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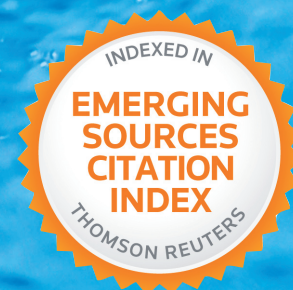
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- Assessment of Physical Therapy Following Knee Arthroplasty
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# CONTENTS/SPIS TREŚCI

## ORIGINAL ARTICLES/PRACE ORYGINALNE

Włodzisław Kuliński, Sylwia Woźniak

### **Assessment of Physical Therapy Following Knee Arthroplasty**

**Analiza postępowania fizykalnego po endoprotezoplastyce stawu kolanowego**

5

Igor V. Kireyev, Natalia V. Zhabotynska, Maryna G. Bakumenko, Victoriia M. Khyzhnyak, Inna B. Knizhenko

### **Rehabilitation in Post COVID-19 Neurological Syndrome**

**Rehabilitacja w zespole neurologicznym po przechorowaniu COVID-19**

11

Yuriy Ye. Lyakh, Oksana V. Usova, Viktoriia O. Melnychuk, Maryna V. Lyakh, Natalia S. Voinarovska, Oleksandr S. Marchenko

### **Possibilities of Non-Invasive Analyzer of Blood Formula in Rehabilitation of Patients with Post-Covid Syndrome**

**Możliwości nieinwazyjnej analizy składu krwi u pacjentów z zespołem pocovidowym poddawanych rehabilitacji**

16

Tetiana G. Bakaliuk, Nadiya R. Makarchuk, Halina O. Stelmakh

### **Efficacy of Application of Hydrogen Sulfide Baths in Patients with Diabetic Polyneuropathy**

**Skuteczność kąpeli siarkowodorowych u pacjentów z polineuropatią cukrzycową**

20

Vladyslav A. Smiianov, Nataliia O. Dryha, Lesia A. Rudenko

### **Improving the Quality of Medical Care and Prevention in Patients with Type 2 Diabetes**

**on the Basis of Remote Medical Service**

**Poprawa jakości opieki medycznej i prewencji u pacjentów z cukrzycą typu 2**

**w sytuacji porad medycznych świadczonych na odległość**

24

Nataliia R. Golod, Igor K. Churpiy, Olesia V. Yaniv, Tetiana V. Buhaenko, Oksana O. Bespalova, Yuriy L. Rohalya, Mariana V. Sabadosh

### **The Influence of the Application of Mineral Water on the Functional State of the Liver**

**of Patients after Laparoscopic Cholecystectomy in the Long Period of Rehabilitation**

**Wpływ stosowania wody mineralnej na stan funkcjonalny wątroby u pacjentów po cholecystektomii laparoskopowej**

**w długim okresie rehabilitacji**

29

Olexandr S. Stepanenko, Olha O. Yezhova, Nadia Yu. Dovgan, Nataliia V. Petrenko, Nataliia O. Dolgova, Olha I. Smiianova, Yevgen V. Smiianov

### **Laser Therapy in the Comprehensive Program of Physical Rehabilitation of Athletes with Chronic Patellar Tendinopathy**

**Laseroterapia w kompleksowym programie rehabilitacji fizycznej sportowców z przewlekłą tendinopatią rzepki**

34

Valentyn V. Bondarenko, Ivan M. Okhrimenko, Volodymyr S. Medvediev, Maryna M. Didukh, Maksym O. Hrebenuk, Olena A. Levenets

### **Effectiveness of Means of Restoring the Working Capacity of Employees of the Security**

**and Defense Sector in the Conditions of Rehabilitation After Injury**

**Skuteczność metod rehabilitacji umożliwiających powrót do pracy pracownikom sektora bezpieczeństwa**

**i obronności po urazie**

39

Olena M. Myatyga, Ganna V. Tamozhanska, Nataliia V. Goncharuk, Liana V. Duhina, Oksana P. Kanishcheva

### **Physical Therapy for Nonspecific Pain in the Thoracic Spine**

**Fizykoterapia niespecyficznego bólu kręgosłupa w odcinku piersiowym**

44

Ostap F. Muzyka, Kateryna A. Tymruk-Skoropad, Iuliia O. Pavlova, Sergiy V. Romanchuk

### **Injury Framework and Relevance of Physiotherapy of Upper Limbs` Injury and Pain Syndromes**

**in Cadets of Higher Military Educational Institutions**

**Zakres urazów i znaczenie fizjoterapii urazów i zespołów bólowych kończyny górnej u kadetów wojskowych szkół wyższych**

50

Oryna Z. Detsyk, Halyna Ya. Yukish, Olha L. Burak, Iryna V. Stovban, Zhanna M. Zolotarova, Nataliia B. Fedorkiv, Ihor M. Karpinets

### **Analysis of Rehabilitation Inefficiency in Persons with Disabilities After Musculoskeletal Injuries**

**Analiza nieskuteczności rehabilitacji u osób z niepełnosprawnościami po urazach układu mięśniowo-szkieletowego**

55

Orest M. Chemerys, Sergii D. Khimich

### **Characteristics of the Medical Nutrition of the Polytraumatized Patients in Presence of Obesity**

**Charakterystyka żywienia leczniczego u otyłych pacjentów po urazie wielonarządowym**

61



## REVIEW ARTICLES/PRACE POGLĄDOWE

Mateusz Dziwulski, Gustaw Wójcik, Monika Kadłubowska, Joanna Łuczak <b>Interdisciplinary Team – is there a Form of Cooperation in Medical Rehabilitation?</b> Zespół interdyscyplinarny – czy w rehabilitacji medycznej występuje forma współpracy?	65
Dariya V. Popovych, Valentyna I. Bondarchuk, Olena V. Vayda, Ivan I. Lukasevych <b>The Range of Physical Rehabilitation Methods in Children with Cerebral Palsy</b> Zakres metod rehabilitacji fizycznej u dzieci z porażeniem mózgowym	68
Valeriya V. Brych <b>State of Provision of Medical Rehabilitation to People with Disorders of the Musculoskeletal System at the Regional Level</b> Regionalna dostępność rehabilitacji medycznej dla osób z chorobami układu mięśniowo-szkieletowego	73
Dmytro S. Voropaiev, Iryna A. Brizhata, Oleksandr S. Stepanenko, Nataliia V. Petrenko <b>Particularities of Multidisciplinary Approach in Physical Therapy</b> Cechy charakterystyczne wielodyscyplinarnego podejścia w fizjoterapii	77
Nataly V. Hasiuk, Nataliya A. Yaskiv, Pavlo V. Leonenko, Volodymyr B. Radchuk <b>Modern Approach to Prevention of Chronic Recurrent Aphthous Stomatitis</b> Nowoczesne metody zapobiegania przewlekłemu nawrotowemu aftowemu zapaleniu jamy ustnej	83
Hanna V. Hubenko, Nataliia M. Boichenko, Svitlana M. Piven, Natallia G. Kuchma, Anna M. Bondarkova <b>Interactive Cases of Bioethics and Public Health: By the Examples of Counteraction to Xenophobia, Discrimination and Inequality</b> Interaktywne zagadnienia z bioetyki i zdrowia publicznego na przykładach przeciwdziałania ksenofobii, dyskryminacji i nierówności	88
<b>Abstracts book</b> <b>International Balneology and Physical Medicine Conference</b> «Challenges and Prospects of Public Health and Physical Medicine Development» January 27-28, 2022, Sumy, Ukraine	95

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# The Influence of the Application of Mineral Water on the Functional State of the Liver of Patients after Laparoscopic Cholecystectomy in the Long Period of Rehabilitation

## Wpływ stosowania wody mineralnej na stan funkcjonalny wątroby u pacjentów po cholecystektomii laparoskopowej w długim okresie rehabilitacji

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### SUMMARY

**Aim:** To determine the effectiveness of the influence of the use of mineral medicinal water on the functional state of the liver of patients after laparoscopic cholecystectomy in a long period of rehabilitation in the conditions of the Morshynkurort health resort complex.

**Materials and Methods:** An analysis of 100 medical records of patients after laparoscopic cholecystectomy who were undergoing rehabilitation at the Morshynkurort health resort complex in 2017 and 2018 was carried out. Medical records were selected by a randomized method using the Random Allocation Rule program. Blinded evaluators while processing medical records. The method of comparison of indicators of the functional state of the liver of patients before the beginning of rehabilitation and after its completion was carried out by the method of mathematical statistics – Student's t-test. The studied parameters: total protein (g/l), thymol test (unit), total bilirubin (mkmol/l), activity of alanine transaminase (ALT, (units/hour · l)), aspartate transaminase (AST, (units/hour · l)), total cholesterol (mmol/l), triglycerides (mmol/l), blood glucose (mmol/l). All patients were examined before and after treatment. There was no dropout from the study among the surveyed.

**Results:** Mathematical statistics revealed a significant ( $p < 0,05$ ) improvement in such indicators as: thymol test, alanine transaminase activity, total cholesterol.

**Conclusions:** Hydrotherapy for 14 days MPO well No. 3-k and groundwater source No. 4 in Morshyn diluted to mineralization 3,0-3,4 g/dm<sup>3</sup> at a long stage of rehabilitation leads to an improvement in liver function in patients after laparoscopic cholecystectomy.

**Key words:** hydrotherapy, postcholecystectomy syndrome, recovery

**Słowa kluczowe:** hydroterapia, zespół pocholecystektomii, powrót do zdrowia

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### INTRODUCTION

According to the approved medical protocol for the provision of medical care to patients with cholelithiasis (housing and communal services) by the Order of the Ministry of Health of Ukraine dated June 13, 2005 N 271 "On approval of minutes for the provision of medical care in the specialty" Gastroenterology "and according to the International Classification of Diseases (CD) 10 by the method of the" gold standard "surgical treatment of housing and communal services is laparoscopic cholecystectomy.

The medical protocol states that with routine surgical intervention, the likelihood of postoperative complications is significantly reduced. Indications for surgery are divided into absolute and relative. The absolute indications for cholecystectomy include: acute calculous cholecystitis, frequent recurrent hepatic colic, non-functioning gallbladder, choledocholithiasis, pancreatitis, suspected gallbladder cancer. Relative indications for cholecystectomy include: chronic calculous cholecystitis. The document also notes that the average duration of surgical

treatment is 4-10 days (depending on the type of surgery). The criteria for the effectiveness of surgical treatment is the absence of complications of housing and communal services. According to the medical protocol, rehabilitation after surgery should include: "an individual dietary regimen (frequent small meals with the exclusion or restriction of individually unreceptive foods, fatty, fried foods), work and rest, exercise. Alcohol consumption is prohibited. Sanatorium treatment after surgery with stable remission (Morshyn, Truskavets, Svalyava, Caucasian Mineral Waters, Berezovsky Mineral Waters, Mirgorod, Kuyalnik). Complications of surgical treatment of housing and communal services at a long stage of rehabilitation are manifested by various dysfunctions [1]. In scientific sources, the term "Postcholecystectomy syndrome" is found. Patients complain of abdominal pain and dyspeptic symptoms after cholecystectomy [2]. Analyzing the complaints and complications with which the patients of laparoscopic cholecystectomy are treated in a long period for undergoing sanatorium-resort treatment, it becomes clear that the issue of rehabilitation of such patients is quite relevant and not fully resolved [3].

## AIM

Determine the effectiveness of the impact of mineral medicinal water of well No. 3-k. with. Goreshnee Stryisky district of Lviv region in a dilution of 3,0-3,4 g/dm<sup>3</sup> for the functional state of the liver of patients after laparoscopic cholecystectomy in a long period of rehabilitation in the conditions of the Morshynkurort health resort complex (MHRC).

## MATERIALS AND METHODS

**Materials.** An analysis of 100 medical records of patients after laparoscopic cholecystectomy who were undergoing rehabilitation at the Morshynkurort sanatorium complex in 2017 and 2018 was carried out. Women – 66 patients, men – 34 patients. The average age of the patients was 53±2,3 years. The patients consumed diluted mineral medicinal water (DMMW) from well No. 3-k. with. Verkhnee Stryisky district of Lviv region in a dilution of 3,0-3,4 g/dm<sup>3</sup> for internal use. DMMW is a product of dilution in certain proportions of underground brines svr. No. 3-k and underground waters of the source No. 4 in Morshyn for mineralization 3,0-3,4 g/dm<sup>3</sup>. Inclusion criteria: patients after laparoscopic cholecystectomy from 1 month to 1 year after surgery. Exclusion criteria: patients with contraindications to the use of the specified DMMW, namely, with the following nosologies: exacerbation of the inflammatory process in the stomach and duodenum; exacerbation of the inflammatory process in the pancreas, chronic enteritis and colitis of the acute phase of severe form; acute pyelonephritis; malignant diseases of the digestive system; violation of the passage of food masses through the gastrointestinal tract; complicated urolithiasis; circulatory insufficiency is sharply expressed.

**Methods:** Medical records were selected by a randomized method using the Random Allocation Rule program. Blinded evaluators while processing medical records. The method of comparison of indicators of the functional state of the liver of patients before the beginning of rehabilitation and after its

completion was carried out by the method of mathematical statistics – Student's t-test. The studied parameters: total protein (g/l), thymol test (u), total protein, activity of alanine transpeptidase (ALT, mmol (tsp)), aspartate transaminase (AST, mmol (tsp)), total cholesterol (mmol/l), triglycerides (unit l), blood sugar. All patients were examined before and after treatment. There was no dropout from the study among the surveyed. The average course of treatment was 15,2±0,83 days.

The methods used for the study were approved by the moral commission of the Ivano-Frankivsk Medical University (IFMU) when planning complex research work, approved by the decision of the Academic Council of the IFMU Minutes No. 19 dated 20.12.2018. on the topic: "Development and improvement of the organizational and methodological foundations of physical therapy in patients with diseases of the abdominal cavity and nervous system" (state registration number 0119U000448) and scientific research of the IFMU in the field of health in specialty 227 "Physical therapy": "Theoretical and methodological foundations of physical therapy of patients after laparoscopic cholecystectomy" (state registration number 01119 U 2951).

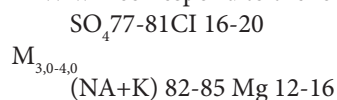
## RESULTS

Mineral brines from the Ninivsk deposit began to be used at MHRC after the State Administration (SA) "Ukrainian Research Institute of Medical Rehabilitation and Balneology of the Ministry of Health of Ukraine) in 2008-2012 with the participation of certified laboratories for the study of sanitary bacteriological salt. For the purpose of practical application, the corresponding medical reports and instructions were formed, approved by the Academic Council of the State Institution "Ukrainian Research Institute of Medical Rehabilitation and Balneology of the Ministry of Health of Ukraine" Minutes No. 5 dated February 28, 2012.

To obtain mineral diluted waters of various salt concentrations, brines were diluted with groundwater from the Morshyn spring No. 4, characterized as low-mineralized chloride-hydrocarbonate magnesium-sodium-calcium (or complex cationic composition) without specific components and properties. on natural mineral table waters. Macrocomponent composition of groundwater source. No. 4, Morshyn is presented in table 1 [4].

Possibility of using groundwater. No. 4 for obtaining DMMW does not deny the current regulatory documents, provided that low-mineralized waters are used in their natural state without any additional processing [4].

The performed calculations established that when diluting the brines of the well No. 3-k with groundwater sources No. 4 in the proportions of 1: 41,69-1: 41,55; 1: 18,16-1: 21,29; 1: 8,11-1: 10,42; 1: 4,98-1: 6,50 diluted mineral waters with a salinity of 4,0 g/dm<sup>3</sup>, respectively; 6,5-7,5 g/dm<sup>3</sup>; 13,5-4,5 g/dm<sup>3</sup>; 20,5-22,0 g/dm<sup>3</sup>. When diluting brines svr. No. 3 - to the low-mineralized water of the source No. 4 in a proportion from 1: 41,69 to 1: 41,55, the chemical composition of the DMMW will correspond to the following formula:



**Table 1.** Macrocomponent composition of groundwater source No. 4, Morshyn

CATIONI, MG / DM <sup>3</sup>			ANIONI, MG / DM <sup>3</sup>			MINERALIZATION, G / DM <sup>3</sup>	THE FORMULA OF THE CHEMICAL COMPOSITION OF WATER
Na <sup>+</sup> +K <sup>+</sup>	Ca <sup>2+</sup>	Mg <sup>2+</sup>	Cl	SO <sub>4</sub> <sup>2-</sup>	HCO <sub>3</sub> <sup>-</sup>		
17,5	16,0	5,5	14,2	14,8	79,3	0,15	HC03 65 Cl 20 SO 415 Ca 40 (Na+K) 38 Mg 22

**Table 2.** Estimated limits of fluctuations in the content of macrocomponents in the DMMW with mineralization 3,0-4,0 g/dm<sup>3</sup>

CATIONI, MG / DM <sup>3</sup>			ANIONI, MG/DM <sup>3</sup>			MINERALIZATION, G/DM <sup>3</sup>
Na <sup>+</sup> +K <sup>+</sup>	Ca <sup>2+</sup>	Mg <sup>2+</sup>	Cl	SO <sub>4</sub> <sup>2-</sup>	HCO <sub>3</sub> <sup>-</sup>	
0,84-1,13	0,02-0,04	0,06-0,12	0,25-0,43	1,71-2,22	0,08-0,09	3,0-4,0

The given composition of DMMW characterizes it as low-mineralized sulfate, chloride-sulfate sodium. The limits of the content of basic cations and anions in DMMW with a mineralization of 3,0-4,0 g/dm<sup>3</sup> are presented in Table 2 [4].

When receiving DMMW, groundwater is used, containing standardized components and compounds within acceptable limits, therefore, their concentration in DMMW with a salinity of 3,0-4,0 g/dm<sup>3</sup>. DMMW does not contain specific biologically active components and compounds in therapeutic concentrations. The performed control physicochemical analysis of the DMMW confirmed the specified physicochemical parameters of the DMMW – total mineralization, basic chemical composition and compliance with the requirements of regulatory documents. Macrocomponent composition of DMMW svr. No. 3-k with. Burned in certain proportions of dilution are presented in Table 3 [4].

Along with hydrotherapy, a component of the rehabilitation process in patients after laparoscopic cholecystectomy was dietary nutrition, organized in the conditions of the MHRC. A feature of the diet was the presence of a normal content of proteins, fats (with an equal ratio of animal and vegetable fats) and carbohydrates. Refractory fats, cholesterol-rich foods, essential oils, spices, and extractives were excluded from the diet. The diet included vegetables and fruits. All dishes were cooked boiled or steamed or baked. For drinks, they used compotes from seasonal local fruits or compote without sugar. Butter or vegetable oil was added to prepared meals. The food was taken warm, hot and cold dishes are

excluded. Chopped diet – after 3-4 hours. Dinner – no later than 2 hours before bedtime. List of products and dishes on the menu: wheat or rye bread, uncomfortable varieties of bakery products, pastries (only yesterday's pastries or dried ones are required), dry biscuits. Soups based on vegetable or cereal broths, vegetarian, dairy, 1-2 times a week – low-fat meat soup. Meat dishes from lean meats (beef, chicken, turkey, rabbit) boiled, baked or steamed. Fish dishes from low-fat varieties of fish, boiled or baked. Cereals and pasta – rice, buckwheat, oatmeal, semolina and puddings, pasta. Dishes and side dishes from vegetables, except for legumes – boiled or stewed potatoes, carrots, beets, zucchini, pumpkin, etc. Fruits and berries – baked apples of non-acidic varieties, bananas, berry jelly, compotes, mousses. Sweets – sugar, jam, honey in moderation. Dairy products – whole milk (different fat content of milk), kefir, yogurt, low-fat cottage cheese and cheese. During the rehabilitation period, the following products were prohibited on the menu: fried foods, buns, pastries, cakes, fat meat and fish broths, mushrooms, caviar, offal, fatty meats and lard, sour cream, cream, fatty fish, canned food, smoked meats, beans and other legumes, radishes, onions, garlic, radishes, radishes, cabbage, tomatoes, cucumbers, spices, spicy dishes and seasonings, chocolate, cocoa, strong coffee, alcohol and carbonated drinks. Prohibited foods were not on the menu of organized meals at the MHRC, and we cannot be sure that the patients did not consume prohibited foods in commercial food outlets in the city of Morshyn during their rehabilitation.

**Table 3.** Macrocomponent composition of DMMW well No. 3-k s. Upper in certain proportions of dilution

Cationi, mg / dm <sup>3</sup>			Anioni, mg/dm <sup>3</sup>			Mineralization, g/dm <sup>3</sup>	The formula of the chemical composition of water
Na <sup>+</sup> +K <sup>+</sup>	Ca <sup>2+</sup>	Mg <sup>2+</sup>	Cl	SO <sub>4</sub> <sup>2-</sup>	HCO <sub>3</sub> <sup>-</sup>		
0,999	0,032	0,083	0,362	1,934	0,085	3,50	pH 6,2 SO 78 Cl 20 (Na+K)84 Mg 13



**Table 4.** The results of biochemical pre-treatment of blood in the implantation of mineral diluted drinkable water from the Sverdlov region No. 3-k. at a concentration of 3,0-3,4 g/dm<sup>3</sup>.

Indicator	Before rehabilitation (M±m)	After rehabilitation (M±m)	p
Total protein, (g/l)	60 ± 6,32	68 ± 6,73	>0,05
Thymol test, unit	4,23 ± 0,45	2,21 ± 0,42*	<0,01
Total bilirubin, mmol/l	17,85 ± 1,88	15,37 ± 1,69	>0,05
ALT, mmol (units/hour · l)	0,98 ± 0,11	0,68 ± 0,10*	<0,05
AST, mmol (units/hour 1 · l)	0,46 ± 0,08	0,42 ± 0,08	>0,05
Total cholesterol, mmol/l	6,21 ± 0,37	5,23 ± 0,32*	<0,05
Triglycerides, mmol/l	2,10 ± 0,30	1,29 ± 0,29	>0,05
Blood glucose, mmol/l	6,20 ± 0,56	5,13 ± 0,49	>0,05

\* reliability of indicators in comparison with rehabilitation –  $p < 0,05$

The results of a biochemical blood test were analyzed in 100 patients after laparoscopic cholecystectomy, who were undergoing rehabilitation at the Morshynkurort sanatorium complex in 2017, 2018 and consumed diluted mineral healing water from well No. 3-k. with. Verkhnee Stryisky district of Lviv region in a dilution of 3,0-3,4 g/dm<sup>3</sup> for internal use. The method of hydrotherapy was carried out according to the instructions for practical use, approved by the Academic Council of the State Institution “Ukrainian Research Institute of Medical Rehabilitation and Balneology of the Ministry of Health of Ukraine”: amount of intake: 200-250 ml. at one time, temperature 40-42°C, 3 times a day, 40 minutes before meals.

Blood sampling for the study was carried out before the beginning of rehabilitation and after 14 days of hydrotherapy. Inclusion criteria: patients after laparoscopic cholecystectomy from 1 month to 1 year after surgery. Contraindications to the use of diluted mineral medicinal water from wells No. 3-k. with. Goreshnee Stryisky district of Lviv region in a dilution of 3,0-3,4 g/dm<sup>3</sup> was the presence in patients: exacerbation of the inflammatory process in the stomach and duodenum; exacerbation of the inflammatory process in the pancreas, chronic enteritis and colitis of the acute phase of severe form; acute pyelonephritis; malignant diseases of the digestive system; violation of the passage of food masses through the gastrointestinal tract; complicated urolithiasis; circulatory insufficiency is sharply expressed. The results of a biochemical blood test of the use of diluted mineral medicinal water from well No. 3-k. At a concentration of 3,0-3,4 g / dm<sup>3</sup> are presented in Table 4 [4].

## DISCUSSION

According to the medical instructions, the indication for hydrotherapy of DMMW in the specified proportions is the presence of patients with the following diseases: chronic non-atrophic gastritis with increased and preserved acid-forming function of the stomach in the stage of unstable and stable remission; chronic atrophic gastritis with reduced and preserved acid-forming function of the stomach at the stage of unstable and stable remission; uncomplicated peptic ulcer disease in remission; uncomplicated peptic ulcer of the duodenum in remission; functional dyspepsia; chronic colitis accompanied

by diarrhea or constipation in the stage of unstable and stable remission; diverticular bowel disease without complications; irritable bowel syndrome; dysfunctional disorders of the biliary tract; other diseases of the biliary tract of various origins of unstable and stable remission; postcholecystectomy syndrome; gastric surgery syndromes; chronic viral hepatitis with minimal inflammatory processes in the liver; chronic liver disease in unstable and stable remission; chronic pancreatitis in the stage of unstable and persistent remission; diabetes mellitus; chronic pyelonephritis in remission; urolithiasis without impaired patency of the urinary tract; chronic cystitis in the stage of unstable and persistent remission; uric acid diathesis; alimentary obesity, which allows the use of this method for patients with comorbidities.

The presence of calculous cholecystitis leads to functional disorders in the liver, which are manifested by increased activity of transaminases, levels of C-reactive protein, cholesterol and other studied indicators, which persist after laparoscopic cholecystectomy. Hyperbilirubinemia develops, the genesis of which is due not only to the violation of the evacuation of bile from the extrahepatic bile ducts, but also functional changes in hepatocytes. The total amount of whey protein in patients who were in the long-term stage of rehabilitation in MHRC, despite hypoalbuminemia and hypergammaglobulinemia, is within the norm, which coincides with the work of other scientists [3, 5].

As a result of rehabilitation of patients with use in the conditions of a sanatorium hospital after 14 days of the use of the mineral diluted medical water of a well №3-k. with. Control laboratory studies were performed at a concentration of 3,0-3,4 g/dm<sup>3</sup>. Mathematical statistics revealed a significant ( $p < 0,05$ ) improvement in such indicators as: thymol test, alanine transpeptidase activity, total cholesterol. Analyzing the results of the study, it can be argued that the use of diluted mineral healing water well №3-k. with. Upper, at a concentration of 3,0-3,4 g / dm<sup>3</sup> for at least 14 days in the long-term rehabilitation phase in patients after laparoscopic cholecystectomy led to improved protein-synthesizing function of the liver – Thymol test decreased from 4,23 ± 0,45 To 2,21 ± 0,42 unit ( $p < 0,01$ ). The activity of alanine transpeptidase ALT decreased, from 0,98 ± 0,11 to 0,68 ± 0,10 units/hour · l, ( $p < 0,05$ ), which indicates the recovery of liver cells. There was

a statistically significant ( $p < 0,05$ ) decrease in total cholesterol from  $6,21 \pm 0,37$  to  $5,23 \pm 0,32$  mmol/l. Of course, current trends in the development of rehabilitation require not only a medical, biological approach to the recovery of patients, but also psychosocial. However, it can be argued that the inclusion of hydrotherapy according to this scheme leads to improved liver function. Therefore, in our further research, to develop and improve the tactics of rehabilitation of patients after laparoscopic cholecystectomy at a long stage of rehabilitation along with physical therapy, occupational therapy, we will recommend, based on these studies, hydrotherapy DMMW svr. №3-k and groundwater source №4 Morshyn in dilution to mineralization 3,0-3,4 g/dm<sup>3</sup>.

## CONCLUSIONS

Hydrotherapy for 14 days DMMW svr. №3-k and groundwater source №4 city Morshyn in dilution to mineralization of 3,0-3,4 g/dm<sup>3</sup> in the long-term stage of rehabilitation leads to improved liver function of patients after laparoscopic cholecystectomy.

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The Authors declare no conflict of interest

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