NO-therapy in the treatment of purulent and necrotic lesions of lower extremities in diabetic patients

A. M. Shulutko, N. V. Antropova, Yu. A. Kruger

NO-therapy with “Plazon” system was used in complex treatment of purulent and necrotic lesions of the lower extremities in 65 diabetic patients. Efficacy was evaluated with clinical, cytological and bacteriological studies. All the phases of wound process were shorter when NO-therapy was used. Complex treatment with NO-therapy led to faster (2 times) epithelization of diabetic ulcers compared with conventional treatment.

According to the statistics the number of diabetic patients might reach 250 million by 2025 compared with 120 million in 1996. An increased number of diabetic patients lead to greater number of people suffering from purulent and necrotic lesions of lower extremities. Problems with appropriate treatment of such patients are far from being solved completely. However, the approach to treat patients of that kind has recently become more advanced, and now allows for avoiding the phase of wound process when an amputation is necessary.

Nowadays, NO-therapy (air-plasmatic flow of nitrogen) with “Plazon” system is used in complex treatment of purulent and necrotic lesions of lower extremities. The discovery of NO became one of the greatest scientific and medical happenings of the 20th century. NO functions as a universal regulator-messenger and is being produced by live cells as a result of NO generation. All the phases of wound process were shorter when NO-therapy was used. Diabetic patients with lack of NO will likely develop diabetic neuropathy and microcirculation functions’ dysfunction. Combined together diabetic neuropathy and troubled microcirculation contribute negatively to lower extremities’ ulcer expansion, which might also be aggravated by second infection and further enlargement of necrotic lesions.

The goal of this study is to research efficacy of the NO-therapy and reach some possible improvement of results used in the complex treatment of diabetic patients with purulent and necrotic lesions of lower extremities.

Resources and methods

The most current and statistically correct data had been gathered by observing a treatment course of 65 patients. 37 patients (56.9%) had ulcers of different localization, and 28 patients (43.1%) had various necrotic problems. The group of patients consisted of 19 (29.2%) males and 46 (70.8%) females, an average of 60 and 57 years old accordingly. Control-group consisted of 53 people and everyone was treated using conventional methods of medicine. Parameters such as middling age, sex, a degree of diabetes, and a degree of change in the lower extremities’ condition, were used accordingly for each selected group of patients. Those who had a higher risk of their lower extremities being amputated were not included in the groups.

Distribution of patients depending on a degree of diabetic foot syndrome is shown in table 1. It is typical that the length of pathological changes is 7-10 days for necrotic lesions, and 1-2 months for ulcer development. For various treatment purposes an apparatus “Plazon” is used as a source of NO. “Plazon” was elaborated in the Moscow State Technical University (Bauman) in Kozlov’s laboratory under the supervision of Peksheva A. V. To perform NO-therapy manipulator with 2mm in diameter of outer channel is required in order to create a gas flow of low temperature (25-40 C) with a high consistency of NO molecules (2000-3000 ppm).

Table 1.	**Purulent and necrotic lesions' spreading degree based on intensity of wound by Vagner**			
Stage, by Vagner	main group		control group	
	absolute	%	absolute	%
I	4	6.2	4	7.5
II	19	29.2	18	34
III	32	49.2	24	45.3
IV	10	15.4	7	13.2

All treatment was subdivided on broad-spectrum procedures and local treatment. Broad-spectrum procedures included antibacterial therapy, and used medications to improve blood microcirculation. These medications were used specifically for complex treatment of patients with diabetic foot syndrome.

Local treatment included daily exposition of wounded tissues to NO-contained gas stream. An average exposition to a gas stream was 90 seconds. An outer channel of manipulator was located 5 cm high from the affected zone. An overall consistency of NO molecules close to ulcer damaged zone remains 2000ppm. Given longer distance from the damaged zone, the consistency would remain only 1000ppm, consequently making an overall concentration of NO molecules become smaller in number and less efficient.

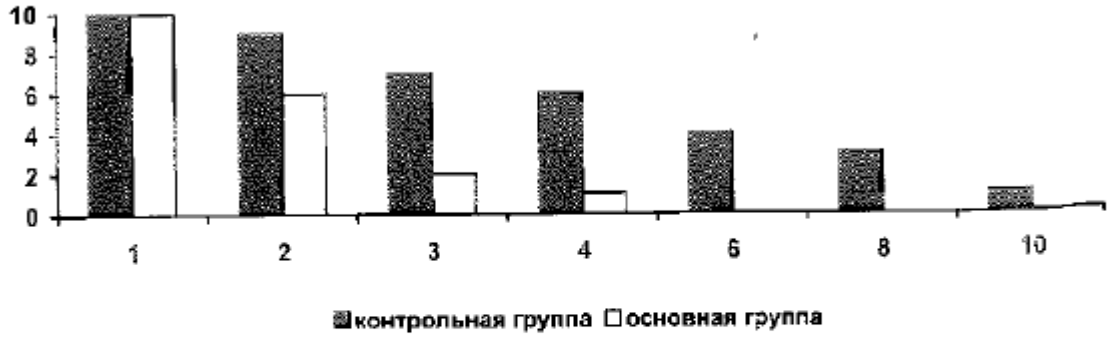
Prior to a beginning of the NO-therapy procedure local work up of wounded zone is required, and consists of eliminating of all over clustered tissues. As soon as an ongoing thorough cleaning leads to exposure of more and more healthy tissues, it is suggested to limit cleaning to antiseptically proved solution and thorough drying before the NO-therapy is used. The course of treatment with NO suggests 20 sittings.

To better understand the efficiency of NO-therapy, scientists were set to track the dynamics of wound process: amount and consistence of ulcer discharge, bacteriological research, cytological research of prints taken from the wounded surfaces in their dynamics, morphological research of wounded tissues, and detection of levels of oxygen. To capture dynamics of pain syndrome it was agreed to use a 10-grade system (an intensity of pain usually was determined based on observation, no specific measurements were performed), where 0 was meant to stand for “no pain” and 10 – “maximum of pain”.

Results

Results had been proving that the very first improvement was detected after a few sessions. Inflammatory activeness and swellings went down in patients with purulent necrotic lesions of lower extremities. It is very important to mention that an overall expressiveness of pain syndrome plays a significant role in the whole process of treatment. Its (pain syndrome) dynamics is shown on the Scheme 1. After 7 days of treatment, zones affected by ulcer showed less symptoms of necrotic lesions development. After 14 days a half of treated patients had visible improvements around ulcer wounds that showed bright granulation with distinguished edge’s revitalization. The dynamics of wound process is shown in Table 2.

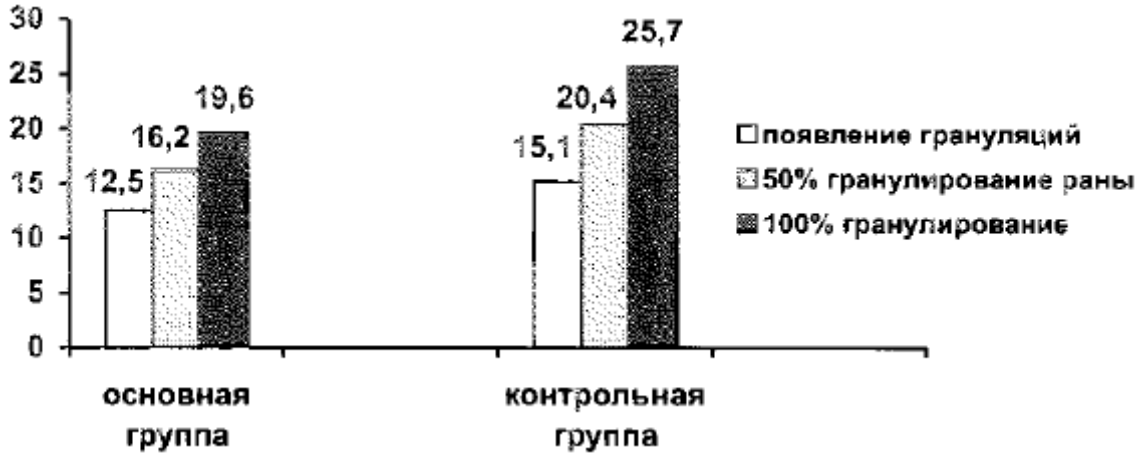
Table 2.	**Dynamics of wound process (given in days)**	
Symptomatics	Control group	NO Therapy
Wound Healing	25.2+/-2.1	19.1+/-2
Granulation	15.1+/-1.6	12.6+/-1.1
Edge Epithelization	22.8+/-1.9	14.1+/-1.7



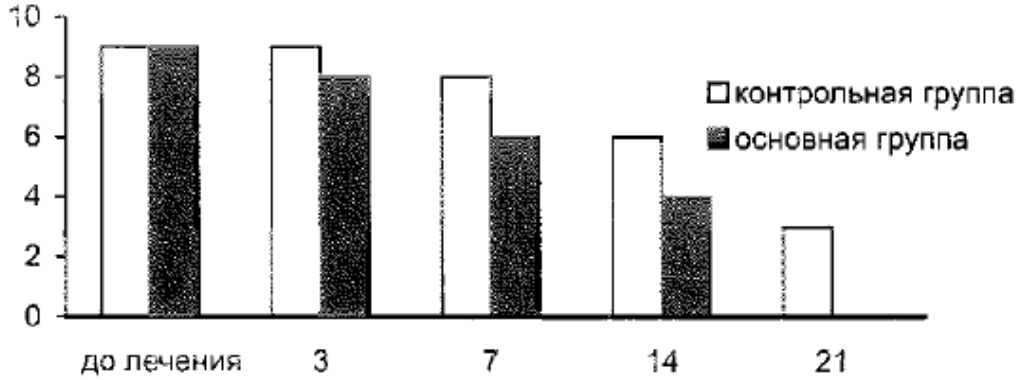
Scheme 1 Dynamics of pain syndrome within clinical groups (bals)
(black bars control group white bars therapy group

Results also showed that it took 19,1+/-2 days to get through the stage of compete wound healing. Compared to the control group of patients, which was through only in (25,2+/-2,1 days) ($p<0.05$), timing results appeared to be 1.3 times shorter for the main group of patients. Period of time necessary for a complete wound healing almost matched the period of time essential for ulcer wound to granulate. Detailed study of damaged tissues showed that inflammations lessened after 7th day of complex treatment with NO-therapy. Revitalization of wounds became visible after 14 day, when epithelial activeness was detected.

During the bacteriological research it also became clear that 1 gram of damaged tissue contained from 10^8 to 10^9 of microbial cells when left not treated, though after 3 days of NO-therapy the level of microbial cells went down from 10^7 to 10^6 in 1 gram. On the day 14th activeness no longer was considered critical showing only 10^3-10^4 of microorganisms in 1 gram. For the patients of “control” group the same parameters and results were a few days behind see scheme 3. To see the wound healing dynamics for patients treated under the “control” and “main” groups of patients, please, refer to the scheme 2.
In general, scientists witnessed absence of any kind of inflammation within ulcer damaged areas of the foot in almost any given case.

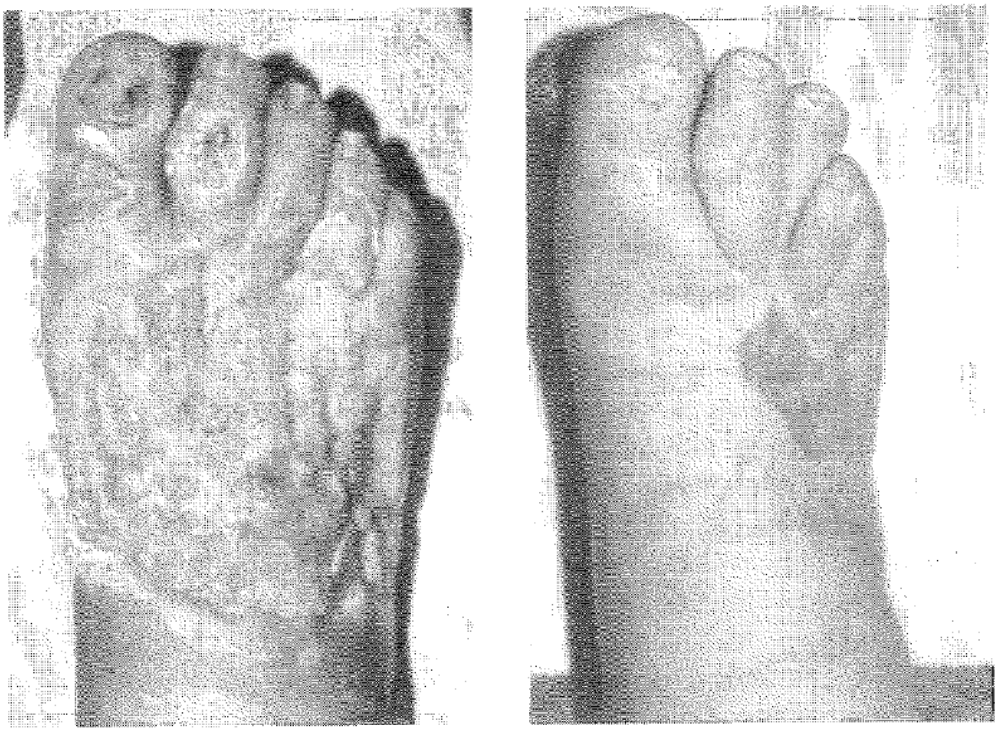


Scheme 2 Average time of wound granulation (days) First bars main, second bars control
White first granulation shows up, Grey 50% Granulation, Black 100% Granulation



Scheme 3 Wound bacterial cell count (to the power 10)
Black bars main group, white bars control group

To illustrate effectiveness of the NO-therapy method, the results of treatment of the female patient E. are shown in scheme 4 below . Patient E. entered the program diagnosed with over-extended purulent and necrotic lesions of inner part of her foot.



Scheme 4 Patient E a) before the treatment; b) 10 weeks from the day of the first NO session).