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## DETERMINATION OF NON-SPECIFIC RESISTANCE OF THE ORGANISM IN PATIENTS WITH ACUTE INTESTINAL OBSTRUCTION

**Relevance of the topic.** The course of acute intestinal obstruction in many cases depends on the patient's non-specific resistance, which is based on the production of humoral (antibody) or cellular factors.

Immunologically competent cells that indicate the activation of immune cellular responses are neutrophils, lymphocytes, monocytes, and platelets.

**The aim of study** is to conduct an analysis and identify valid diagnostic tools for determining the non-specific resistance of the organism in patients with acute intestinal obstruction, establishing a correlational link between the indicators and the state of resistance.

**Results and discussion.** The study was based on the examination of 278 patients with acute intestinal obstruction (AIO), of whom 221 underwent surgical treatment, and in 57 patients the obstruction phenomena were successfully resolved by a conservative method. Additionally, a retrospective analysis was conducted on 30 medical records of hospitalized patients with AIO with fatal outcomes. Clinical cases from each relevant group were described.

During the investigations it was established that the neutrophil-lymphocyte index (NLI) is a more sensitive prognostic indicator of the disease course than leukocytes and band neutrophils, responding to changes in the patient's organism one to two days earlier than other blood parameters. It was proven that a tendency toward a dynamic decrease in the NLI starting from the 2<sup>nd</sup> day is an indication of a favorable disease course and is in a tightly inverse correlation with the non-specific resistance of the organism. Thus, among patients with AIO who maintained stable non-specific resistance, and consequently recovered, the average NLI at the time of discharge was  $0.36 \pm 0.04$ , whereas in patients with fatal outcomes it was  $3.06 \pm 0.72$ .

**Conclusion.** A strong inverse correlation was established between the neutrophil-lymphocyte index and the non-specific resistance of the organism. The use of the proposed method for determining non-specific resistance in patients with acute intestinal obstruction by means of dynamic assessment of the neutrophil-lymphocyte index allows for more prompt, physiological, and effective control of the disease course, as well as the prediction of possible complications, thereby enabling the treatment process to be adjusted in a timelier manner.

**Key words:** non-specific resistance, acute obstruction, rod-lymphocyte index, leukocytes.

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## ВИЗНАЧЕННЯ НЕСПЕЦИФІЧНОЇ РЕЗИСТЕНТНОСТІ ОРГАНІЗМУ У ХВОРИХ НА ГОСТРУ НЕПРОХІДНІСТЬ КИШКИ

**Актуальність.** Перебіг гострої кишкової непрохідності в багатьох випадках залежить від неспецифічної резистентності пацієнта, яка базується на виробленні гуморальних (антитіл) або клітинних факторів.

Імунологічно компетентними клітинами, що свідчать про активацію імунних клітинних реакцій, є нейтрофіли, лімфоцити, моноцити й тромбоцити.

**Метою дослідження** є аналіз і визначення валідних діагностичних інструментів неспецифічної резистентності організму в пацієнтів з гострою кишковою непрохідністю, установлення кореляційного зв'язку між показниками й станом резистентності.

**Результати дослідження.** Дослідження базувалося на обстеженні 278 пацієнтів з гострою кишковою непрохідністю (ГКН), із яких 221 респондентові проведено оперативне втручання, а в 57 пацієнтів явища обструкції успішно вирішені консервативним методом. Додатково проведено ретроспективний аналіз 30 медичних карток госпіталізованих хворих на ГКН з летальними наслідками. Описано клінічні випадки з кожної відповідної групи.

У ході досліджень встановлено, що нейтрофільно-лімфоцитарний індекс (НЛІ) є більш чутливим прогностичним показником перебігу захворювання, ніж лейкоцити й паличкоядерні нейтрофіли, реагує на зміни в організмі пацієнта на один-два дні раніше, ніж інші показники крові. Доведено, що тенденція до динамічного зниження НЛІ, починаючи з 2-го дня, є ознакою сприятливого перебігу захворювання та знаходиться в тісній оберненій кореляції з неспецифічною резистентністю організму. Так, серед пацієнтів на ГНТК зі стабільною неспецифічною резистентністю, а відповідно, видужанням середній показник ПЛІ на момент виписки становив  $0,36 \pm 0,04$ , а в пацієнтів з летальним наслідком –  $3,06 \pm 0,72$ .

**Висновок.** Встановлено щільний обернений кореляційний зв'язок між паличкоядерним-лімфоцитарним індексом і неспецифічною резистентністю організму. Використання запропонованого способу визначення неспецифічної резистентності організму у хворих на гостру непрохідність кишки шляхом визначення паличкоядерно-лімфоцитарного індексу в динаміці дає змогу більш оперативно, фізіологічно й ефективніше контролювати перебіг захворювання, прогнозувати можливі ускладнення, що дає можливість корегувати процес лікування в більш стислі терміни.

**Ключові слова:** неспецифічна резистентність, гостра непрохідність, паличко-лімфоцитарний індекс, лейкоцити.

**Introduction.** Approximately 15% of acute abdomen cases involve intestinal obstruction. The treatment strategies for small bowel obstruction vary from conservative approaches to surgical intervention (Berman, 2025). Acute small bowel obstruction (AIO) remains a complex surgical problem and a common cause of emergency operations in general surgical practice (Dzubanovsky, 2020; Kryvoruchko, 2022). The mortality rate in these pathological conditions remains high (Klingbeil, 2022; Islam, 2024; Wang, 2024). The most common initiating mechanism of mortality in small bowel obstruction is intoxication syndrome (Christian, 2022), which leads to a cascade of pathological changes in the patient's organism. In many cases, the course of this pathological condition depends on the non-specific resistance of the patient's organism in each particular instance.

Non-specific resistance (NR) is the protection of our body against all types of pathogens, which is based on the interaction of humoral and cellular immunity. (Droniak, 2023). Non-specific resistance includes six main factors, the primary one being phagocytosis. Thanks to their antigen-presenting and effector functions, neutrophils can participate in and regulate the immune response. Neutrophils release mediators that increase vascular permeability, perform phagocytosis, etc. According to A. I. Strukov et al. (1990), neutrophils undoubtedly occupy a central position in the inflammatory reaction. They function not only as phagocytes but also as a "true secretory gland", especially playing a role in purulent inflammation. Significant infiltration of tissues by these

formed elements, combined with vascular thrombosis, causes impaired tissue perfusion and a decrease in their resistance.

Lymphocytes are immunologically competent cells (Khem, Cormack, 1983). A. I. Strukov et al. (1990) also indicate that during inflammation there is an activation of immune cellular responses. According to the theory of immunity, all its manifestations are considered as interactions between different populations and subpopulations of immunocompetent cells, which also include lymphocytes. Specific changes in components of the complete blood count, such as neutrophils, lymphocytes, monocytes, and platelets, are key responses of the immune system that are influenced by various factors and are decisive in systemic inflammation (Ten Broek, 2018). Therefore, selecting these formed blood elements to determine the non-specific resistance of the organism is entirely appropriate.

Considering the constant evolution of medicine driven by rapid progress, changes in treatment strategies, and the emergence of new diseases, the development and validation of diagnostic tools remains a continuous and dynamic process. It has been reported that indicators such as the neutrophil-to-lymphocyte ratio (NLR), the platelet-to-lymphocyte ratio (PLR), the systemic immune-inflammation index (SII), the systemic inflammation response index (SIRI), and the delta neutrophil index-calculated using various ratios of these elements-are important predictors of different outcomes in conditions where the inflammatory process predominates. A drawback of

all these methods is the complexity of studying these indicators of non-specific resistance in patients with acute surgical diseases of the abdominal organs.

**Objective:** to conduct an analysis and identify valid diagnostic tools for determining the non-specific resistance of the organism in patients with acute intestinal obstruction by establishing a correlational relationship, with the aim of improving patient treatment outcomes.

**Materials and methods.** Throughout the investigation, all rules of patient safety, preservation of rights and the canons of human dignity were observed. Moral and ethical norms are observed in accordance with the basic provisions of the GSP (1996) of the Council of Europe Convention on Human Rights and Biomedicine of (04.04.1997), the Helsinki Declaration of the World Medical Association on the Ethical Principles of Conducting Scientific Medical Research Involving Human Subjects (1964–2000), the Code of Ethics of a Scientist of Ukraine (2009) and the Recommendations of the International Committee of Journal Editors (ICMJE). Confirmed by the Protocol of the meeting of the Commission on Bioethics No. 81 dated 04.03.2025 Ternopil National Medical University named after I. Ya. Gorbachevsky. To assess the status of various components of the immune system and determine the non-specific resistance of the organism in patients with AIO, changes in the leukocyte formula of peripheral blood were analyzed. The study was based on the examination of 278 patients with acute small bowel obstruction (AIO) and a retrospective analysis of 30 medical records of hospitalized patients with AIO with an unfavorable course. Among the 278 patients, 221 underwent surgical treatment, and in 57 patients the obstruction was successfully resolved by a conservative method.

All patients underwent general clinical investigations: complete blood and urine analyses, coagulation

tests, biochemical blood analysis, a radiographic contrast study of the small intestine, an overview X-ray of the abdominal organs, and ultrasonography (USG) of the abdominal organs. The study we proposed, as well as the ratio of band neutrophils to lymphocytes in peripheral blood (neutrophil-lymphocyte index, NLI), was determined dynamically.

Statistical processing of the results was carried out using generally accepted methods of variation statistics. Correlation analysis (Uçaner, 2025) was performed using the “Microsoft Excel-2016” software package.

**Results and discussion.** The ratio of band neutrophils to lymphocytes, or the neutrophil-lymphocyte index (NLI), reflects the activity of systemic non-specific inflammation and the immune system response.

In the study of changes in the leukocyte formula of peripheral blood in 278 patients dynamically and in a retrospective analysis of 30 medical records of hospitalized patients with AIO with an unfavorable course, three indicators were considered: the number of leukocytes, band neutrophils, and the neutrophil-lymphocyte index. The determination of the indicators of non-specific resistance of the organism at the stages of treatment of patients with AIO is presented in table.

As can be seen from the data presented in table 1, the ratio of band neutrophils to lymphocytes (NLI) is a more sensitive prognostic indicator of the disease course than leukocyte count and band neutrophils, reacting to changes in the patient’s condition one to two days earlier than other blood parameters. In cases with a favorable course (n = 278), the NLI shows a tendency to decrease dynamically starting from Day 2, which cannot be said for leukocytes and band neutrophils. In the analysis of 30 medical records of hospitalized patients with AIO with an unfavorable course, we observed that with clinical deterioration, the NLI increases from Day 4 while

Table

**Comparative Characteristics of Laboratory Criteria in Patients with AIO at Different Observation Periods**

Patient Groups with AIO	Laboratory Parameters	Observation Periods					
		Upon admission	1 day	2 day	3 day	5 day	Discharge
Non-operated (n = 57)	Leukocyte count x 10 <sup>9</sup> /L	9.33±0.63	7.39±0.80	7.31±0.66	7.99±0.84	6.70±0.52	6.84±0.48
	Band neutrophils (%)	8.46±1.01	9.15±1.17	9.0±2.03	7.67±1.72	6.5±0.63	6.63±1.11
	NLI (units)	0.80±0.18	0.92±0.42	0.78±0.48	0.37±0.17	0.27±0.04	0.22±0.03
Operated, favorable course (n = 221)	Leukocyte count (x 10 <sup>9</sup> /L)	8.68±0.22	8.03±0.26	7.12±0.30	7.26±0.28	7.71±0.30	7.72±0.30
	Band neutrophils (%)	11.81±0.67	22.47±1.07	19.61±1.25	13.77±0.96	13.77±0.96	8.04±0.53
	NLI (units.)	0.82±0.07	2.04±0.26	1.24±0.11	0.77±0.07	0.53±0.04	0.50±0.06
Patients with unfavorable outcome (n =30)	Leukocyte count (x 10 <sup>9</sup> /L)	7.72±0.21	8.17±0.72	8.37±0.74	8.25±1.33	10.1±1.78	9.85±0.32
	Band neutrophils (%)	18.57±2.52	31.26±3.27	27.29±3.76	31.17±5.62	22.22±4.0	19.33±3.25
	NLI (units)	1.21±0.33	2.91±0.57	2.05±0.48	3.82±1.33	4.45±1.82	3.06±0.72

the values of leukocytes and band neutrophils fluctuate (Days 4–6).

In order to study the diagnostic tools for determining the non-specific resistance of the organism in patients with acute intestinal obstruction more thoroughly, we propose to consider several clinical cases from each relevant group.

**Clinical Case 1.** A 65-year-old female patient G. was admitted to the surgical clinic 2 days after the onset of symptoms with the diagnosis: acute adhesive intestinal obstruction of the small intestine with a pronounced pain syndrome, second phase of disease progression, compensation stage. Radiological examination of the abdominal organs showed marked pneumatisation of the small intestine; sonographic examination revealed dilated loops of the small intestine, a segment exhibiting a pendulum-like movement of intestinal contents, and a small amount of free fluid between the loops. The data of the leukocyte formula (leukocytes, band neutrophils, and NLI) during treatment are presented in fig 1.

As can be seen from the graphical presentation (Figure 1), the patient exhibited an increase in the number of leukocytes in peripheral blood during the period from Day 1 to Day 2 of treatment –  $9,3 \times 10^9/L$  and  $9,6 \times 10^9/L$ , followed by a gradual decrease in the subsequent period –  $8,4 \times 10^9/L$ ,  $8,0 \times 10^9/L$ , and  $7,2 \times 10^9/L$  on Days 3–5, respectively, with a significant reduction at discharge to  $5,8 \times 10^9/L$ . Regarding the dynamics of band neutrophils in the leukocyte formula, patient G. demonstrated an increase in the examined parameter above the normal range during Days 2–5 of treatment (8%, 8%, 7%, respectively), which is indicative of an infectious-inflammatory process in the patient.

It should be noted that during this period the NLI remained within the normal range (0.4–0.25 units), indicating a satisfactory state of non-specific resistance of the organism in the patient with acute small intestinal

obstruction and a favorable prognosis. The manifestations of acute intestinal obstruction were resolved conservatively.

Thus, the determination of the ratio of band neutrophils to lymphocytes is a sensitive and highly effective prognostic tool for the course of acute diseases of the abdominal organs, particularly in acute gastrointestinal tract obstruction.

**Clinical Case 2.** A 61-year-old female patient D. was admitted to the surgical department with the diagnosis: acute adhesive obstruction, second phase of disease progression, compensation stage. After preoperative preparation, an operation was performed consisting of laparotomy, nasogastrintestinal intubation, resection of the necrotized segment of the small intestine, ileotransverse anastomosis, and drainage of the abdominal cavity. During dynamic observation in the postoperative period, alongside changes in the overall condition of the patient, the following changes in the aforementioned peripheral blood parameters were noted. A significant decrease in leukocyte count was observed on Days 1–2 of the postoperative period (approximately 1.4 and 1.9 times lower, respectively – see fig. 2), which is associated with the removal of toxic contents from the small intestine and resection of the necrotized segment of the gastrointestinal tract.

During this period and in the subsequent days after surgery, an increase in the NLI was observed (from 1.09 units on Day 1, 3.92 units on Day 2, and 3.2 units on Day 3), indicating a deterioration in the level of non-specific resistance of the organism due to the development of gastrointestinal paresis. Thus, on Days 2 and 3 of the postoperative period, the value of the proposed indicator reached 388.0% and 316.8% of the preoperative value, respectively. Along with comprehensive treatment and clinical evaluation of the patient's overall condition, additional measures were prescribed to stimulate the

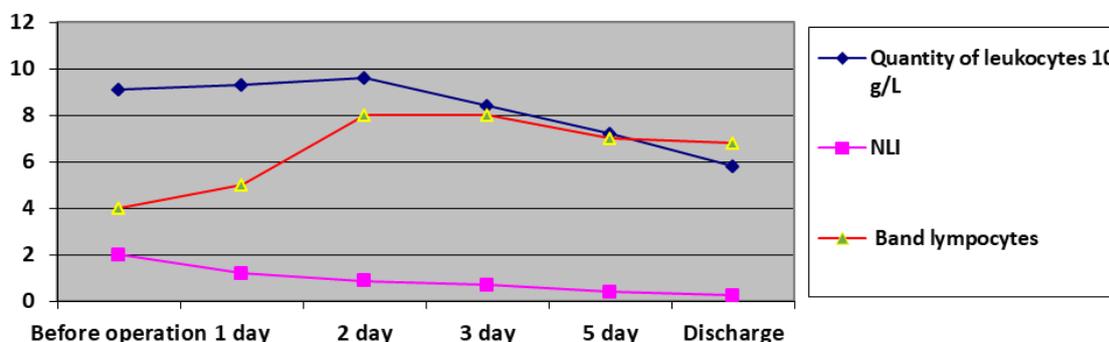


Fig. 1. Diagnostic markers of non-specific resistance in the non-operated patient

motor-evacuator function of the gastrointestinal tract. After the functional state of the gastrointestinal system was restored, the NLI on Day 5 still indicated stress in the non-specific resistance (1.06 units), but by the time of discharge from the surgical hospital, it reached a normal value (0.39 units) – as shown in figure 2.

At the same time, during the entire postoperative period-except for the first day-the leukocyte counts remained within the permissible normal range. Regarding the dynamics of band neutrophils in the leukocyte formula of patient D., there was a rapid, peak-like increase on Days 1–2 of the postoperative period (43%), followed by a gradual slight decrease in the subsequent treatment period. Due to the severity of the disease and the extent of the operation, this parameter at discharge was 14.2%.

Thus, the leukocyte count and the number of band neutrophils in the leukocyte formula from peripheral blood analysis in patients with acute intestinal obstruction cannot, by themselves, reflect or characterize the state of the organism’s non-specific resistance.

Clinical Case 3. A 68-year-old female patient O. was admitted to the surgical clinic three days after the onset

of symptoms with the diagnosis: acute small intestinal obstruction, Stage III of disease progression, decompensation stage. She also had ischemic heart disease, paroxysmal atrial fibrillation, and Stage II heart failure. After preoperative preparation, an operation was performed consisting of laparotomy, nasogastrintestinal intubation, resection of the necrotized segment of the small intestine, entero-enteroanastomosis, and drainage of the abdominal cavity. The postoperative course was severe and the treatment outcome was unfavorable. A retrospective analysis of the patient’s medical record revealed changes in blood parameters, which are shown in fig. 3.

From the graphical illustration of the changes in leukocyte and band neutrophil counts (fig. 3), it is evident that the leukocyte count in peripheral blood tended to increase on Days 1 and 3 after surgery, though it did not significantly exceed the preoperative value.

In the analysis of the numerical values of the neutrophil-lymphocyte index (NLI) in this patient, a significant increase in the indicator was observed on Day 1-to 7 units-and from Day 3 of treatment it rose from 2.8 units to 4.35 units (by Day 5). While the initial increase on Day 1

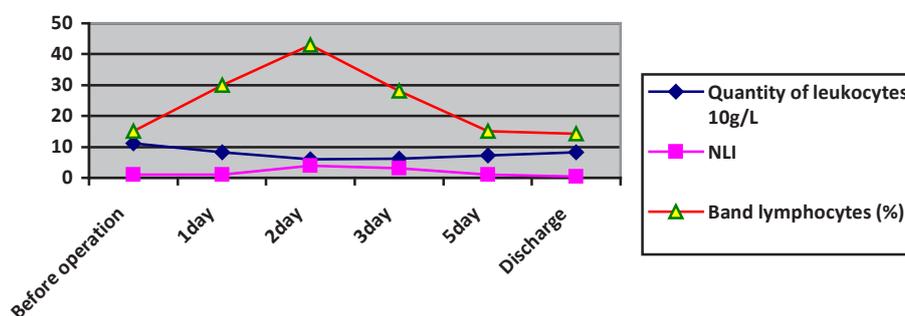


Fig. 2. Diagnostic markers of non-specific resistance in the operated patient

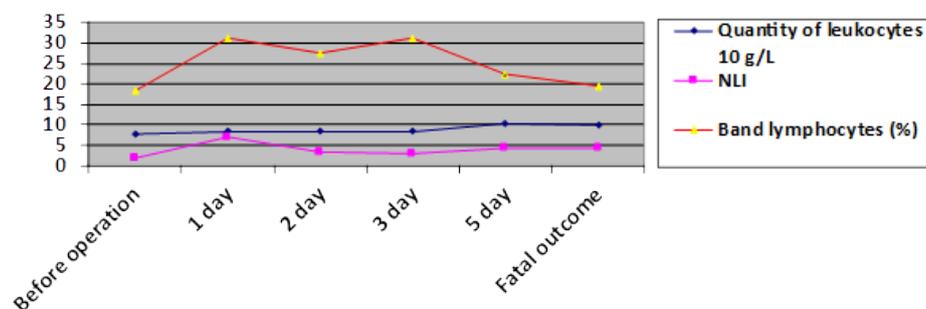


Fig. 3. Diagnostic markers of non-specific resistance in the case of an unfavorable course

is associated with the operation and the severity of the disease, the subsequent rise is attributed to tension and instability in the patient's non-specific resistance. Starting from Day 5 after surgery and continuing until the fatal outcome, an increase in the proposed parameter was observed compared to its preoperative value—from 261.8% to 255.9%, respectively. The quantitative leukocyte count in the peripheral blood of patient O. did not change significantly. The concentration of band neutrophils in the leukocyte formula (Figure 3) increased on Day 1 of the postoperative period with only insignificant changes thereafter. Thus, in this case the proposed neutrophil-lymphocyte index proved to be more sensitive than the leukocyte count and the band neutrophils considered separately.

It is noteworthy that among the three immune status parameters, only one (the NLI) demonstrated a strong inverse correlation with the non-specific resistance of

the organism. It was established that changes in the neutrophil-lymphocyte index are reliably associated with the stability of non-specific resistance ( $p < 0.05$ ). Thus, among patients with AIO who maintained stable non-specific resistance and consequently recovered, the average NLI at discharge was  $0,36 \pm 0,04$ , whereas in patients with a fatal outcome it was  $3,06 \pm 0,72$ .

**Conclusion. A strong inverse correlation was established between the neutrophil-lymphocyte index and the non-specific resistance of the organism. The use of the proposed method for determining non-specific resistance in patients with acute intestinal obstruction by means of dynamic assessment of the neutrophil-lymphocyte index allows for more prompt, physiological, and effective control of the disease course, as well as the prediction of possible complications, thereby enabling the treatment process to be adjusted in a timelier manner.**

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