limb. During treatment, these signs of intoxication and the inflammatory response to the infection gradually returned to normal.

The following were used during the examination: generally accepted clinical, Laboratory and instrumental methods. Upon admission, much attention was paid to collecting the anamnesis of patients. Information was obtained on pain syndrome, duration of intermittent claudication, nature and localization of pain when walking, pain-free walking distance, pain at rest, its intensity, increase or decrease in pain in a horizontal position and when lowering the leg from the bed. During examination of the patient, skin color and the presence of visible trophic disorders were visually assessed: thinning of the skin, roughness and porosity of the nail plates, the presence of trophic ulcers or necrosis. Objective examination included: palpation of the pulsation of the arteries of the lower extremities at typical points, auscultation of the aorta, iliac and femoral arteries. All patients in the control group underwent duplex angioscanning. In 45 patients in the main group

Angiographic endovascular diagnostics was performed. The anklebrachial index was calculated to determine critical limb ischemia. The leukocyte intoxication index was calculated to determine endogenous intoxication.

All patients had multilevel occlusive-stenotic lesions in the arterial system of the extremity, including the femoral (general, superficial, and deep), popliteal, and crural arteries (anterior and posterior tibial, and interosseous). Based on clinical examination, further treatment was determined based on the vascularity.

A complete blood count included determination of red blood cell count, hemoglobin content, and platelet count as screening tests; white blood cell count was determined using a Celloskop device. A white blood cell count was calculated using a visual microscopic examination of stained smears, which revealed the presence of a regenerative leukocyte shift, as evidenced by an increase in the ratio of band neutrophils to the total white blood cell count of more than 6%.

When determining the tactics of surgical treatment of patients in the first control group, we focused mainly on the severity of the purulent necrotic process using the Wagner classification.

The results of treatment of 56 patients with diabetic foot with critical ischemia of the lower extremities were analyzed, for whom angiographic studies and local treatment without the use of abacterial media were used in determining the diagnosis and treatment tactics..

The general condition of the patients in most cases upon admission was moderate to severe: they all complained of constant pain at rest, trophic ulcers, gangrene of the fingers or feet, numbness, general weakness, malaise, thirst, and an increase in body temperature to 39_0From and above.

All patients had pronounced signs of general intoxication: high hyperthermia, increased heart rate (tachycardia) up to 110 beats per minute and higher, dry tongue and skin (signs of hypovolemia), and constipation in most patients. Impaired sensitivity in the affected limb was noted: 35 (62.5%) patients with affected areas of the foot experienced complete loss of sensitivity and local hypothermia of the limb,

hyperemia, and swelling of the skin tissue around the ulcerative-necrotic skin defect.. Duplex angioscanning of the vessels of the affected lower extremities in most cases revealed: in the a. poplitea, the patency of the vessels is critically reduced due to stenosis. a. tibialis posterior, a. tibialis anterior, a.
dorsalis pedis.

When assessing purulent-necrotic limb lesions, we followed the classification proposed by Wagner (1979). The distribution of patients in the control group according to this classification is presented below. Treatment of patients with purulent-necrotic limb lesions was provided by a team of specialists: a purulent-necrotic surgeon, a vascular surgeon, an endocrinologist, a general practitioner, and an anesthesiologistresuscitator.

An analysis of the duration of purulent-necrotic foot lesion (PNFL) before admission to the clinic in patients in the comparison group revealed that of 56 patients (100%), 26 (46.4%) were admitted 30 days or later after the onset of the disease. Thirty-one (55.3%) patients presented to our clinic from other medical institutions due to treatment failure. Most patients with grades IV-V limb lesions showed signs of intoxication upon late admission.

All patients, regardless of the type of diabetes mellitus (DM), were switched to short-acting insulin using the "intensive insulin therapy" principle. Intensive insulin therapy included frequent (more than 3 times a day), subcutaneous or intravenous administration of small doses (8-10 units) of short-acting insulin with careful monitoring of glycemic levels throughout
days. In severe cases, combined insulin administration (intravenous and subcutaneous) was used. Alpha-lipoic acid drugs were used as the basis of pathogenetic therapy.

The complex of conservative measures also included treatment of concomitant diseases and correction of blood rheology disorders. Indications for emergency surgical interventions were primarily wet gangrene of the toes and feet, cellulitis of the foot, cellulitis of the foot with inflammation extending to the lower leg, and severe intoxication posing a threat to the patient's life. In such cases, surgery was usually performed with the aim of saving the patient's life.

Indications for urgent surgical interventions were: purulent-necrotic wounds that do not have adequate drainage - deep abscesses of the foot with distant septic metastatic foci, newly formed abscesses and poorly drained purulent leaks.

When choosing a general anesthesia method, it was essential to achieve the most complete blockade possible of the body's stress response, which leads to the release of counter-regulatory hormones and increased blood glucose levels. Intubation anesthesia was used in patients with severe multiple organ failure. Lower limb surgeries were performed under regional anesthesia according to A. Yu. Pashuk (1987) or conduction epidural anesthesia.

The results of a study of patients in the control group by localization of the purulent-necrotic process showed that the pathological process in the area of the first toe was characterized by a more malignant course, especially when it was affected in combination with other toes, than when other toes or their combinations were affected. This is due to the topographic and anatomical features of the first toe.

The study of the functional state of the vessels was carried out using duplex angioscanning, by determining the regional MCC and

MDS. Examination of the a. poplitea and a. tibialis posterior vessels on the day of admission showed that the MSS and MDS were significantly below normal.

To determine the tactics of surgical treatment of the control group of patients, endovascular X-ray contrast diagnostics of the vessels of the leg and foot was performed. Based on the angiographic diagnostic results, we determined the method of choice for endovascular minimally invasive surgery to eliminate blood flow to the affected vessel. We also considered the anatomical structure of the leg and foot vessels and their lumen at various levels of the foot. To differentiate the approach to endovascular surgical interventions based on vessel size, we followed the principle of dividing the foot vessels into three levels, as proposed in our clinic by Zh.R. Nazarov.

The primary diagnostic method for assessing vascular condition was X-ray contrast angiography. Angiographic studies were performed after appropriate preparation under local anesthesia in the angiography room. A detailed methodology is provided in Chapter II.

In the absence of contraindications, all patients were prescribed intravenous drip heparin up to 15-20 thousand units per day or other anticoagulants (Clexane 0.6, 0.8, Enoxaparin 0.6, 0.8, Fraxiparin 0.6, 0.8, subcutaneously).

All surgical procedures were performed on an urgent, deferred basis, after appropriate preoperative preparation. Examination of the distal crural arteries was performed with the patient supine, knees slightly bent, and legs slightly apart. To visualize the distal crural arteries, a transducer is positioned along the lower third of the leg and slightly posterior to the medial malleolus. The distal crural arteries are located along the lower third of the leg on the anterior surface, along the extension of an imaginary line drawn between the first and second toes of the foot.

In Group I, amputations at the lower leg level were performed in 1 patient (1.7%). In this patient, the primary reasons for lower leg amputation were severe (Wagner grade V) lesions of the lower leg and foot tissues prior to admission. Despite cessation of occlusive vessel blood flow in the lower leg and foot, amputations at the upper leg level (Mitisch method) were performed within 3-5 days of treatment due to failure to restore limb tissue viability. Fatal outcomes were observed in 3 patients admitted late in the disease course with Wagner grade V lesions. Two of these patients were elderly (64 and 68 years old). One of them had a history of myocardial infarction a year earlier. Despite comprehensive detoxification and specific treatment, death occurred within 5 days due to severe intoxication and multiple organ failure. Taking into account the degree of damage, level and localization, data of objective, subjective studies, as well as the results of duplex angioscanning according to indications, out of 56 examined patients of the control group, amputation at the level of the lower leg was performed in 11 (19.6%), atypical resection of the foot in 14 (25.0%), amputation of the fingers in 19 (33.9%), necrectomy in 11 (19.6%) patients. Thus, in our study, the following unsatisfactory results were observed: suppuration of the postoperative wound in 9 (10.7%) patients, of which 3 (5.3%) of the treatment ended in forced reamputation of the lower leg.The average duration of treatment for patients in group I was 9.8±1.1 days.

An analysis of the study results for patients in the control group showed that, in severe forms of critical lower limb ischemia, the use of known methods of modern endovascular interventions and local wound treatment for diabetic foot syndrome is effective, but has a number of drawbacks in the form of complications that require improved treatment methods. In our opinion, the results obtained from treating patients with diabetic foot syndrome using known methods

treatment requires improvement of local treatment of purulent wounds and thus it is possible to achieve better treatment results for this category of patients.All of the above became the basis for the development of a new treatment approach that contributes to improving treatment results by reducing the number of complications, mortality and accelerating the wound healing process. Amputations of the limb and postoperative complications with the use of minimally invasive surgeries..

Following this, it was decided to improve treatment methods by using a local, abacterial environment in the comprehensive treatment of patients with diabetic foot syndrome. This became the focus of the next chapter.

When determining the comprehensive treatment strategy for patients in the second main group, unlike those in the control group, on the day of presentation, an emergency surgical procedure was performed to incise the purulent lesion and debride the purulent cavity with antiseptic solutions, including 3% hydrogen peroxide. After drying, the wound was debridement with electroactivated solution-A (ERA-A), followed by a bacterial culture using ERA-A solution using a device specially developed by us.

It should be noted that on the day of admission of patients, before the first procedure, material was taken from the wound wall (using a sterile ball) or from the wound discharge (wound exudate) for bacteriological examination to conduct a targeted Antibiotic therapy. With improvement, the the condition of patients per day procedure was suspended before discharge. abacterial environment. All recovered patients were discharged in the second phase of the early process.

The general condition of the patients in the main group, like that of the control group, was moderate to severe in most cases upon admission: they all complained of constant pain at rest, trophic ulcers, gangrene of the fingers or feet, numbness, general weakness, malaise, thirst, and an increase in body temperature to 39^{0}C and above. In all patients

There were pronounced signs of general intoxication of the body: high hyperthermia, increased heart rate (tachycardia) to 110 beats per minute and higher, dry tongue and skin (signs of hypovolemia), and constipation in most patients. Impaired sensitivity in the affected limb was noted: 29 (61.7%) patients with affected areas of the foot had a neuropathic form of diabetic foot syndrome, complete loss of sensitivity and local hypothermia of the limb, hyperemia and swelling of the skin tissue around the ulcerative-necrotic skin defect.

An analysis of the duration of purulent-necrotic lesion of the foot (PNLF) before admission to the clinic of patients in the comparison group revealed that out of 48 (100%), 26 (54.1%) were admitted to the clinic 30 days or later after the onset of the disease. Most patients with grade IV-V limb damage showed signs of intoxication and anemia upon late admission.

A study of the microflora of purulent necrotic wounds in patients in the control group revealed the following: as can be seen from Table 3.3, 59 strains of aerobic microflora were identified in 48 patients examined in the main group. Most cases were culturedStaph.aureus(49.2%),Proteus spp. (32.2%). Percentage of occurrence of microfloraStreptococcusAndE. coli amounted to 11.9% and 6.7%, respectively. The study of the functional state of the vessels was carried out using duplex angioscanning, determination of regional MSS and MDS. Examination of vesselsa.Poplitea, a. tibialisposterior on the day of admission it showed that MSS, MDS were significantly below the norm – 30.5-1.2 and 2.2-0.16, respectively.

During the X-ray contrast angiographic study of the second group of patients, lesions of the vessels under the genicular artery and level I vessels of the foot were revealed in 26 (54.1%) patients of the second group (peroneal, anterior and posterior tibial arteries). In 12 (25.0%) patients, stenosis and occlusion at level II of the vessels of the foot (dorsal, medial plantar artery of the foot). Ten (20.8%) patients had vascular lesions in the form of stenosis and occlusion up to level III of the vessels of the foot.

The use of endovascular diagnostics and a differential approach to endovascular surgical intervention with local application of an abacterial medium according to our developed method in the complex treatment of diabetic foot syndrome has improved the indicators of postoperative complications and research results compared to the control group.

Of the 48 examined patients in Group II, amputation at the level of the lower leg was performed in 3 (6.2%) patients..In these patients, the primary reasons for leg amputation were severe (Wagner grade V) lesions in the leg and foot prior to admission. Despite cessation of occlusive vessel flow in the leg and foot due to failure to restore limb tissue viability, these patients underwent amputation at the upper third of the leg using the Mitish procedure on days 3-5 of treatment. All these patients had high-grade vascular occlusion in the leg, with levels 1-2 of the foot vessels. A fatal outcome was observed in one elderly patient (69 years old), who presented late in the disease with Wagner grade V lesions. The patient's medical history included a myocardial infarction two years earlier. According to the indications, balloon angioplasty and stenting of the first and second levels of the foot vessels (posterior tibial artery and dorsal artery) were performed on day 2 of treatment. Despite the implementation of complex detoxification and specific treatment, by the 5th day, against the background of severe intoxication and multiple organ failure, a fatal outcome was observed.

An analysis of the results of the study of patients in the control group showed that in severe forms of critical ischemia of the lower limb, the use of known methods of modern endovascular interventions and local treatment of wounds in diabetic foot syndrome is an effective method, but has a number of disadvantages in the form of complications that require improved treatment methods. In our opinion, the results obtained in treating patients with SDS using known treatment methods require improved local treatment of purulent wounds, thereby achieving better treatment results for this category of patients..All of the above formed the basis for the development of a new treatment approach that improves treatment outcomes by reducing complications, mortality, and accelerating wound healing. This approach is aimed at limb amputations and postoperative complications using minimally invasive procedures.

The results of our studies showed that in the treatment of patients with SDS with critical ischemia of the lower limb, the use of a differential approach to surgical tactics taking into account X-ray endovascular diagnostics and the use of a local abacterial environment according to the method we developed helps improve the treatment results for this category of patients.. In this case, the rate of lower leg amputation decreased from 19.6% to 6.2%, high amputation by 1.7%, foot amputation from 25.0% to 12.5%, reamputation by 5.3%, and postoperative stump suppuration decreased by 10.7%. It should be noted that amputations at the thigh level, postoperative stump suppuration, and reamputation were not observed in the main group of patients. Due to the reduction of major traumatic surgeries, which in most cases lead to disability, the number of low-trauma surgeries such as necrotectomy increased to 52% of patients. The average duration of inpatient treatment decreased from 9.8±1.1 to 7.4±1.2 days. Mortality from 5.3% to 2.0%.. All this demonstrates the rather high economic efficiency of the proposed method of differential treatment of patients with diabetic foot syndrome with critical ischemia of the lower limb using an abacterial environment according to the method we developed.

All of the above allows us to recommend the widespread use of the surgical treatment method in clinical practice.

Patients with diabetic foot syndrome (DFS) using an abacterial environment for the limb. In this case, to create a constant abacterial environment and lavage, an EAR-A solution should be used in the first phase of the foot and leg wound, and an EAR-K solution should be used in the second phase.. If only the foot area (level III) of the limb is affected, an ablative environment can be created by administering EAR-A through one chamber of the lavage chamber (B). If the foot and lower leg are affected, the medicinal EAR-A solution must be administered through chambers A and B. All of this, the technique we have developed, allows us to recommend its widespread use in clinical practice as a modern, new treatment method with clinical and economic effectiveness.

All this allows us to recommend it for widespread use in clinical practice as a modern new treatment method that has clinical and economic effectiveness, which reduces the number of complications and allows us to significantly improve the quality of life of patients.

1. With the traditional method of treating patients with critical Lower limb ischemia associated with diabetic foot syndrome is associated with a number of undesirable treatment outcomes, including postoperative stump suppuration in 10.7% of patients, leading to forced leg reamputation in 5.3% of cases, high amputation at the femur in 1.7% of cases, and death in 5.3% of cases. The average length of hospital stay for patients in Group I was 9.8±1.1, necessitating the development of additional measures aimed at improving treatment methods.

2. Treatment of patients with SDS with critical ischemia of the lower limbs, the use of an abacterial environment with the use of ERA-A in the first phase of the wound process helps to improve the treatment results for this category of patients. At the same time, the average length of hospital stay is reduced from 9.8±0.7 to 7.4±0.8 days.

Mortality decreases from 5.3% to 2.0%.

3. In severe cases of damage with critical ischemia lower limbs against the background of SDS, the use of a special device for conducting an abacterial environment using EAR-A by conducting a long-term lavage of the affected limb helps to reduce amputation at the level of the lower leg from 19.2% to 6.2%, high amputation from

1.7% to zero, amputation of the foot from 25.0% to

12.5%, reamputation 5.3% to zero.

4. Application of endovascular diagnostics and choice of method minimally invasive surgical interventions: the subsequent creation of a local abacterial environment of the affected limb by prolonged lavage for 6 hours with ERA-A solution twice a day in combination with a water-soluble ointment + ERA-A under dressings is a more effective method of treatment for patients with severe critical ischemia of the lower extremities in SDS, which can be

recommend widespread use in clinical practice for this category of patients.

PRACTICAL RECOMMENDATIONS

1. When determining the treatment tactics for patients with critical In case of ischemia of the lower extremities, after carrying out endovascular diagnostic therapeutic measures, it is necessary to create an abacterial environment in the affected limb.

2. Use of a special device for abacterial
The environment promotes the creation of a long-term effect on the wound of highly effective bactericidal solutions.

3. Carrying out long-term lavage of the affected area limbs using EAR-A for 6 hours twice a day in combination with a water-soluble ointment + EAR-A under bandages is a more effective method of treating patients with SDS, with critical ischemia of the lower limbs is an effective method of treatment.

4. The special device we offer helps
The creation of an abacterial environment and the simultaneous implementation of long-term regional lavage of the affected limb with aseptic solutions thereby improves the treatment results for patients with CSI with critical ischemia of the lower limbs.

BIBLIOGRAPHY

1. Abdullaev S. A. et al. Surgical treatment tactics purulent-necrotic complications of soft tissues in patients with diabetes mellitus and diabetic foot // Research Focus. - 2023. - V. 2. - No. 1.
– P. 399-404.

2. Akmatov N. E. et al. Results of instrumental examination of patients with diabetic foot syndrome in critical lower limb ischemia // Ural Medical Journal. 2020. No. 2 (185). - 2020.

3. Aliev M.A., Safarov S.Yu., Magomedov M.S. Results
The use of balloon angioplasty for critical lower limb ischemia in the complex treatment of diabetic foot syndrome. High lower limb amputations in children and adults. // Collection of scientific papers of the international scientific and practical conference. Moscow:
Pero, 2019. - Pp. 9-11.

4. Aliyev M. A. et al. Efferent methods in a complex treatment of diabetic foot syndrome complicated by endogenous intoxication (analysis of a series of observations) // Bulletin of the Dagestan State Medical Academy. - 2021. - No. 2. - P. 16-22.

5. Artikova D. M., Artikov A. F. Epidemiology, etiology and pathogenesis of diabetic foot syndrome // Academic research in educational sciences. - 2023. - No. 1. - P. 248-254.

6. Aslanov A. D. et al. Surgical possibilities in treatment of patients with critical lower limb ischemia // Moscow Surgical Journal. - 2022. - No. 3. - P. 86-95.

7. Ayubova N.L., Bondarenko O.N., Galstyan G.R. et al. Features of lower extremity arterial lesions and clinical outcomes of endovascular interventions in patients with diabetes mellitus with critical lower extremity ischemia and chronic kidney disease. // Diabetes mellitus. - 2023. - V. 16. - No. 4 - P. 85-94.

8. Babajanov B. D. et al. Reconstructive operations on the foot after revascularization in patients with diabetic foot syndrome: diss. - Uzbekistan. Toshkent, 2022.

9. Bondarenko O.N., Ayubova N.L., Galstyan G.R. et al. Preoperative visualization of peripheral arteries using ultrasound duplex scanning in patients with diabetes mellitus and critical lower limb ischemia. // Diabetes mellitus. - 2023. - Vol. 16. - No. 2 - P. 52-61.

10. Barkhatova N. A., Yanbekov T. B. Influence of conditions abacterial environment on the course of generalized forms of infectious complications of diabetic foot syndrome // Medical and pharmaceutical journal "Pulse". - 2019. - Vol. 17. - No. 4. - P. 44-48.

11. Bardyugov P.S., Parshikov M.V. Deformations of the feet in patients with diabetic foot syndrome (literature review) // Genius of Orthopedics. - 2022. - V. 28. - No. 3. - P. 452-458.

12. Belik B.M., Chumburidze I.P., Shtilman M.Yu., Yavruyan O.A., Savchenko Yu.P. Complex treatment of patients with purulentnecrotic

complications in the neuropathic form of diabetic foot syndrome// Surgery. Journal named after N.I. Pirogov. 2020;4:81-7.

13. Belozertseva Yu. P., Kurlaev P. P., Gritsenko V. A. Syndrome diabetic foot: etiology, pathogenesis, classification and treatment // Man and his health. - 2018. - No. 1. - P. 69-78.

14. Bolatchiev Albert Dobaevich Antibiotic resistance Microorganisms in diabetic foot syndrome and the development of defensin preparations for external use in infected wounds: Abstract of a Cand. Sci. (Medicine). - Stavropol, 2019. - 25 p.

15. Bregovskiy V. B., Karpova I. A. Analysis of specialized assistance to patients with diabetic foot syndrome in St. Petersburg for 2010-2021 // Diabetes mellitus. - 2022. - V. 25. - No. 5. - P. 477-484.

16. Burleva E.P., Babushkina Yu.V., Galimzyanov F.V., Fominykh A.N. Results of differentiated treatment of patients with diabetic foot syndrome at the stage of specialized surgical care. // Surgery.

Journal named after N.I. Pirogov. 2019; 5: 42-51.

17. Butyrsky A. G., Skoromny A. N., Novodranov V. V. Clinical and cytological comparisons in the treatment of purulentcomplicated forms of diabetic foot syndrome using the NPWT method // Tavricheskiy Medico-Biological Bulletin. - 2023. - V. 26. - No.

1. - P. 12-21.

18. Vruchinsky E. E., Turgunov E. M. Diabetic foot, Relevance in the 21st century (literature review) // Internauka. - 2020. - No. 15-1. - P. 39-46.

19. Galimov O. V. et al. Angiographic methods in treatment patients with diabetic foot syndrome // Creative surgery and oncology. - 2021. - No. 4. - P. 300-306.

20. Galstyan G.R., Tokmakova A.Yu., Egorova D.N., Mitish V.A., and Dr. Clinical guidelines for the diagnosis and treatment of diabetic foot syndrome. Wounds and wound infections // Journal named after prof. B.M. Kostyuchenok. - 2018. - No. 2. - P. 61-83

21. Glukhov A. A., Aralova M. V., Alimkina Yu. N.
A mathematical method for predicting the effectiveness of treatment of surgical complications of diabetic foot syndrome // collection of scientific articles. - 2023. - P. 182.

22. Grekova N.M., Lebedeva Yu.V., Shishmentsev N.B., Dinerman G.V. Ways to reduce the frequency of high amputations in diabetes mellitus and prognosis for operated diabetic foot.// Modern problems of science and education. 2017;5.

23. Gubko A. Yu., Potrubeiko V. L., Bibkin A. A. Influence forms of diabetic foot syndrome and compensation diabetes mellitus on the duration of the postoperative period.
– 2021.

24. Davlatov S. S. Clinical, immuno-microbiological aspects of the development of diabetic foot syndrome (literature review) //
Achievements of science and education. - 2022. - No. 4 (84). - P. 21-26.

25. Davlatov S. S. Frequency of occurrence of critical ischemia lower extremities with systemic inflammatory response syndrome in diabetic foot syndrome (literature review) // Achievements of science and education. - 2022. - No. 4 (84). - P. 26-33.

26. Dedov I.I., Shestakova M.V., Mayorov A.Yu., et al. Algorithms of specialized medical care for patients with diabetes mellitus // Diabetes mellitus. - 2019. - No. 22. - P. 1-144.

27. Denisyukova A. S. Changes in catalase activity during diabetic polyneuropathy and diabetic foot syndrome // Youth science - the first step into big science. - 2022. - P. 10-14.

28. Dubrovshchik O. I. et al. Critical ischemia of the lower Limb pain associated with diabetic foot syndrome: evaluation of the effectiveness of complex treatment options in a general surgical hospital. – 2023.

29. Eroshkin A. I. et al. CT angiography of the lower extremities and CT perfusion of the feet in the diagnosis, planning, and monitoring of revascularization results in a patient with diabetic foot syndrome // Russian Electronic Journal of Radiation Diagnostics. – 2020.
– T. 10. – No. 2. – pp. 78-86.

30. Esipov A. V. et al. Current issues in diagnostics diabetic foot syndrome // Bulletin of the National Medical and Surgical Center named after N. I. Pirogov. - 2023. - Vol. 18. - No. 2.

31. Zorkal'tsev M. A. et al. Pathogen-specific Molecular imaging and molecular testing methods in the prognosis of complicated diabetic foot syndrome, risk amputations and patient survival // Bulletin of Siberian Medicine. - 2022. - Vol. 21. - No. 3. - P. 166-180.

32. Zohirov A. R., Ernazarov Kh. I., Ergashev U. Yu. Pathological features of wound healing in an experimental model of diabetic foot. – 64th scientific and practical conference of students "Science and Health" dedicated to Science Day of the Republic of Kazakhstan with international participation, 2022.

33. Zohirov A. R., Nabieva A. Sh. Study pathomorphological features of modern treatment of purulentnecrotic processes in diabetes mellitus // Interpretation and researches. - 2023. - V. 1. - No. 2. - P. 25-36.

34. Zhakiev B.S. et al. Comparative analysis of the application indirect revascularization operations in patients with purulentnecrotic complications of diabetic foot syndrome: a randomized clinical trial //West Kazakhstan Medical Journal. - 2020. - No. 2 (62). - P. 164-175.

35. Zhigzhitova E. B. et al. Diabetic foot syndrome: A modern view of the mechanisms of development, diagnosis and treatment // VIII Congress of Therapists of the Trans-Baikal Territory. - 2020. - P. 20-27.

36. Ivchenko A.O. Vascular prostheses used in reconstructive operations on the main arteries of the lower extremities / A.O. Ivchenko, A.N. Shvedov, O.A. Ivchenko // Bulletin of Siberian Medicine. - 2019. - Vol. 16, No. 1. - P. 132-139

37. Ismailov D. D., Novikov I. I. Cardiovascular Autonomic neuropathy in the pathogenesis of diabetic foot syndrome // Fundamental science and clinical medicine - man and his health. - 2023. - P. 747-748.

38. Kavteladze Z.A., Pyumpulyan A.G., Ermolaev P.M., Danilenko S.Yu., Zavalishin S.E., Asatryan K.V., and others. Opportunities

endovascular surgery. Endovascular treatment occluded arteries of the leg after multiple vascular interventions. // Endovascular surgery. 2020;7(1):94-100.

39. Krivoshchekov E. P., Elshin E. B., Romanov V. E. Pathogenetic treatment of complications of diabetic foot syndrome // Practical medicine. - 2017. - No. 6 (107). - P. 77-84.

40. Kuznetsova O. A. et al. Some aspects of diagnostics and treatment of purulent-necrotic lesions of the diabetic foot // XLVIII Ogarev readings. - 2020. - P. 413-420.

41. Lipin A. N. et al. Application of histoequivalentbioplastic material GI-DERM in the treatment of postoperative wounds and trophic ulcers in diabetic foot syndrome // National Health. - 2020. - No. 2. - P. 24-29.

42. Lutsenko Yu. G., Sycheva D. R. Pathomorphological Features of the course of reparative processes in patients with diabetic foot syndrome // Novoobrazovanie. - 2022. - V. 14. - No. 4. - P. 169-172.

43. Matyulevich V. V., Denisov A. L., Neverov P. S. Efficiency of revascularization of the main arteries of the lower extremities using donor vascular grafts // 100th anniversary of the Perm Medical Journal. - 2023. - P. 216-220.

44. Mitish V. A. et al. 45th anniversary of the Department of Wounds and Wound Infections Institute of Surgery named after A. V. Vishnevsky // Wounds and wound infections. Journal named after Professor B. M. Kostyuchenok. - 2018. - V. 5. - No. 2. - P. 6-31.

45. Mikhailov A. Yu. et al. Features of pathogenesis and treatment diabetic foot syndrome //Modern Science. - V. 202. - No. 12-2. - P. 84.

46. Mursalov M. M., Dzhamalov F. G. Main directions complex treatment of the neuropathic form of diabetic foot syndrome // Medical news. - 2022. - No. 5 (332). - P. 63-67.

47. Narzullaev Sh. Sh., Saidullaev Z. Ya. Modern

Diagnostics and tactics of complex treatment of diabetic foot // Research Focus International Scientific Journal. - 2023. - Vol. 2. - No. 4. - P. 242-246.

48. Narchaev Zh., Narchaev F. Supplement to the classification diabetic foot syndrome // Medicine and Innovation. - 2021. - T. 1. – No. 2. – P. 50-53.

49. Norchaev Zh. A., Khamdamov Sh. I., Rakhmonov O. R. Prediction of the course of diabetic foot syndrome // Re-health journal. - 2022. - No. 2 (14). - P. 245-249.

50. Obolensky V. N. et al. Diabetic foot syndrome in clinical practice // RMZh. - 2019. - Vol. 18. - No. 2. - P. 45-54.

51. Okhunov A. O., Pulatov U. I., Okhunova D. A. Clinical laboratory characteristics of the course of the wound process of soft tissues // Bulletin of Science and Education. - 2018. - No. 9 (45). - P. 104-110.

52. Parshikov M.V., Bardyugov P.S., Yarygin N.V. Orthopedic aspects of diabetic foot syndrome classifications // Genius of Orthopedics. - 2020. - Vol. 26. - No. 2. - P. 173-178.

53. Parshikov M.V., Bardyugov P.S., Yarygin N.V. Orthopedic aspects of diabetic foot syndrome classifications // Genius of Orthopedics. - 2020. - Vol. 26. - No. 2. - P. 173-178.

54. Parfenov I. P. et al. Clinical case of successful multiple endovascular revascularization of the arteries of a single lower limb in a patient with diabetic foot syndrome // Moscow Surgical Journal. - 2022. - No. 2. - P. 67-72.

55. Paskhalova Yu. S. Complex treatment strategy Neuroischemic form of diabetic foot syndrome in critical ischemia and the presence of resistant forms of purulent infection pathogens using bacteriophages as an example of clinical observation // Wounds and wound infections. Journal named after Professor B. M. Kostyuchenok. - 2022. - Vol. 9. - No. 3. - P. 40-47.

56. Petrova V. V., Smirnov G. A., Arzhelas M. N. Role angiosomal-oriented method endovascular

revascularization in the complex treatment of diabetic foot syndrome // Wounds and wound infections. Journal named after Professor B. M. Kostyuchenok. - 2020. - Vol. 7. - No. 1. - P. 36-45.

57. Rakhmatov Sh. Sh. Effect of electroactivated water solution on the dynamics of biochemical parameters and the rate of wound healing in the treatment of purulent diseases of soft tissues in outpatient settings // Central Asian Journal of Medical and Natural Science. - 2023. - Vol. 4. - No. 3. - P. 366-374.

58. Rogova N.V., Kuzmina T.N. Review of Russian and international clinical guidelines for the management of patients with diabetic foot syndrome // Bulletin of the Volgograd State Medical University. - 2022. - Vol. 19. - No. 2. - P. 177-183.

59. Rudman V. Ya., Kalashnikov K. A., Burov G. A. Experience Endovascular treatment of patients with chronic ischemia threatening limb loss // Healthcare of the Far East. – 2021. – No. 2. – pp. 38-43.

60. Safarov S.Yu., Aliev M.A., Magomedov M.S., Suleymanov Sh.A., Sultanova R.S. Implementation of innovative methods in the complex treatment of diabetic foot syndrome. //Bulletin of the DSEA. 2018;2:35-40.

61. Safoev B.B., Nazarov Zh.R. Comparative analysis endovascular intervention in patients with critical lower limb ischemia in diabetic foot syndrome // Central Asian Journal of Medical and Natural Science. - 2022. - Vol. 3. - No. 5. - P. 690-693.

62. Safoev B. B., Boltaev T. Sh., Hamroev Sh. Own experience application of ultrasonic treatment of wounds with an electroactivated aqueous solution // AMALIY VA TIBBIYOT FANLARI ILMIY JURNALI. - 2023. - T. 2. - No. 12. - P. 111-120.

63. Soloviev V. A. et al. Multidisciplinary approach in treatment of patients with diabetic foot syndrome // Russian Journal of Personalized Medicine. - 2023. - Vol. 3. - No. 1. - P. 109-123.

64. Stupina T. A. et al. Modern aspects of pathomorphology foot tissues in diabetic neuroosteoarthropathy syndrome, including those complicated by osteomyelitis (literature review and results of our own research) // Genius of Orthopedics. - 2022. - V. 28. - No. 2. - P. 282-288.

65. Styazhkina S. N. et al. Bacterial etiology inflammatory diseases accompanying diabetic foot syndrome // Modern science. – P. 144-146.

66. Sudakov D. V. et al. Treatment of purulent wounds in patients diabetes mellitus using electroactivated aqueous solutions // Systems analysis and control in biomedical systems. - 2019. - Vol. 10. - No. 2. - P. 427-429.

67. Tarabrin A.S. Methods of revascularization in patients with violation of patency of previously performed arterial reconstructions / A.S. Tarabrin, M.R. Kuznetsov, R.G. Khovalkin et al. // Surgery. - 2020. - No. 9. - P. 102-108.

68. Tikhomirova G.I., Pustovalova A.D., Talipov R.R. Modern aspects of diagnostics of diabetic foot syndrome: angiography of the lower extremities // Practice in a medical university and the pandemic realities and prospects. - 2022. - P. 128-130.

69. Fedyushkin V. V. et al. Multidisciplinary approach in treatment of complicated forms of diabetic foot syndrome // Innovative Medicine of Kuban. - 2023. - No. 3. - P. 99-104.

70. Khaidarova F. A., Inogamova D. T. Assessment of the central hemodynamics in patients with type 2 diabetes mellitus with and without chronic heart failure before cardiac revascularization // Central Asian Endocrinology Journal. - 2022. - Vol. 2. - No. 2.

71. Khamdamov B.Z., Khamdamov A.B., Razhabov D.U. Assessment methods of amputation at the level of the lower leg in severe forms of diabetic foot syndrome // Issues of Science and Education. - 2023. - No. 6 (171). - P. 35-43.

72. Khamdamov B.Z., Teshaev Sh.Zh., Khamdamov I.B. An improved method of amputation at the level of the lower leg in severe forms of diabetic

foot syndrome // Operative surgery and clinical anatomy (Pirogov Scientific Journal). - 2020. - Vol. 4. - No. 2. - P. 37-40.

73. Tsvetkova E. V. et al. A case of successful healing chronic wound of the amputation stump in a patient with diabetic neuroischemic foot syndrome after revascularization // Research Initiative-2023. - 2023. - P. 103-116.

74. Chevgun S. D. et al. X-ray surgical endovascular Methods of revascularization (balloon angioplasty with stenting) of peripheral arteries in patients with critical lower limb ischemia in diabetes mellitus // Ural Medical Journal. 2020. No. 4 (187). - 2020.

75. Chervyakov Yu.A. The nearest results of conservative treatment of “non-reconstructable” patients with critical lower limb ischemia / Yu. A. Chervyakov, Kh. N. Ha, A. E. Klimov et al. // Angiology and vascular surgery. - 2019. - Vol. 25, No. 2. - P. 11–15.

76. Chur S. N., Alekseev S. A., Alekseev V. S. Features revascularization interventions for chronic ischemia in patients with diabetic foot syndrome // indelible tablets: sepsis et cetera. - 2020. - P. 635-637.

77. Chur S.N., Adzerikh I.E., Davidovsky I.A. Complex approach to the treatment of patients with ischemic and neuroischemic forms of diabetic foot syndrome. // Current issues of purulent-septic surgery. Bobruisk, 2019. 213-215.

78. Chur N. N. et al. Experience in the use of donor vascular grafts in surgery of the main arteries of the lower extremities. – 2023. pp. 68-70

79. Shabrykina N. S., Lukin P. S. Mathematical model microcirculation for predicting reperfusion syndrome in patients with diabetes mellitus // Russian Journal of Biomechanics. - 2022. - Vol. 26. - No. 4. - P. 88-96.

80. Skoda M. V., Chur N. N., Kondratenko G. G. Revascularization in critical ischemia in patients with diabetic foot syndrome // Intraabdominal infection. Diagnostic and treatment issues. - 2020. - P. 238-240.

81. Skoda M.V., Chur N.N., Chernomorets N.V. et al. Foot and tibial bypasses for critical ischemia of diabetic foot syndrome. // Current issues in the diagnosis, treatment, and prevention of diabetic foot syndrome. Kazan, 2018. pp. 167-17

82. Shumilina M.V., Keren M.A., Khadzegova O.A. Index Ankle pressure is the first-line non-invasive screening test for diagnosing lower extremity arterial disease:
Possibilities and limitations of the method. //Clinical physiology of blood circulation. 2020;17(3):183-8.

83. Ergashev U. Yu. et al. Study of liver pathomorphology in experimental diabetic foot syndrome //European Journal of Interdisciplinary Research and Development. - 2023. - Vol. 12. - P. 27-31.

84. Yamshchikov O. N. et al. Diagnosis of diabetic syndrome feet using radiological examination methods // International Journal of Humanities and Natural Sciences. - 2023. - No. 6-2 (81). - P. 87-90.

85. Abrahamian H, Kautzky-Willer A, Rießland-Seifert A, Fasching P, Ebenbichler C, Kautzky A, et al. Psychische Erkrankungen und Diabetes mellitus (Update 2019) //Wien Klin Wochenschr. 2019;131(1):186–195.

86. Alavi, A. Diabetic foot ulcers: Part I. Pathophysiology and prevention/ A. Alavi, RG Sibbald, D. Mayer, L. Goodman [et al.]// J Am Acad Dermatol. – 2019.- Vol. 70.-Is. 1.- P. 1.e1-1.e18.

87. Algharib A, Koning GG, van Dortmont LMC, Riedel S, Möller R. Reduzierte Amputationsrate bei Patienten mit diabetischem Fußsyndrom seit Einführung eines minimalinvasive Konzepts [Reduced Amputation Rate in Patients with Diabetic Foot Syndrome Since the Introduction of a Minimalinvasive Concept]. //Zentralbl Chir. 2023 Nov 23. German. R.54-58

88. Alharbi TJ, Tourkmani AM, Abdelhay O, Alkhashan HI, Al-Asmari AK, Bin Rsheed AM, et al. The association of metformin use with vitamin B12 deficiency and peripheral neuropathy in Saudi individuals with type 2 diabetes mellitus.// PLoS ONE. 2018;13(10):e0204420.

89. American Diabetes Association Microvascular complications and foot care: Standards of medical care in diabetes-2018. Diabetes Care. 2018;41(Suppl 1):105–118.

90. arć P., Antkiewicz M., Śliwa B., Baczyńska D., Witkiewicz W., Skóra J. Treatment of critical limb ischemia by pIRES/VEGF165/HGF administration. //Ann.Vasc.Surg. 2019;60:346–354

91. Bakker K, Apelqvist J, Lipsky BA, Van Netten JJ; International Working Group on the Diabetic Foot. The 2015 IWGDF guidance documents on prevention and management of foot problems in diabetes: development of an evidence-based global consensus. //Diabetes Metab Res Rev. 2020 Jan;32

92. Barć P, Antkiewicz M, Frączkowska-Sioma K, Two-Stage Gene Therapy (VEGF, HGF and ANG1 Plasmids) as Adjunctive Therapy in the Treatment of Critical Lower Limb Ischemia in Diabetic Foot Syndrome. //Int J Environ Res Public Health. 2022 Oct 6;19(19):12818.P36-38

93. Berchiolli R, Bertagna G, Adami D, Piaggesi A, Peripheral Interventional Strategy Assessment (PISA) for Diabetic Foot Ulcer Revascularization: Preliminary Outcomes of a Multidisciplinary Pilot Study. //Diagnostics (Basel). 2023 Sep 8;13(18):2879P148-151 94. Callaghan BC, Cheng HT, Stables CL, Smith AL, Feldman EL. Diabetic neuropathy: clinical manifestations and current treatments. //Lancet Neurol. 2020;11(6):521–534.

95. Casanova-Molla J, Valls-Solé J. Electrodiagnostic testing of small fiber neuropathies: A review of existing guidelines. //J Clin Neurophysiol. 2020;37(4):288–293.

96. Clodi M, Abrahamian H, Brath H, Brix J, Drexel H, Fasching P, et al. Antihyperglycemic treatment guidelines for diabetes mellitus type 2 (Update 2019) //Wien Klin Wochenschr. 2019;131(Suppl 1):27–38.

97. Collins R., Cranny G., Burch J., Aguiar-Ibáñez R., Craig D., Wright K., Berry E., Gough M., Kleijnen J., Westwood M. A systematic review of duplex ultrasound, magnetic resonance angiography and computed tomography angiography for the diagnosis and assessment of symptomatic, lower limb peripheral arterial disease. Health Technol. Assess.

2017;11:iii-184.

98. David G. Armstrong, Tze-Woei Tan, Andrew JM Boulton, Sicco A. Bus, Diabetic Foot Ulcers, //JAMA,2023.10578, 330, 1, (62),

99. Eiberg JP, Grønvall Rasmussen JB, Hansen MA, Schroeder TV Duplex ultrasound scanning of peripheral arterial disease of the lower limb. //Eur. J.Vasc. Endovasc. Surg. 2020;40:507–512.

100. Elgendy R, Deschênes SS, Burns RJ, Levy M, Schmitz N. Alcohol consumption, depressive symptoms, and the incidence of diabetesrelated complications. //J Diabetes. 2019;11(1):14–22.

101. Eslami, M.H. The adverse effects of race, insurance status, and low income on the rate of amputation in patients presenting with lower extremity ischemia/ M. H. Eslami, M. Zayaruzny, G. A. Fitzgerald// J Vasc Surg.- 2019.- Vol. 45.- Is. 1.- P. 55-59.

102. Fabiani I., Calogero E., Pugliese NR, Di Stefano R., Nicastro I., Buttitta F., Nuti M., Violo C., Giannini D., Morgantini A., et al. Critical Limb Ischemia: A Practical Up-To-Date Review. //Angiology. 2017;69:465–474.

103. Farber A., Eberhardt RT The Current State of Critical Limb Ischemia: A Systematic Review. //JAMA Surg. 2019;151:1070–1077.

104. Feldman EL, Callaghan BC, Pop-Busui R, Zochodne DW, Wright DE, Bennett DL, et al. Diabetic neuropathy. Nat Rev Dis Primers. 2019;5(1):41.

105. Freisinger E., Malyar N.M., Reinecke H., Lawall H. Impact of diabetes on outcome in critical limb ischemia with tissue loss: A large-scaled routine data analysis. //Cardiovasc. Diabetol. 2019;16:41.

106. Hernandez-Cardoso GG, Rojas-Landeros SC, Castro-Camus E. Terahertz imaging for early screening of diabetic foot syndrome: A proof of concept. //Sci Rep. 2019 Feb 6;7:42124P45-49

107. Hinchliffe RJ, Forsythe RO, Apelqvist J, et al (2020) Guidelines on diagnosis, prognosis, and management of peripheral artery disease in patients with foot ulcers and diabetes (IWGDF 2019 update). //Diabetes Metab Res Rev.2020

108. Hingorani A, LaMuraglia GM, Henke P, Murad MH. The management of diabetic foot: A clinical practice guideline by the Society for Vascular Surgery in collaboration with the American Podiatric Medical

Association and the Society for Vascular Medicine. //J Vasc Surg. 2016 Feb;63(2 Suppl):3S-21S.P96-98

109. Hoeldtke RD, Bryner KD, VanDyke K. Oxidative stress and autonomic nerve function in early type 1 diabetes.// Clin Auton Res. 2019;21(1):19–28.

110. Hofmann W.J., Forstner R., Kofler B., Binder K., Ugurluoglu A., Magometschnigg H. Pedal artery imaging--a comparison of selective digital subtraction angiography, contrast enhanced magnetic resonance angiography and duplex ultrasound. Eur. J.Vasc. Endovasc. Surg. 2020;24:287–292.

111. Ignatovich IN, Kondratenko GG, Sergeev GA, Kornievich SN, Taganovich DA, Khrapov IM, Mikhailova NM. [Effect of revascularization of on therapeutic outcomes of treatment for lower-limb chronic critical ischaemia in neuroischaemic form of diabetic foot syndrome]. //Angiol Sosud Khir. 2020;17(1):71-5

112. Inampudi C., Akintoye E., Ando T., Briasoulis A. Angiogenesis in peripheral arterial disease. //Curr. Opin. Pharmacol. 2018;39:60–67

113. Jhamb S, Vangaveti VN, Malabu UH. Genetic and molecular basis of diabetic foot ulcers: Clinical review. //J Tissue Viability. 2019 Nov;25(4):229-236

114. Khan A, Shafiq I, Hassan Shah M. Prevalence of vitamin B12 deficiency in patients with type II diabetes mellitus on metformin: A study from Khyber Pakhtunkhwa. //Cureus. 2019;9(8):e1577.

115. Kofler M, Leis AA, Valls-Solé J. Cutaneous silent periods—Part 1: Update on physiological mechanisms. //Clin Neurophysiol. 2019;130(4):588–603.

116. Köhler G, Eichner M, Abrahamian H, Kofler M, Sturm W, Menzel A. Diabetic neuropathy and diabetic foot syndrome (update 2023)]. //Wien Klin Wochenschr. 2023 Jan;135(Suppl 1):164-181.

117. Kulbaba I, Kritsak M, Konowalenko S. Algorytm do angioplastyki balonowej u pacjentów z krytycznym niedokrwieniem z zespołem stopy cukrzycowej [Algorithm for balloon angioplasty in patients with critical limb ischemia with diabetic foot syndrome]. //Pol Merkur Lekarski. 2022 Dec 22;50(300):370-373.

118. Kulzer B, Albus C, Herpertz S, Kruse J, Lange K, Lederbogen F, et al. Psychosocial factors and diabetes. //Exp Clin Endocrinol Diabetes. 2021;129(S 01):S91–105.

119. Lanting SM, Twigg SM, Johnson NA, Baker MK, Caterson ID, Chuter VH. Non-invasive lower limb small arterial measures co-segregate strongly with foot complications in people with diabetes. //J Diabetes Complications. 2017 Mar;31(3):589-593.

120. Lapeyre M., Kobeiter H., Desgranges P., Rahmouni A., Becquemin JP, Luciani A. Assessment of critical limb ischemia in patients with diabetes: Comparison of MR angiography and digital subtraction angiography. //AJR Am. J. Roentgenol. 2020;185:1641–1650.

121. Lee JW, Kwon OH, Kim TK, Cho YK, Choi KY, Chung HY, Cho BC, Yang JD, Shin JH. Platelet-rich plasma: quantitative assessment of growth factor levels and comparative analysis of activated and inactivated groups. //Arch Plast Surg. 2023 Sep;40(5):P530-531

122. Levin SR, Arinze N, Siracuse JJ. Lower extremity critical limb ischemia: A review of clinical features and management. //Trends Cardiovasc Med. 2020 Apr;30(3):125-130.

123. Lu Y, Xing P, Cai X, Luo D, Li R, Lloyd C, et al. Prevalence and risk factors for diabetic peripheral neuropathy in type 2 diabetic patients from 14 countries: Estimates of the INTERPRET-DD study. //Front Public Health. 2020;8:534372.

124. Luo X, Huang K, Huang B, Single-Center experience of treating chronic limb-threatening ischemia of lower limbs combined with diabetes]. // Sichuan Da Xue Xue Bao Yi Xue Ban. 2022 Nov;53(6):988-992.

125. Maser RE, Steenkiste AR, Dorman JS, Nielsen VK, Bass EB, Manjoo Q, et al. Epidemiological correlates of diabetic neuropathy. Report from Pittsburgh Epidemiology of Diabetes Complications Study. //Diabetes. ;38(11):1456–1461.

126. Matricali GA, Dereymaeker G, Muls E, Flour M, Mathieu C (2017) Economic aspects of diabetic foot care in a multidisciplinary setting: a review. Diabetes Metab Res Rev 23(5):339–347.

127. Meza-Torres B, Carinci F, Heiss C, Joy M, de Lusignan S (2021) Health service organization impact on lower extremity amputations in people with type 2 diabetes with foot ulcers: systematic review and meta-analysis. // Acta Diabetol 58(6):735–747.

128. Monami M, Ragghianti B, Nreu B, et al (2022) Major amputation in non-healing ulcers: outcomes and economic issues. data from a cohort of patients with diabetic foot ulcers. //Int J Low Extreme Wounds.

129. Monteiro-Soares M, Hamilton EJ, Russell DA, Srisawasdi G, Boyko EJ, Mills JL, Jeffcoate W, Game F. Classification of foot ulcers in people with diabetes: A systematic review. //Diabetes Metab Res Rev. 2023 May 2:e3645.

130. Monteiro-Soares M, Hamilton EJ, Russell DA, Srisawasdi G, Boyko EJ, Mills JL, Jeffcoate W, Game F. Guidelines on the classification of foot ulcers in people with diabetes (IWGDF 2023 update). //Diabetes Metab Res Rev. -2023 May 14:P36-48.

131. Monteiro-Soares M, Russell D, Boyko EJ, International Working Group on the Diabetic Foot (IWGDF). Guidelines on the classification of diabetic foot ulcers (IWGDF 2019). //Diabetes Metab Res Rev. 2020 Mar;36 Suppl 1:e3273.

132. Monteiro-Soares M, Russell D, Boyko EJ, Jeffcoate W, Mills JL, Morbach S, Game F; International Working Group on the Diabetic Foot (IWGDF). Guidelines on the classification of diabetic foot ulcers (IWGDF 2019). //Diabetes Metab Res Rev. 2020 Mar;36 Suppl 1:e32-73.

133. Morbach S, Eckhard M, Lobmann R, Müller E, Reike H, Risse A, Rümenapf G, Spraul M. Diabetic foot syndrome. //Exp Clin Endocrinol Diabetes. 2023 Feb;131(1-02):84-93.

134. Morbach S, Lobmann R, Eckhard M, Müller E, Reike H, Risse A, Rümenapf G, Spraul M. Diabetic Foot Syndrome. //Exp Clin Endocrinol Diabetes. 2021 Aug;129(S 01):S82-S90.

135. Musuuza J, Sutherland BL, Kurter S, Balasubramanian P, Bartels CM, Brennan MB (2020) A systematic review of multidisciplinary teams to reduce major amputations for patients with diabetic foot ulcers. //J Vasc Surg 71(4):1433-1446.e3.

136. Němcová A, Dubský M, Jirkovská A, Syndrome diabeticke nohy: význam MR spektroskopie lýtkových svalů pro hodnocení končetinové ischemie a efektu revaskularizace

[Diabetic foot syndrome: importance of calf muscles MR spectroscopy in the assessment of limb ischemia and effect of revascularization]. //Vnitr Lek. 2017 Spring;63(4):236-241.

137. Niță O, Arhire LI, Mihalache L, Popa AD, Niță G, Gherasim A, Graur M. Evaluating classification systems of diabetic foot ulcer severity: A 12-Year retrospective study on factors impacting survival. //Healthcare (Basel). 2023 Jul 20;11(14):2077.

138. OuYang H, Tang Y, Yang F, Ren X, Yang J, Cao H, Yin Y. Platelet-rich plasma for the treatment of diabetic foot ulcer: a systematic review. //Front Endocrinol (Lausanne). 2023 Nov 18;14:1256081P.110-112

139. Pam Chen, Nalini Campillo Vilorio, Ketan Dhatariya, William Jeffcoate, Ralf Lobmann, Caroline McIntosh, Alberto Piaggesi, John Steinberg, Prash Vas, Vijay Viswanathan, Stephanie Wu, Fran Game, Guidelines on interventions to enhance healing of foot ulcers in people with diabetes (IWGDF 2023 update), Diabetes/Metabolism Research and Reviews, 10.1002/ dmrr.3644, (2023).P16-19

140. Parizad N., Hajimohammadi K., Goli R. Surgical Debridement, Maggot Therapy, Negative Pressure Wound Therapy, and Silver Foam Dressing Revive Hope for Patients with Diabetic Foot Ulcer: A Case Report. Int. //J. Surg. Case Rep. 2021;82:105931. P98-100

141. Pieruzzi L, Napoli V, Goretti C, Adami D, Iacopi E, Cicorelli A, Piaggesi A. Ultrasound in the Modern Management of the Diabetic Foot Syndrome: A Multipurpose Versatile Toolkit. //Int J Low Extreme Wounds. 2020 Dec;19(4):315-333.

142. Pieruzzi L., Napoli V., Goretti C., Adami D., Iacopi E., Cicorelli A., Piaggesi A. Ultrasound in the Modern Management of the Diabetic Foot Syndrome: A Multipurpose Versatile Toolkit. Int. J. Low. Extreme. Wounds. 2020;19:315–333.

143. Rani V, Deep G, Singh RK, Palle K, Yadav UC. Oxidative stress and metabolic disorders: Pathogenesis and therapeutic strategies. //Life Sci. 2016 Mar 1;148:183-93.

144. Rümenapf G, Morbach S. Sigl M; Commission PAVK and

Diabetisches Fußsyndrome der DGG e. V.. Diabetic foot syndromePart 1: Definition, pathophysiology, diagnostics and classification]. // Chirurg. 2021 Jan;92(1):81-94.

145. Sarajlić V.Đ., Totić D., Osmanagić AB, Gojak R., Lincender L. Is 64-Row Multi-Detector Computed Tomography Angiography Equal to Digital Subtraction Angiography in Treatment Planning in Critical Limb Ischemia? Psychiatr. //Danub. 2019;31:814–820.

146. Sechovcová H, Mahayri TM, Mrázek J, Jarošíková R, Husáková J, Wosková V, Fejfarová V. Gut microbiota in relationship to diabetes mellitus and its late complications with a focus on diabetic foot syndrome: A review. //Folia Microbiol (Praha). 2023 Dec 14.

147. Sicco A. Bus et al. (2023) Standards for the development and methodology of the 2023 IWGDF guidelines

148. Skóra J., Barć P., Pupka A., Dawiskiba T., Korta K., Albert M., Szyber P. Transplantation of autologous bone marrow mononuclear cells with VEGF gene improves diabetic critical limb ischaemia. //Endokrynol. Polska. 2023;64:129–138.

149. Skóra JP, Płonek T., Barc P., Baczynska D., Radwanska A., Pupka A., Korta K., Ussowicz M., Strożecki L., Kupczyńska-Markiewicz D., et al. The Formation of Blood Vessel after the Administration of the Plasmid Encoding Ang-1 Gene in Fischer Rats. Adv. //Clin. Exp. Med. 2019;25:611–615.

150. Sun H., Saeedi P., Karuranga S., et al. IDF Diabetes Atlas: Global, regional and country-level diabetes prevalence estimates for 2021 and projections for 2045. Diabetes Res. //Clin. Pract. 2021;183:109119

151. Tesfaye S, Selvarajah D. Advances in the epidemiology, pathogenesis and management of diabetic peripheral neuropathy. //Diabetes Metab Res Rev. 2019;28(Suppl 1):8–14.

152. Troisi N., Bertagna G., Juszczak M., Canovaro F., Torri L., Adami D., Berchiolli R. Emergent management of diabetic foot problems in the modern era: Improving outcomes. //Semin. Vasc. Surg. 2023;36:224–233.

153. Troitskaya NI, Shapovalov KG, Mudrov VA. Possibilities of

Multilayer Perceptron in Complexing Risk Factors of Diabetic Foot Syndrome. //Bull Exp Biol Med. 2022 Aug;173(4):415-418.

154. van Netten JJ, Apelqvist J, Bus SA, Fitridge R, Game F, Monteiro-Soares M, Senneville E, Schaper NC. The International Working Group on the Diabetic Foot: Stories and Numbers Behind Three Decades of Evidence-Based Guidelines for the Management of Diabetes-Related Foot Disease. //Diabetes Ther. 2024 Jan;15(1):19-31. doi: 10.1007/ s13300-023-01510-5.

155. Vas PRJ, Papanas N. Diabetic peripheral neuropathy and depression: dancing with wolves?—Mini-review and commentary on Alghafri et al. “Screening for depressive symptoms among patients with diabetic peripheral neuropathy” // Rev Diabet Stud. 2021;17(1):17–20.

156. Viadé et al. A novel assessment, diagnostic and treatment system for diabetic foot // Journal of Foot and Ankle Research -2023.-R. 16:84 Vincent AM, Callaghan BC, Smith AL, Feldman EL. Diabetic neuropathy: cellular mechanisms as therapeutic targets. Nat Rev Neurol. 2021;7(10):573–583.

157. Wiffen PJ, Derry S, Bell RF, Rice AS, Tölle TR, Phillips T, et al. Gabapentin for chronic neuropathic pain in adults. //Cochrane Database Syst Rev. 2019.

158. Zheng Y, Ley SH, Hu FB. Global aetiology and epidemiology of type 2 diabetes mellitus and its complications. //Nat. Rev. Endocrinol. 2018;14(2):88-98.

159. Ziegler D, Keller J, Maier C, Pannek J. Diabetische Neuropathie. Diabetol Stoffwechs. 2021;16(Suppl 2):S336–S350.

160. Ziegler D, Rathmann W, Dickhaus T, Meisinger C, Mielck A, KORA Study Group Neuropathic pain in diabetes, prediabetes and normal glucose tolerance: the MONICA/KORA Augsburg Surveys S2 and S3. Pain Med. 2019;10(2):393–400.