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АНАЛИЗ ФАКТОРОВ, ПРЕДСКАЗЫВАЮЩИХ АМПУТАЦИЮ
НИЖНИХ КОНЕЧНОСТЕЙ У ПАЦИЕНТОВ
С ДИАБЕТИЧЕСКИМ СИНДРОМОМ СТОПЫ

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ANALYSIS OF PREDICTORS OF LOWER EXTREMITY AMPUTATION
IN PATIENTS WITH DIABETIC FOOT SYNDROME

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Резюме. Синдром диабетической стопы (СДС) ежегодно становится причиной более 1 миллиона ампутаций, при этом примерно одна ампутация нижней конечности происходит каждые 30 секунд в мире. Общий уровень ампутаций среди пациентов с диабетическими язвами стопы составляет около 31%. Годовая заболеваемость оценивается как 139,97 малых и 94,82 больших ампутаций на 100 000 человек с диабетом.

Ключевые слова: синдром диабетической стопы, предикторы ампутации, плохой гликемический контроль, отсутствие нейропротективной терапии, неадекватная сосудистая диагностика.

Resume. Diabetic foot syndrome (DFS) causes over 1 million amputations annually, with roughly one lower-limb amputation occurring every 30 seconds globally. The overall amputation rate among patients with diabetic foot ulcers is approximately 31%. The annual incidence is estimated at 139.97 minor and 94.82 major amputations per 100,000 people with diabetes.

Keywords: diabetic foot syndrome, amputation predictors, poor glycemic control, lack of neuroprotective therapy, and inadequate vascular diagnostics.

Relevance. Diabetic foot syndrome (DFS) is a severe complication of diabetes mellitus (DM) and the leading cause of non-traumatic lower limb amputations worldwide. Early detection of patients at high risk of amputations on an outpatient basis can prevent delays in referral to a doctor and reduce the frequency of such operations. The pathogenesis of DFS involves peripheral neuropathy, peripheral arterial disease, and infection, often coexisting in the same patient. Neuropathy leads to loss of protective sensation, unnoticed trauma, and subsequent ulceration. Concurrent ischemia impairs wound healing and accelerates tissue necrosis. Routine foot examination using a standardized monofilament test, assessment of foot pulses, and Doppler ultrasound are essential screening tools. However, many healthcare systems lack structured outpatient programs for diabetic foot care. Key risk factors for amputation include poor glycemic control (HbA1c >7%), smoking, previous ulcers or amputations, and inadequate vascular supply. Multidisciplinary management involving endocrinologists, podiatrists, vascular surgeons, and diabetes nurses has been shown to reduce amputation rates by up to 50%. Therefore, implementing regular

foot screening, patient education, and timely referral pathways in outpatient settings is critical to reducing the global burden of DFS-related amputations.

Aim: the main goal of this study is to identify clinical, laboratory, and organizational predictors associated with lower extremity amputation in patients with Diabetic Foot Syndrome.

Objectives:

1. To identify clinical predictors (such as comorbidities like coronary artery disease, arterial hypertension, diabetic nephropathy, and the presence of diabetic distal neuropathy) that are associated with lower extremity amputation in patients with Diabetic Foot Syndrome.

2. To identify laboratory predictors (including glycated hemoglobin levels, blood glucose levels, and markers of glycemic control) that contribute to the risk of lower extremity amputation in patients with Diabetic Foot Syndrome.

3. To identify organizational predictors (such as adherence to therapy, frequency of endocrinologist visits, timing of surgical referrals, performance of vascular imaging like Doppler ultrasound, and use of neuroprotective therapy) that influence the likelihood of lower extremity amputation in patients with Diabetic Foot Syndrome.

Materials and methods. The research was carried out at the polyclinic № 34 in Minsk, Belarus. We analysed the medical records of 52 in total with 26 patients with a confirmed diagnosis of type 2 diabetes mellitus who underwent lower extremity amputation or reamputation procedures during the period from 2021 to 2025; and a control group of another 26 patients who didn't undergo amputation. All patients were on insulin therapy with a confirmed diagnosis of diabetic foot.

Results and their discussion. The study included 26 patients with diabetic foot syndrome who underwent lower extremity amputation. Gender distribution showed a predominance of men: 21 patients (80.7%) versus 5 women (19.3%). During the study period, 35 amputations were performed: 19 amputations of the toes (54.3%), 4 amputations of the foot (11.4%), 10 amputations below the knee (transtibial) (28.6%), 2 amputations above the knee (transfemoral) (5.7%).

Primary amputation was performed in 23 cases (88.5%), secondary amputation in 10 cases (38.5%), and tertiary amputation in 2 cases (7.7%), indicating disease progression and insufficient effectiveness of initial treatment. Diabetic distal neuropathy was diagnosed in 100% of patients. Only 9 out of 26 patients (34.6%) received alpha-lipoic acid preparations 6–12 months prior to amputation, indicating inadequate use of neuroprotective therapy in this high-risk group. Low adherence to therapy, glycemic control, and dietary recommendations was noted in 16 patients (61.5%) according to endocrinologists' records. Foot examination by medical staff using a standardized protocol was performed in only 5 cases before the appearance of initial signs of diabetes decompensation (toe pain, wounds, numbness, etc.), indicating insufficient screening for diabetic foot syndrome.

Only 16 patients (61.5%) had an appointment with an endocrinologist within 6 months prior to amputation; all 16 patients underwent therapy correction, but only 6 patients (23% of the total sample) were referred to a surgeon with a diabetic foot. Vascular surgeon consultation was prescribed to only 7 patients, despite the confirmed obliterating atherosclerosis of the vessels of the lower extremities in 24 patients (92.3%). Ultrasound Dopplerography of the lower extremity arteries was performed in only 10 patients (38.5%)

6–12 months before amputation: stenosis 80–90% – in 5 patients, stenosis 50–75% – in 5 patients.

Parameter	Major amputations	Minor amputations	Statistic
N (dm duration known)	9	21	—
Mean dm duration (years)	15.2	10.8	U = 134, p = 0.074
Point-biserial correlation with major amp	R = 0.390	—	P = 0.033*

Fig. 1 – Correlation with the duration to the Major/Minor amputations on the collected patient samples

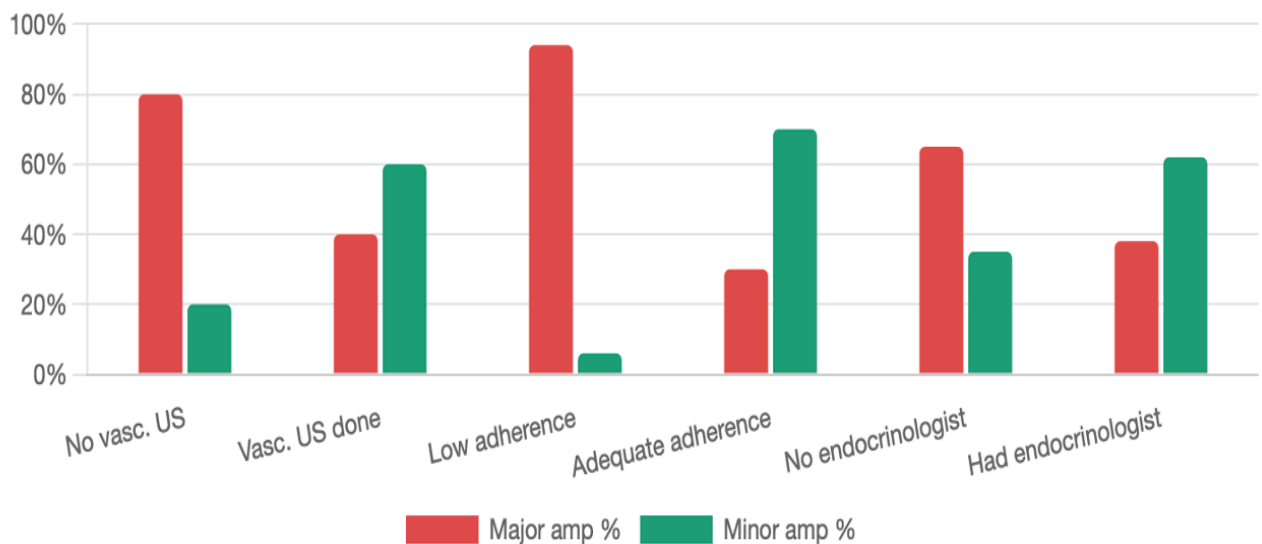


Fig. 2 – The distribution of Amputation severity by care gap and Adherence as a factor

Vascular therapy in the day care unit and in the hospital, setting was administered to 12 patients (46.2%) within 6 months prior to amputation. In 3 cases (11.5%), glycated hemoglobin was lower than 7.0%, in 22 cases (84.6%) it was higher than 7.0%, and in 10 cases (38.5%) glycated hemoglobin was not controlled 6 months before amputation. The glucose level in 6 cases (23.1%) before surgery was 5.6-8.0 mmol/L, in 21 cases (80.8%) 9.0-15.0 mmol/L, and in 8 cases (30.8%) more than 15.0 mmol/L. Coronary artery disease (CAD) and arterial hypertension were diagnosed in 100% of patients. Diabetic nephropathy was identified in 6 patients prior to amputation: stage C3A3 – 3 patients, C3B – 1 patient, C4 – 2 patients.

Conclusions:

1. Structured foot exam: Only 14.3% of amputees had a formal protocol vs. 96.2% of controls (OR = 0.01). Routine documented exams are the single most protective measure.

2. Glycaemic control: Mean HbA1c was 11.6% (amputation) vs. 6.8% (controls). Target levels are non-negotiable.
3. Endocrinologist follow-up: Absent in 62.9% of amputees vs. 0% of controls. Regular specialist care is mandatory.
4. Neuropathy treatment (thioctic acid): Withheld in 77.1% of amputees vs. 15.4% of controls. Treating underlying neuropathy preserves protective sensation.
5. Vascular surveillance: Only 11.4% of amputees had yearly ultrasound vs. 42.3% of controls (OR = 0.18). Silent ischaemia must be actively screened.
6. Podologist access: Only 8.6% of amputees saw a podologist. Professional foot care prevents microtrauma.
7. Repeat amputations: 34.3% were repeat events – secondary prevention has completely failed.
8. Patient adherence: Poor compliance with diet, medication, and self-monitoring dominated the amputation group. Education and shared decision-making are essential.

Literature

1. Azab, B. et al. Usefulness of the neutrophil-to-lymphocyte ratio in predicting short- and long-term mortality in breast cancer patients / B. Azab // *Annals of Surgical Oncology*. – 2012. – Vol. 19, № 1. – P. 217–224.
2. Hu, B. et al. Inflammation-based prognostic score, a valuable biomarker for predicting long-term outcomes in patients with ACS / B. Hu // *Medicine*. – 2018. – Vol. 97, № 28. – e11339.
3. Lim JZ, Ng NS, Thomas C. Prevention and treatment of diabetic foot ulcers. *J R Soc Med*. 2017 Mar;110(3):104-109. doi: 10.1177/0141076816688346. Epub 2017 Jan 24. PMID: 28116957; PMCID: PMC5349377.
4. Castellino LM, Crisologo PA, Chhabra A, Öz OK. Diabetic Foot Infections. *Infect Dis Clin North Am*. 2025 Sep;39(3):465-482. doi: 10.1016/j.idc.2025.02.014. Epub 2025 Apr 9. PMID: 40204567.