The Use of the Results of Intellectual Monitoring in the Practice of Treatment of Inflammatory Bowel Diseases

Serhii Holub[a], Andriy Dorofeyev[b], Gulustan Babayeva[c], Svitlana Kunitskaya[a] and Oleg Ananiin[a]

[a] *Cherkassy State Technological University, 460 Shevchenko Boulevard, Cherkasy 18006, Ukraine*
[b] *National Medical Academy of Postgraduate Education named after P.L.Shupik, 9, Dorogozhytska Street, Kyiv, 04112, Ukraine*
[c] *Azerbaijan State Advanced Training Institute for Doctors named after A.Aliyev, Department of Therapy, Tbilisi ave, 3165, Baku, AZ1012, Republic of Azerbaijan*
[d] *University 1, Address, City, Index, Country*

Abstract

The processes of diagnosis and treatment of inflammatory bowel diseases are characterized by a high level of uncertainty in information about the causes of the disease, its etiology, the influence of external and internal factors on the patient's condition, the patient's individual response, and the standard treatment regimen. The paper presents the results of studies of the process of using intelligent agents of the monitoring information system to adapt the control influences of treatment regimens for Crohn's disease and ulcerative colitis to the mechanisms of individual interaction of processes occurring in the patient's body. As a result of joint research of scientists in the field of medicine and information technologies of Ukraine and Azerbaijan, a methodology for developing treatment regimens for inflammatory bowel diseases using the results of intellectual monitoring of the patient's condition was presented and experimentally tested. The paper formulates a number of hypotheses, for testing which experiments were carried out: an approach to the process of forming indicators to describe the patient's condition is described; available laboratory research methods are used; the problem of classification of patients' conditions is being solved; a method for non-invasive diagnostics of the influence of indicators on the patient's condition and interpretation of monitoring results has been developed. As a result of this work, experimental confirmation of the effectiveness of the process of using the results of intelligent monitoring in the practice of treating inflammatory bowel diseases was obtained.

Keywords 1

Inflammatory bowel diseases, intellectual monitoring, assessment of the influence of factors, treatment regimen

1. Introduction

Inflammatory bowel diseases (IBD), including ulcerative colitis (UC) and Crohn's disease (CD), are an urgent problem in modern medicine. According to the WHO, the incidence of IBD is growing worldwide. Despite the high level of health care, only in the United States - 1.5, and in the European Union - 2 million patients [1]. The situation is aggravated by the fact that the etiology of IBD remains unknown, and the pathogenesis is not fully understood. At the same time, it is known that UC develops as an immune reaction of the colon mucosa, and CD - as an autoimmune lesion of the entire digestive tract.

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EMAIL: s.holub@chdtu.edu.ua (S. Holub); dorofeyevand@mail.com (A. Dorofeyev); ghbabayeva@gmail.com (G. Babayeva); kunitskaya33@gmail.com (S. Kunitskaya); olegudacha@ukr.net (O. Ananiin)
ORCID: 0000-0002-5523-6120 (S. Holub); 0000-0002-2631-8733 (A. Dorofeyev); 0000-0002-5805-3741 (G. Babayeva); 0000-0001-6343-9780 (S. Kunitskaya); 0000-0001-9203-597X (O. Ananiin)

The diagnosis of diseases is established on the basis of generally accepted criteria in accordance with the recommendations of the European Crohn's and Colitis Organization (ECCO) [1, 2]. The severity of the clinical course of the disease is assessed in accordance with the Truelove-Witts Index (TW) and Mayo in the case of U^2C and Crohn's Disease Activity Index (CDAI) and the Harvey-Bradshaw activity index in Crohn's disease.

At the same time, laboratory diagnostics, based mainly on taking into account only two parameters (C-reactive protein and calprotectin), in our opinion, needs to be expanded and modernized. Insufficient information content of the patient's test results does not allow using existing methods of processing observation results and using them when choosing or constructing treatment regimens. In such conditions, the effectiveness of treatment is largely determined by the doctor's intuition. Taking this into account, we made an attempt to create a system for assessing the patient's condition on the basis of other laboratory tests and indicators, building an information system for intelligent monitoring [3] and using monitoring results to support the attending physician's decision to choose an individual patient treatment regimen.

2. Existing methods and means of monitoring the condition of patients

Information technology of intelligent monitoring [3] is implemented in the form of a monitoring information system (MIS) [3] in various subject areas. In medicine, a type of MIS is used, which is implemented based on an agent-based approach. The virtual robot solves the global monitoring tasks for the formation of a dictionary of signs, the organization of continuous monitoring of the patient's condition, the development of their results, and the formation of conclusions following the doctor's instructions and using the interactions of intelligent agents.

Each intelligent agent forms and adapts its structure following the local tasks that are assigned to it. The main element of the agent structure is the model knowledge base [3].

A significant process for intelligent monitoring is the formation of a list of indicators that are used to assess the patient's condition. For the formation of signs of the condition of patients with IBD, the results of invasive studies are used, by processing images after endoscopy [4], by analyzing blood and feces [5].

Today, for the diagnosis of IBD, protocols are used that take into account the results of a complete clinical, instrumental, laboratory, and pathomorphological examination of patients. At the same time, the main emphasis in instrumental studies is placed on radiation (CT, MRI, ultrasound) imaging methods and a thorough endoscopic examination with mandatory multiple biopsies of at least 5 sections of the intestine, and in laboratory diagnostics, in addition to routine studies and the exclusion of opportunistic infections, on the determination of calprotectin (a marker of damage to the intestinal mucosa) in feces and a marker of the acute phase of inflammation - "C" reactive protein (CRP) in the blood.

This approach, with undoubted advantages, has two significant drawbacks: the high cost of the study and the remoteness of the timing of the diagnosis (waiting for the results of the pathomorphological study). An important factor is also the patient's adherence to research (MRI, CT, endoscopy). At the same time, laboratory diagnostics is based mainly on only two indicators: the content of calprotectin in feces and CRP in the blood. In the literature, the possibility of using additional methods of laboratory diagnostics is widely discussed [7, 8, 9]..

3. Unsolved problems

The published materials contain the results of studies to describe the condition of patients at different stages of monitoring - expert determination of the list of signs, procedures for determining the characteristics of these signs, processing, and expert interpretation of the results. These results were used to diagnose the patient's condition. It was not possible to find a description of the use of the results of intelligent monitoring in the practice of treating IBD.

4. Aim

Investigation of the processes of using the results of intelligent monitoring to support decision-making in the practice of treating inflammatory bowel diseases using the example of the treatment of Crohn's disease and ulcerative colitis.

5. Research results and discussion

In the course of the research, several hypotheses were put forward.

Hypothesis 1. There are distinctive features that characterize patients with IBD, and MIS can be used in the process of constructing an individual treatment regimen for each of these patients.

Hypothesis 2. The body of each patient individually reacts to the onset of the disease and its course under the influence of drugs. The choice of a treatment regimen should depend on the priority factors that determine the patient's condition.

Hypothesis 3. Using the results of intelligent monitoring can improve the effectiveness of treatment.

A series of experiments were carried out to experimentally test the hypotheses put forward. Based on the research results, the monitoring information system was tasked with determining which processes and in which subsystems of the individual patient's body determine the condition of the patient with IBD.

The aim of the study is formalized as the task of supporting decision-making in the process of adapting treatment regimens by classifying the condition of patients based on the results of medical testing and determining the individual influence of factors. The list of classes of patient conditions, factors, and properties of patients was obtained by expert advice with the involvement of practicing doctors with scientific research experience, who are co-authors of this work.

The assessment of the condition of each patient was carried out especially for him by the intelligent agent MIS. The results of the analyzes were submitted to the agent's input in the form of a table of the input data array. The model knowledge base generated a conclusion about the patient's condition at a given time and the influence of the factors presented in Table 1 on the patient's condition. The assessments of the influence of factors were used by an expert physician as information about the individual characteristics of the patient in the process of adapting the treatment regimen. The effectiveness of using the results of intelligent monitoring was assessed according to the list of typical indicators before the application of the treatment regimen, built using assessments of the influence of factors, and after its application.

The input data array was formed based on the results of clinical studies. The list of indicators of the patient's condition was formulated expertly. When choosing the list of indicators, we proceeded from the fact that the basis of IBD is immunological, aseptic inflammation.

The term "endothelium" was proposed in 1865 to designate the lining of blood and lymphatic vessels, heart, serous, synovial and meninges, posterior chamber of the eye, respiratory tract. Currently, this term is used only to refer to the inner cell lining of the vascular bed. The endothelium, according to modern concepts, is the largest active endocrine organ in the human body, diffusely located in all organs and tissues.

The endothelium - the inner lining of blood vessels - consists of approximately 1-6 × 1013 cells. The endothelium of the vascular intima performs barrier, secretory, hemostatic, vasotonic functions, plays an important role in the processes of inflammation and remodeling of the vascular wall. Endothelial cells create a barrier between blood and tissues and, with the help of the factors they synthesize, perform many important regulatory functions, contributing to the maintenance of homeostasis. It is generally accepted that endothelial dysfunction (ED), as a typical pathological process, is a key link in the pathogenesis of many diseases and their complications, incl. with IBD. The inflammatory process in the intestinal mucosa, in particular leukocyte infiltration, contributes to damage to the vascular endothelium of the intestinal mucosa, causing a violation of microcirculation in it with the appearance of microthrombi and further trophic changes.

It is known that systemic endothelial dysfunction is reflected in damage to the wall of the glomerular apparatus of the kidneys, which in turn leads to increased excretion of albumin in the

urine. It is believed that microalbuminuria (MAU) is an early marker for the development of endothelial dysfunction [5], which can also be used when examining patients with inflammatory bowel diseases to assess their state of vascular endothelium.

To assess endothelial dysfunction, various parameters are currently being studied, such as homocysteine, thrombocytosis, von Willebrand factor, endothelin, high-sensitivity CRP, changes in the lipid spectrum and interleukin series, PAI-1, PAI-2, ICAM-1, NO, P- and E-selectins and many others [10, 11, 12]. At the same time, recently, vitamin D deficiency has been identified as a risk factor for the development of autoimmune pathology [13].

Our results allow us to conclude that the severity of endothelial dysfunction indicators directly correlates with the severity of the patient's condition.

Taking into account the fact that there is no significant difference between the groups of patients with UC and CD, we understand that these changes have a low level of specificity, and, therefore, can be applied only in cases of a previously established diagnosis.

We have selected the most accessible, both in practical terms (availability and availability in the laboratory network) and economically, to study indicators of endothelial dysfunction. The list of these indicators is presented in table 1.

Table 1

Patient indicators used as modeling variables

№	Index	Variable
1	Highly sensitive C-reactive protein, mg / L	x_1
2	Vitamin D, ng / mL	x_2
3	Homocysteine, μmol / L	x_3
4	Platelets, t / mm^3	x_4
5	Fecal calprotectin, μg / g	x_5
6	Albumin in urine, mg/L	x_6

The advantages of using this list of indicators include: 1) economic feasibility, 2) speed of calculation, 3) ease of implementation for the patient, 4) wide availability in outpatient practice.

To obtain the values of the indicators presented in Table 1, in the period from August 2015 to December 2018, 246 patients with IBD were examined at the clinical base of the Department of Therapy of AzSATI, the Department of Invasive Diagnostics and Treatment of the National Center of Oncology, the Medical Center "Memorial Klinika". Of this contingent, 44 people refused to participate in the study, and 19 people were excluded due to comorbid conditions (6 with arterial hypertension, 2 with chronic renal failure, 11 due to previous surgical interventions).

For the study, 183 patients were selected who had no complaints and anamnestic indications of cerebro-, cardio- and nephrovascular pathology. The diagnosis of the disease was established based on generally accepted criteria following the ECCO recommendations. The severity of the disease was assessed using the CDAI, HBI, and TW criteria.

The age of the patients was from 17 to 60 years (42.3 ± 2.7). By sex: 81 women and 102 men. The duration of the disease before going to a specialist doctor is 1.2-9.4 years (3.4 ± 1.1). 167 patients were examined on an outpatient basis, and 16 were on inpatient treatment. Of the patients, 104 (56.8%) suffered from CD, and 79 (43.1%) had UC. The patients were under dynamic observation from 9 to 36 months (14.2 ± 3.8). Patients, if necessary, underwent repeated examinations (426 in total). The results obtained in the study of the main group of patients are presented in table 2.

As can be seen from Table 2, in the total group of IBD patients, out of 426 studies conducted, 369 (86.6%) cases had an increased blood level of homocysteine, 405 (95.0%) - the level of h/s CRP, 322 (75,5%) - thrombocytosis, in 411 (96.4%) - a decrease in vitamin D content, in 308 (72.3%) albumin was found in urine, and in 411 (96.4%) - and increased content of calprotectin in feces. A separate analysis of the detection of each of these indicators in the UC and CD groups did not reveal any difference ($p > 0.05$). Also, no difference was found when analyzing the results by gender ($p > 0.05$).

In the control group K1 (patients diagnosed with irritable bowel syndrome, N = 20), an increase in homocysteine was detected in 3 cases, a decrease in the content of vitamin D, in 3 cases an increase in the level of h/s CRP and in 1 case a slight increase in calprotectin. In the control group K2 (healthy individuals, N = 20), in 3 cases, a decrease in the content of vitamin D was revealed and in 1 - a moderate increase in homocysteine. There was no statistically significant difference between groups K1 and K2. At the same time, the results of studies in both control groups significantly differed from those in the main ($p < 0.01$). The same tendency persisted when the control groups were separately compared with the groups of UC and CD patients ($p < 0.01$).

We carried out statistical processing of the data obtained to search for a possible relationship between the indicators of endothelial dysfunction and the severity of the patient's condition, determined following the ECCO recommendations. The severity of changes in the studied indicators of endothelial dysfunction was assessed as a percentage of the permissible value of the norm (with an increase in the indicator - it's excess of the upper limit of the norm and a decrease in comparison with the lower limit - with a lower content).

Table 2

Distribution of endothelial dysfunction parameters in patients with ulcerative colitis and Crohn's disease

Index	Number of patients		
	With Crohn's disease, %	With ulcerative colitis, %	Total, %
Highly sensitive CRP (x_1)			
before 10 mg/L	69,1	59,8	64,4
10-20 mg/L	17,9	21,0	19,5
more 20 mg/L	12,9	19,1	16,0
Vitamin D (x_2)			
30 - 20 ng/mL	14,6	22,0	18,2
20 - 10 ng/mL	69,6	51,5	60,8
less 10 ng/mL	15,8	26,5	20,9
Homocysteine (x_3)			
before 15 µmol/L	51,8	56,7	54,2
15-20 µmol/L	32,4	30,3	31,4
more 20 µmol/L	15,7	12,9	14,3
Platelets (x_4)			
up to 440t / mm^3	43,8	58,0	51,2
from 440 to 480t / mm^3	35,4	32,9	34,1
more than 480t / mm^3	20,6	8,9	14,5
Calprotectin (x_5)			
before 100 µg/g	11,9	17,3	14,5
from 100 to 150 µg / g	17,2	25,2	21,1
more 150 µg/g	72,1	57,4	64,2
Albuminuria (x_6)			
microalbuminuria (up to 30 mg / L)	80,1	89,1	84,4
macroalbuminuria (more than 30 mg / L)	19,8	10,8	15,5

For simplicity of calculation, a point-based system for assessing the significance of these parameters was developed. The results are shown in Table 3.

Table 3

Correlation of some indicators of endothelial dysfunction and the severity of the clinical course in patients with inflammatory bowel disease

Index	Norm	The severity of the disease		
		I	II	III
h/s CRP	N	1,3 N	1,5 N	>1,5 N
Homocysteine	N	1,3 N	1,5 N	>1,5 N
Platelets	N	1,1 N	1,2 N	>1,2 N
Vitamin D	N	0,7 N	0,4 N	<0,4 N
Calprotectin	N	2 N	3 N	>3 N
Albumin in urine	N	–	Micro-	Macro-
Points	0	1	2	3

As a result, it was found that in the presence of the severity of endothelial dysfunction, estimated from 4 to 6 points, patients with IBD have mild, from 6 to 9 points - medium, and if there are more than 9 points, a high degree of severity of the clinical course of the disease. Clinical and endoscopic remission corresponded to 3 points or less. The degree of correlation was 0.863.

Thus, hypothesis 1 received experimental confirmation. It has been proven that the list of indicators proposed as modeling variables in Table 1 are significant in determining IBD.

The individual condition of the patient was determined based on the results of solving the MIS classification problem. The results of the expert classification of the patient's condition were used as a modeled indicator. It was proposed [15] to distinguish four states (classes) of the patient. Table 4 shows the characteristics of the classes.

Table 4

Characteristics of classes

Class	Name	Condition characteristics	Class value in the input data array
0	Clinical endoscopic remission	Absence of clinical manifestations and macroscopic changes during endoscopy	0
1	Mild course of the disease	In accordance with the indicators of tables 5, 6, 7	50
2	Moderate condition	In accordance with the indicators of tables 5, 6, 7	500
3	Severe condition of the patient	In accordance with the indicators of tables 5, 6, 7	1000

The severity of the disease as a whole was determined by expert judgment, taking into account the severity of the current condition, the presence of extraintestinal manifestations and complications, refractoriness to treatment, in particular, the development of hormonal dependence and resistance [14,15] in accordance with the data in Tables 5-7.

Table 5

UC attack severity according to Truelove-Witts criteria [15]

The indicator	Patient condition class		
	Easy course of the disease	Medium severity condition	Severe condition of the patient
The frequency of bowel movements	<4	≥ 4 if:	≥ 6, if:
Pulse	Normal values	≤ 90 heart rate / min	> 90 heart rate / min or
Temperature	Normal values	≤ 37,5°C	> 37,5°C or
Hemoglobin	Normal values	≥ 105 g / l	< 105 g / l or

ESR	Normal values	≤ 30 mm / h	> 30 mm / h
Contact vulnerability of the mucous membrane of the colon	No	There is	There is

Table 6

The severity of the attack according to the UC Activity Index (Mayo Index) [13]

Index value	Patient condition class			
	Clinical and endoscopic remission	Easy course of the disease	Medium severity condition	Severe condition of the patient
Stool frequency	Plain	1-2/day more than usual	3-4/day more than usual	5 / day more than usual
Blood in stool	No	Blood veins	Visible blood	Mostly blood
The condition of the mucous membrane	Norm	Easy vulnerability (1 point on the Schroeder scale)	Moderate vulnerability (2 points on the Schroeder scale)	Severe vulnerability (3 points on the Schroeder scale)
General assessment by a doctor	Norm	Satisfactory condition	Moderate condition	Grave condition

State of moderate severity and serious condition are detected when the index value (the sum of the ratings for 4 parameters) is from 6 and above.

Table 7

Harvey Bradshaw CD Activity Index [15]

Symptom	Severity	Rating
Overall well-being	Good	0
	A bit below average	2
	Bad	3
	Very bad	4
	Terrible	5
Abdominal pain	Not	0
	Weak	1
	Moderate	2
	Strong	3
Diarrhea		1 point for each bowel movement per day
Abdominal infiltrate	Not	0
	Availability is doubtful	1
	Availability	2
	The presence of muscle tension in the abdominal wall	3
Complications	Arthralgia, uveitis, erythema nodosum, gangrenous pyoderma, aphthous stomatitis, anal fissure, new fistula or abscess	1 point for each complication

The sum of the ratings determines the class of condition of the patient.: ≤4 remission; 5-6 - light attack; 7-8- medium-heavy; ≥ 9 – heavy

Table 8 shows a fragment of the input data array, built according to the results of observations and testing described above.

Table 8

Elements of the input data array

A patient	Class	h/s CRP	Vitamin D, *ng / mL*	Homocysteine, *μmol / L*	Platelets, t / mm^3	Calprotectin, *μg / g*	Albumin in urine, *mg/L*
245	50	2,6	13,2	11	251	166	15
244	500	1,3	26,2	13,4	351	304	3
241	0	0,6	40,2	11,1	361	266	13
240	50	1,9	52,1	8,8	224	171	14
233	1000	16,3	8,2	23,4	301	744	10
232	500	11,8	16	9,4	249	93	13
230	500	3,2	7,4	8,5	241	612	12
…	…	…	…	…	…	…	…

Factors were assessed according to standard MIS procedures. The structure of the agent of the monitoring information system includes a model knowledge base and a model synthesizer [3].

Agent model synthesizers build of model knowledge base to classify the conditions of each patient adaptively. The influence of the indicators presented in Table 1 was determined after calculating the values of partial derivatives. Table 9 presents the influence of factors found in agent models that were synthesized using the multi-line GMDH algorithm [6].

Table 9

Elements of the input data array

A patient	Influence, %					
	h/s CRP	Vitamin D	Homocysteine	Platelets	Calprotectin	Albumin in urine
245	35,00	0,00	7,00	12,00	46,00	0,00
244	0,00	0,00	30,00	8,00	62,00	0,00
241	59,00	33,00	7,00	1,00	0,00	0,00
240	0,00	23,00	4,00	2,00	34,00	38,00
233	34,00	15,00	17,00	0,00	34,00	0,00
232	53,00	13,00	8,00	1,00	0,00	25,00
230	43,00	0,00	0,00	0,00	57,00	0,00
…	…	…	…	…	…	…

The results presented in Table 9 make it possible to determine the prevalence of processes that determine the course of the disease in a patient whose name is encrypted in Tables 8 and 9. As a result of a detailed study of the data in Table 9, decisions were made on the individual correction of treatment regimens based on indicators that affect the course of the pathological process. For example, when correcting the treatment regimen for patient 245, it was taken into account that the prevailing factor at the time of diagnosis is an increase in the level of fecal calprotectin (influence 46%) with a concomitant increase in the level of h/s CRP (influence 35%) and an increase in the level of platelets (influence 12%). This means that in this patient, the course of the disease is determined by inflammatory processes in the intestinal mucosa, directly related to disturbances in microvascular hemodynamics, and as a consequence, correction is necessary not only in terms of escalating the dose of the basic drugs used, but also the correction of microvascular processes.

In patient 244, the prevailing factor at the time of diagnosis is also an increase in the level of fecal calprotectin (influence 62%), but with a concomitant increase in the level of homocysteine (influence 30%), which means that one of the triggers is deep intracellular hypoxia with a deficiency of folic acid and vitamin B_{12} and the correction of therapy in this patient must take these aspects into

account. In the majority of patients, one of the highly prevalent factors at the time of diagnosis, along with calprotectin, was h/s CRP, the drug correction of which significantly improved the treatment results in patients.

At 12 weeks of treatment, patients were asked to undergo re-examinations. Some of the patients refused to take a complete list of tests. Therefore, 59 patients remained in the control group. The results of assessing the condition of patients by intelligent agents, expertly confirmed by a doctor, after 12 weeks of treatment using adapted regimens are presented in Table 10.

Table 20

Patient indicators used as modeling variables

№	A patient	The patient's condition before the correction of treatment regimens	The patient's condition at 12 weeks of treatment for the adjusted regimen
1	245	The average	Easy
2	244	The average	Average improved
3	241	Remission	Remission
4	240	The average	Remission
5	233	Heavy	Remission
6	232	The average	Easy
7	230	The average	Easy
8	226	Remission	Remission
9	224	The average	Average improved
10	223	Easy	Remission
11	222	The average	Easy improved
12	218	Easy	Remission
13	217	Easy	Easy
14	215	The average	Average improved
15	210	The average	Remission
16	209	The average	Easy
17	208	The average	Remission
18	207	Heavy	Average improved
19	204	The average	Remission
20	203	The average	Average improved
21	202	Average improved	Average improved
22	201	The average	Remission
23	200	Remission	Remission
24	194	Remission	Remission
25	192	Average improved	Remission
26	191	Remission	Remission
27	190	Easy	Remission
28	189	The average	Remission
29	188	The average	Average improved
30	187	Average improved	Remission
31	186	The average	Average improved
32	185	Average improved	Remission
33	184	The average	Average improved
34	181	Easy	Remission
35	180	Easy	Easy
36	178	Easy	Easy improved
37	176	The average	Remission
38	170	Easy	Remission
39	166	The average	Easy

40	165	The average	Remission
41	163	The average	Average improved
42	162	Easy	Average improved
43	161	The average	Average improved
44	160	Average improved	Without changes
45	159	Remission	Remission
46	156	Remission	Remission
47	151	Heavy	Average improved
48	148	Remission	Remission
49	146	Remission	Remission
50	145	Heavy	Easy
51	144	Remission	Remission
52	141	Heavy	Average improved
53	139	The average	Easy
54	138	Easy	Easy improved
55	136	The average	Easy improved
56	135	Easy	Remission
57	133	Remission	Remission
58	132	Easy	Easy improved
59	131	Easy	Easy

The results of Table 10 suggest that the use of the results of intelligent monitoring of MIS agents increases the efficiency of treatment of patients with IBD.

At 12 weeks of treatment according to the adjusted scheme, 52 patients (88.0%) showed a significant improvement in well-being; at the same time, 10 (16.9%) patients showed remission, 34 (57.6%) patients showed a decrease in the severity of the disease course, and 8 (13.5%) patients showed subjective improvement in well-being was not accompanied by a noticeable improvement in the process activity indicators (false positive result). Another 4 (6.7%) patients did not notice an improvement in their condition, and 3 (5.1%) patients showed a deterioration. These patients were re-examined and it turned out that the patient under code 162 did not comply with the treatment period (he completely stopped taking one and reduced the dosage of other drugs). In patients under codes 131 and 160, opportunistic infections were detected (in 1- tuberculosis according to the quantiferon test, in 1 - herpes viruses HSV6 and EBV, detected by PCR of biopsies of the gastrointestinal mucosa). That is, 74.7% of patients achieved a positive treatment result.

Thus, we obtained experimental confirmation of hypothesis 2 and 3. It has been proved that taking into account the individual reactions of the patient's body when constructing a treatment regimen and using the results of intellectual monitoring increases the effectiveness of treatment.

6. Conclusions

The process of supporting decision-making by a doctor in the process of treating inflammatory bowel diseases consists in providing an intelligent agent with information about the patient's condition, the influence of well-known factors, and the prognosis of the results of the use of adapted treatment regimens.

The hypothesis of the existence of signs that characterize patients with IBD has been experimentally confirmed, and MIS can be used in the process of constructing an individual treatment regimen for each of these patients.

The source of increasing the effectiveness of the treatment of inflammatory bowel diseases in a patient is the correction of his treatment regimen, taking into account the priority factors that determine the patient's condition. As a result of combining methods for solving intellectual problems by agents of the monitoring intellectual system and correcting the methods of treating inflammatory bowel diseases used by a doctor, a systemic effect was obtained in the form of improving the health of patients.

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