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PREDICTING THE COURSE OF SOFT TISSUE NECROBIOTIC INFECTIONS IN PATIENTS WITH DIABETES

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Abstract. Consideration of cytological indices and rapid microbiological signs allows us to develop a reliable set of criteria that reflect the key mechanisms of necrobiotic process development in necrotizing soft tissue infections in patients with diabetes.
Keywords: necrotizing soft tissue infections, prognosis, diabetes mellitus

Relevance. NSI remains one of the most severe forms of surgical pathology, occupying a significant place among the causes of acute life-threatening conditions globally. Large international studies highlight that the prevalence of necrotizing infections continues to increase, and mortality rates remain high even with the use of modern intensive care methods [1,18].
An additional challenge is the lack of universal tools that allow for an objective assessment of the intensity of the necrobiotic process at an early stage and monitoring of the transition zone [1,2,3,4,5,12].There is a tendency towards a steady increase in the number of patients with sepsis of various origins in the world, however, the number of patients against the background of surgical pathology leads in this list [2,6,7,8,9,10]. Surgical soft tissue infections are the leading pathology in the structure of primary admission of surgical patients to outpatient clinics. Interest and constant attention to this problem are explained by the severe course of the wound process, the continuing tendency towards an increase in long-term and recurrent forms. One of the most pressing and complex problems of emergency surgery, for many years, remains the treatment of purulent-inflammatory diseases of soft tissues against the background of diabetes mellitus. According to various authors, systemic inflammatory response syndrome and sepsis accompany purulent-inflammatory diseases of soft tissues in 62.5–77.6% [1, 12], and mortality tends to increase, which varies from 16 to 80%, depending on the development of generalization forms and the presence of underlying diseases [2,11]. Diabetes mellitus is the most common endocrine disease in the world, affecting 4-5% of the planet's population and, according to WHO experts, the number of people with diabetes on our planet may reach 250 million by 2025 [1; 5,12,13]. A study of the prevalence of diabetes mellitus by region of Uzbekistan, according to the Research Institute of Endocrinology, showed that 986 out of 100,000 people in the Republic develop diabetes. Of course, the true prevalence of the disease is several times higher than the number of registered patients with diabetes [1;14,15]. Purulent-necrotic diseases in diabetes mellitus are accompanied by severe endogenous intoxication and an atypical course. In this regard, the treatment of surgical infections that arise or occur against the background of diabetes mellitus is a complex and painstaking task [1; 16,19].
In this regard, the implementation of integrated approaches combining early risk stratification, objective assessment of microcirculation, rapid cytology, and modern physical methods of local intervention is particularly important. Such technologies not only allow for a more accurate

determination of the volume of primary necrosectomy but also ensure differentiated subsequent management tactics, which is especially important in patients with diabetes mellitus, who have limited tissue reparative capacity.

Study objective: to improve methods for predicting the course of the necrobiotic process in soft tissues in patients with diabetes mellitus.

Materials and methods. According to the study's objectives and goals, all patients were divided into two groups: the control group included 63 patients treated between 2016 and 2020, when the treatment of necrotic lesions was based on the traditional scheme; The main group included 65 patients observed between 2021 and 2025, using the comprehensive LDA method we developed.

Results and discussion. The data obtained showed that increasing degrees of soft tissue necrobiosis are accompanied by significant changes in the cytological characteristics of the smears. Taken together, this forms a consistent pattern of progression from the intact periphery to the questionable zone and then to the established necrotic lesion, as reflected in the Spearman rank coefficients.

Among the main indices, four stood out as demonstrating the closest correlation with the progression of the necrobiotic process. The IDN had a strong positive correlation coefficient ($r=0.919$ at $p<0.001$), reflecting the sequential destruction of polymorphonuclear cells as tissue dies. The IGN also demonstrated a pronounced linear correlation ($r=0.798$ at $p<0.001$), consistent with an increase in the volume of detritus and lysis of cellular structures in more severe zones. The ICI demonstrated comparable behavior ($r=0.731$ at $p<0.001$), indicating an increasing imbalance between the microbial mass and the number of protective cells. The last of the leading markers, the tissue destruction index, had a stable positive correlation ($r=0.835$ at $p<0.001$), emphasizing the direct relationship between the volume of destruction of the fibrous framework and the severity of necrobiosis. The characteristics of mixed microbial communities require special attention, especially when the proportion of polymicrobial complexes had one of the highest correlation coefficients at $r=0.827$ at $p<0.001$. This indicator demonstrates that as necrobiosis intensifies, the microflora becomes not only more aggressive in composition but also more synergistic, which enhances the destructive effect on tissue. Facultative anaerobes demonstrated a moderately pronounced positive correlation ($r=0.497$ at $p=0.003$), occupying an intermediate position between early and late participants in the infectious process.

The values of the correlation coefficients for the IDN reflected the most pronounced relationship of this indicator with the express microbiological characteristics of the wound surface. High positive coefficients were established for gram (-) rods ($r=0.742$ at $p<0.001$) and for the gram (-) / gram (+) ratio ($r=0.771$ at $p<0.001$), which demonstrates a stable association between the increase in the destruction of the neutrophil pool and the shift of flora towards aggressive gram (-) forms. Even more pronounced was the relationship of the IDN with obligate anaerobes ($r=0.904$ at $p<0.001$), as well as with the proportion of polymicrobial complexes ($r=0.789$ at $p<0.001$) and the anaerobes / aerobes ratio ($r=0.758$ at $p<0.001$). The IGN showed a similar profile, with coefficients of $r=0.703$ for Gram (-) rods, $r=0.863$ for obligate anaerobes, $r=0.941$ for Gram (-)/Gram (+), $r=0.722$ for anaerobes/aerobes, and $r=0.755$ for polymicrobial complexes, with a significance level of $p<0.001$ for all correlations.

The IGN demonstrated one of the most significant sets of correlation values among all cytological parameters. Associations with gram (-) rods were $r=0.768$ at $p<0.001$, with obligate anaerobes $r=0.923$ at $p<0.001$, with the gram (-)/gram (+) ratio $r=0.791$ at $p<0.001$ and with anaerobes/aerobes $r=0.979$ at $p<0.001$. Correlation with polymicrobial complexes reached

r=0.812 at p<0.001. The ICD showed even more pronounced associations, namely, r=0.881 with gram-negative rods, r=0.946 with obligate anaerobes, r=0.804 for gram-negative/gram-positive, r=0.793 for anaerobes/aerobes, and r=0.838 for polymicrobial complexes at a significance level of p<0.001 for each combination. This profile demonstrates that the ICD and ICD are most sensitive to microbial shifts associated with severe necrobiosis.

Thus, a comparison of cytological characteristics with microbiological parameters revealed a stable system of relationships reflecting the progression of necrobiosis from early changes to the phase of severe tissue destruction. An increase in the proportion of gram-negative rods and obligate anaerobes was accompanied by a consistent shift in the cytological profile toward an increase in destructive forms of neutrophils, increased purulent-necrotic decay, a growing microbial-cellular imbalance, and a loss of the structural integrity of the tissue matrix. This configuration emphasizes that the degree of necrobiosis is formed under the simultaneous influence of microbial aggression and the local cellular response, and each of the four identified indices reflects a distinct element of this process. The combination of the identified patterns provides a sufficient basis for moving to the next stage, which requires formalizing the obtained characteristics into an integrated scale capable of quantifying the degree of necrobiosis and serving as a tool for early prediction of wound healing dynamics.

CONCLUSIONS:

1. The intelligent PIN-SD-AI system demonstrated the highest diagnostic value, with an AUC of 0.96 and a CI of 0.93-0.99. Sensitivity was 92.3%, specificity 90.1%, positive predictive value 89.5%, and negative predictive value 93.7%. A threshold of 0.65 provided an overall accuracy of 91.5%.

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