Marfiyan Olena M, Zukow Walery. Relationships between parameters of gall-bladder motility and neuroendocrine-immune complex and metabolism in men with chronic cholecystitis and pyelonephritis. Journal of Education, Health and Sport. 2015;5(12):434-449. ISSN 2391-8306. DOI http://dx.doi.org/10.5281/zenodo.35660
http://ojs.ukw.edu.pl/index.php/johs/article/view/2015%3B5%2812%29%3A434-449
http://pbn.nauka.gov.pl/works/684422
Formerly Journal of Health Sciences. ISSN 1429-9623 / 2300-665X. Archives 2011–2014
http://journal.rsw.edu.pl/index.php/JHS/issue/archive

Deklaracja.
Specyfika i zawartość merytoryczna czasopisma nie ulega zmianie.
Zgodnie z informacją MNiSW z dnia 2 czerwca 2014 r., że w roku 2014 nie będzie przeprowadzana ocena czasopism naukowych; czasopismo o zmienionym tytule otrzymuje tyle samo punktów co na wykazie czasopism naukowych z dnia 31 grudnia 2014 r.
The journal has had 5 points in Ministry of Science and Higher Education of Poland parametric evaluation. Part B item 1089. (31.12.2014).

The authors declare that there is no conflict of interests regarding the publication of this paper.
Received: 10.11.2015. Revised 15.12.2015. Accepted: 17.12.2015.

RELATIONSHIPS BETWEEN PARAMETERS OF GALL-BLADDER MOTILITY AND NEUROENDOCRINE-IMMUNE COMPLEX AND METABOLISM IN MEN WITH CHRONIC CHOLECYSTITIS AND PYELONEPHRITIS

Olena M Marfiyan[1,2], Walery Zukow[3]

[1]JSC "Truskavets'kurort", Truskavets', Ukraine olenka80@meta.ua
[2]Department of Pediatry, OO Bohomolets' National Medical University, Kyiv, Ukraine
[3]Faculty of Physical Education, Health and Tourism, Kazimierz Wielki University, Bydgoszcz, Poland w.zukow@ukw.edu.pl

SUMMARY

Objective. Long known about cholecystokinetic and diuretic effects balneotherapy on spa Truskavets'. However known about modulation by bioactive water Naftussya neuroendocrine-immune complex **Aim:** clarification relationships between parameters of gall-bladder motility and neuroendocrine-immune complex as well as metabolism. **Material and Methods.** At 22 men with chronic cholecystitis combined with pyelonephritis we recorded basal and postprandial volume of gall-bladder (Echoscopy by "Radmir"), urinary excretion electrolytes and nitrogenous metabolites, EEG ("NeuroCom"), HRV ("CardioLab+HRV"), plasma level of cortisol, testosterone and triiodthyronine (ELISA), routine immune parameters. **Results.** Discovered 23 neural, metabolic and immune parameters, canonical correlation which with the parameters of gall-bladder motility is very strong. In particular, basal and early (in 5 min) postprandial volume determinated positively by HRV markers of vagal tone (pNN_{50}, HF, LF, VLF), Bayevskiy's activity regulatory systems index, α-rhythm laterality index, θ-rhythm deviation, circulating immune complexes, chloride and magnesium urina concentration and electrokinetic index buccal epithelium as marker of biological age, while negatively determinated by passport age as well as by α-rhythm frequency, oxaluria and body massa. Tardy (in 15 and 30 min) postprandial volume determinated negatively by θ-rhythm asymmetry, killing index by neutrophils Staphylococcus aureus, glomerular filtration, diurese, creatinineuria, phosphaturia, while positively by sodium urina concentration. **Conclusion.** Cholecystokinetic effect balneotherapy on spa Truskavets' may be the result of modulation of neuroendocrine-immune complex.

Keywords: gall-bladder motility, neuroendocrine-immune complex, metabolism, relationships.

Abbreviations

AMo/ΔX Ratio	Bayevskiy's Vegetative Balance Index.
AMo/2•ΔX•Mo Ratio	Bayevskiy's Stress Index.
ANS	Autonomic nervous system.
EEG	Electroencephalogram.
HFnu	Normalized power in HF band, a derived index that is computed by dividing HF by some suitable denominator representing the total relevant power, as discussed in the text.
HF power	Power in the High Frequency band of the HRV spectrum, often between 0.15–0.40 Hz, often reported in units of milliseconds-squared.
HRV	Heart rate variability (usually measured as summaries of heart period variability).
KVI	Kerdö's Vegetative Index.
LF/HF Ratio	Spectral HRV index HRV sympatho-vagal balance represents Ratio HRV computed as (LF/HF).
LFnu	Normalized power in LF band, a derived index that is computed by dividing LF by some suitable denominator representing the total relevant power, as discussed in the text.
LF power	Power in the Low Frequency band of the HRV spectrum, often between 0.04 – 0.15 Hz, often reported in units of milliseconds-squared.
PSD	Power Spectrum Density in Parietal and Central loci.
PSNS	Autonomic parasympathetic nervous system.
SA	Node Sino-atrial pacemaker node of the heart.
SNS	Autonomic sympathetic nervous system.
VLF power	Power in the Low Frequency band of the HRV spectrum, often with band limits strictly greater than 0.00 Hz and less than 0.04 Hz, often reported in units of milliseconds-squared.

INTRODUCTION

We have previously shows that 10-12-days course balneotherapy in the spa Truskavets' (drinking bioactive water Naftussya, ozokerite applications, mineral baths) in men with chronic cholecystitis combined with pyelonephritis reduces fasting gall-bladder volume by 16% and increases it contractile response to clolekinetic by 44%. This is combined with an increase in urinary excretion of phosphate, calcium, oxalates, creatinine, uric acid, urea and magnesium with no significant changes in urinary excretion chloride, potassium and sodium. However reduces the plasma level of creatinine and urea. Cholecystokinetic effect and activation depurative and excretory functions of the kidneys accompanied by modulation of neuroendocrine-immune complex, including a decrease in the levels of neuroendocrine markers of stress and increase killing by neutrophils Staphylococcus aureus and Escherichia coli. Ascertained as the growth electrokinetic rate of cell nuclei buccal epithelium, indicating that the "rejuvenation" of the body [11]. We hypothesized that cholecystokinetic and diuretic effects are the results of modulation of neuroendocrine-immune complex [13-15]. The goal of this study is clarification relationships between parameters of gall-bladder motility and neuroendocrine-immune complex and metabolism.

MATERIAL AND METHODS

The object of observation were 22 men aged 24-70 (mean 49,1±2,5) years old, who came to the spa Truskavets' (Ukraine) for the treatment of chronic cholecystitis combined with pyelonephritis in remission. The survey was conducted twice, before and after balneotherapy. On the tone and motility of gall-bladder judged by its volume on an empty stomach in the morning and after 5, 15 and 30 min after ingestion cholekinetic (50 ml of 40% solution of xylitol). The method echoscopy (echocamera "Radmir") applicated [11].

We recorded also electrocardiogram in II lead to assess the parameters of HRV [1] (software and hardware complex "CardioLab+HRV" production "KhAI-MEDICA" Kharkiv) and background electroencephalogram in 16 monopolar leads (software and hardware complex "NeuroCom" the same production). Details are given in our previous articles [16,17].

Plasma levels of cortisol, testosterone and triiodthyronine tested by ELISA using the analyzer 'Tecan" (Oesterreich) and kits for company "Alkor Bio" (RF).

About phagocytic function of neutrophils judged by activity (percentage of neutrophils, in which found microbes - phagocytic index), intensity (number of microbes absorbed one phagocytes - microbial count) and completeness (percentage of dead microbes - Killing index) phagocytosis museum cultures Staphylococcus aureus (ATCC N 25423 F49) and Escherichia coli (O55 K59) from laboratory Truskavetsian hydrogeological regime-operational station [3].

Immune status evaluated on a set of I and II levels recommended by the WHO. For phenotyping subpopulations of lymphocytes used the methods of rosette formation [7] and indirect immunofluorescent binding reaction monoclonal antibodies [12] from company "Sorbent" (RF) with visualization under fluorescent microscope. T-cellular immunity assessed by the following parameters: blood levels of a subpopulation of "active", theophilline resistance and sensitive T-lymphocytes and T-lymphocytes phenotype of $CD3^+CD4^+$(helpers/inductors). State of killer link of immunity estimated by the content of $CD3^+CD8^+$-lymphocytes (T-killers) and $CD16^+$-lymphocytes (natural killers). The state of humoral immunity judged by the content of EAC and $CD19^+$ B-lymphocytes and concentration in serum of immunoglobulins classes G, A, M (radial immunodiffusion method) and circulating immune complexes (with polyethylene glycol precipitation method), using standardized methods described in manual [10].

In the urine collected during the day, determined oxalate content and nitrogen metabolites: creatinine, urea and uric acid, electrolytes: phosphates, chloride, calcium, magnesium, potassium and sodium. Nitrogenous metabolites in plasma of venous blood were determined also. Used unified methods [5].

Also recorded electrokinetic index buccal epithelial cell nuclei (by micro electrophoresis device "Biotest", Kharkiv), which is considered a marker of biological age [18].

Results processed by methods of correlation and canonical analyses, using the software package "Statistica 5.5".

RESULTS AND DISCUSSION

Since the tone and motility of gall-bladder subordinates neuro-humoral influences [2,4,6], correlation analysis is advisable to start with neural regulatory parameters. Screening correlation basal volume of gall-bladder (V_0) showed its moderate direct dependence on HRV markers vagal tone: pNN_{50} (r=0,41), HF (r=0,33), RMSSD (r=0,29), VLF (r=0,28). Bayevskiy's Activity

Regulatory Systems Index (BARSI) significantly correlated with V_0 only in orthostase (r=0,37), but not in the supine position (r=0,24).

Among the options EEG significantly associated with V_0 Laterality Indexes (LI) α- (r=0,34) and β- (r=0,31) Rhythms as well as Amplitude β-Rhythm (r=-0,30) and Frequency α-Rhythm (r=-0,28). Among the Hormones only Cortisol weakly correlates with V_0 (r=0,21). In regression analysis model with a turn except there were only 6 neural parameters (Table 1), which causes basal volume of Gall-bladder on 55% (Fig. 1).

Table 1. Regression Summary for Dependent Variable V_0 and Neural Variables

R=0,782; R^2=0,612; Adjusted R^2=0,549; $F_{(6,4)}$=9,7; $\chi^2_{(6)}$=36,9; $p<10^{-5}$; Std. Error of estimate: 9,4 ml.

	Beta	St. Err. of Beta	B	St. Err. of B	$t_{(37)}$	p-level
Intercpt			76,4	18,7	4,08	,0002
pNN_{50}	1,017	,364	1,14	,41	2,80	,008
BARSI(o)	,471	,112	2,19	,52	4,21	,0002
α-R LI	,247	,106	,157	,067	2,33	,025
RMSSD	-,700	,412	-,577	,340	-1,70	,098
VLF	,290	,165	,004	,002	1,75	,088
α-R Frequence	-,217	,109	-3,63	1,82	-1,99	,054

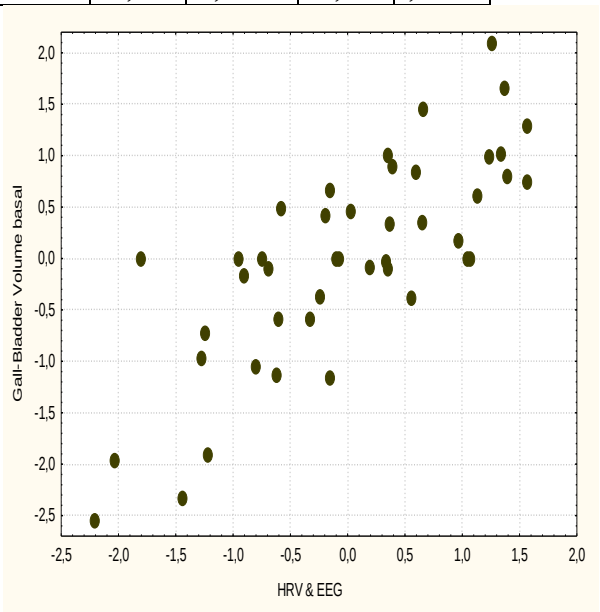

Fig. 1. Canonical correlation between parameters HRV and EEG (X-line) and basal volume of Gall-bladder (Y-line)

Among the urinary parameters significantly associated with V_0 Oxaluria (r=-0,48), Diurese (r=-0,39) as well as Uric acid (r=0,32) and Magnesium (r=0,29) concentration. Body Massa Index as integral parameter of metabolism correlates with V_0 as much as Age (r=-0,33 and -0,32 respectively), while Electrokinetic Index of Epitheliocytes (EKIE) as marker of Biological Age [18] correlates with V_0 negatively (r=0,45). Fees metabolic parameters determine the V_0 of 45% (Table 2, Fig. 2). Take together Neural and Metabolic parameters determine the Basal Volume of Gall-Bladder of 69% already (Table 2, Fig. 2).

Table 2. Regression Summary for Dependent Variable V_0 and Metabolic Variables

R=0,706; R^2=0,499; Adjusted R^2=0,447; $F_{(4,4)}$=9,69; $\chi^2_{(4)}$=27,6; $p<10^{-4}$; Std. Error of estimate: 10,4 ml.

	Beta	St. Err. of Beta	B	St. Err. of B	$t_{(39)}$	p-level
Intercpt			76,2	13,6	5,60	10^{-5}
Oxalates Excretion	-,381	,121	-7,88	2,50	-3,15	,003
Urates Concentrat.	,374	,121	8,88	2,87	3,10	,004
Body Massa Index	-,462	,119	-1,45	,37	-3,89	10^{-3}
Mg Concentration	,145	,120	3,42	2,82	1,21	,232

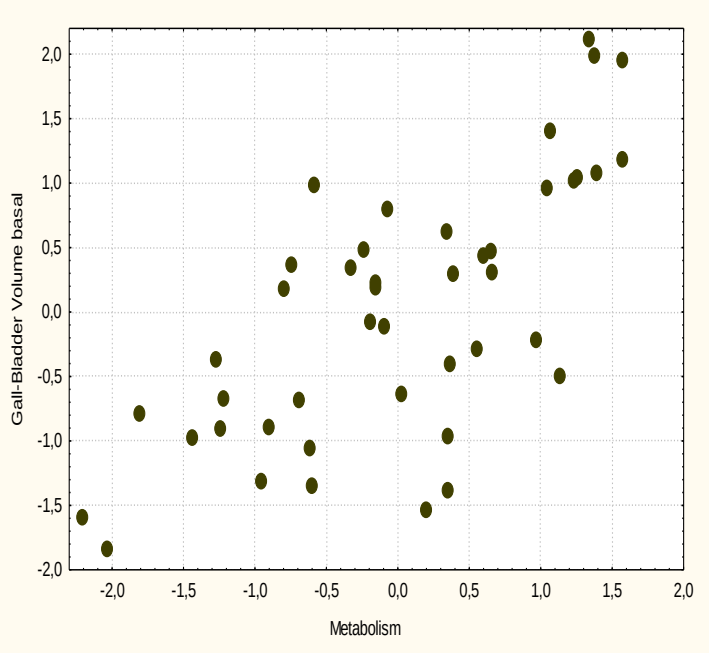

Fig. 2. Canonical correlation between Metabolic parameters (X-line) and basal volume of Gall-bladder (Y-line)

Table 3. Regression Summary for Dependent Variable V_0 and Neural and Metabolic Variables

R=0,863; R^2=0,746; Adjusted R^2=0,687; $F_{(8,4)}$=12,8; $\chi^2_{(8)}$=52,0; $p<10^{-6}$; Std. Error of estimate: 7,8 ml.

	Beta	St. Err. of Beta	B	St. Err. of B	$t_{(35)}$	p-level
Intercpt			47,1	23,9	1,97	,057
pNN_{50}	,255	,121	,285	,135	2,12	,041
BARSI(o)	,458	,092	2,13	,43	4,98	10^{-4}
α-R LI	,227	,089	,144	,057	2,54	,016
α-R Frequence	-,288	,096	-4,83	1,60	-3,01	,005
Oxalates Excretion	-,198	,102	-4,08	2,10	-1,94	,060
EKIE	,661	,208	,934	,293	3,19	,003
Body Massa Index	-,376	,098	-1,18	,31	-3,82	,0005
Age	,627	,188	,760	,228	3,33	,002

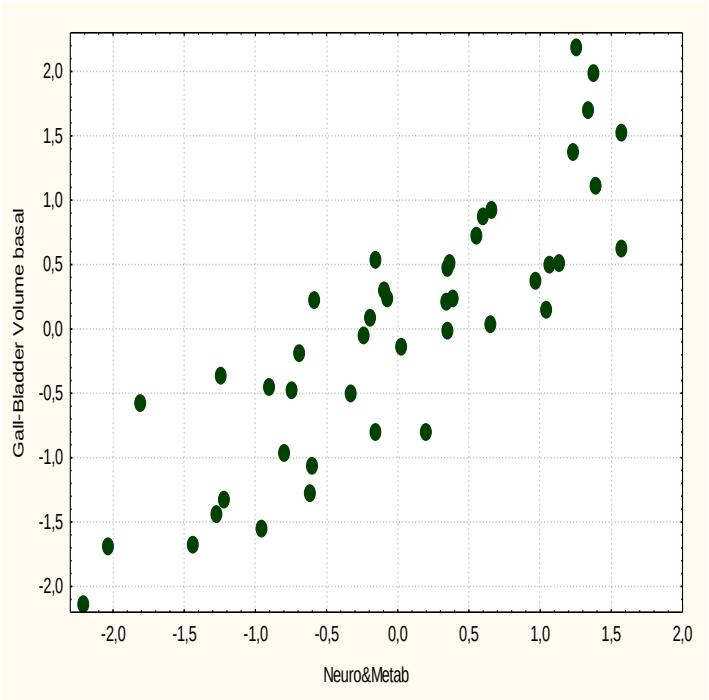

Fig. 3. Canonical correlation between Neural and Metabolic parameters (X-line) and basal volume of Gall-bladder (Y-line)

Early (in 5 min after cholekinetic) Postprandial Volume of gall-bladder correlated on the verge of significance with Asymmetry (r=-0,28) and Deviation (r=0,27) θ-Rhythm, but significanly with VLF HRV (r=0,32), so its conditionality neural influences smaller compared to basal size (21% vs 55%) (Table 4), while metabolic conditionality appeared similar (Table 5).

Table 4. Regression Summary for Dependent Variable V_5 and Neural Variables

R=0,511; R^2=0,262; Adjusted R^2=0,206; $F_{(3,4)}$=4,7; p=0,006; Std. Error of estimate: 1,7%.

	Beta	St. Err. of Beta	B	St. Err. of B	$t_{(40)}$	p-level
Intercpt			95,5	,95	100	10^{-6}
VLF	,375	,137	,0007	,0003	2,73	,009
Asymmetry θ-Rhythm	-,279	,141	-,035	,018	-1,98	,054
Deviation θ-Rhythm	,230	,140	1,157	,704	1,64	,108

Table 5. Regression Summary for Dependent Variable V_5 and Metabolic Variables

R=0,711; R^2=0,506; Adjusted R^2=0,455; $F_{(4,4)}$=10,0; p=10^{-5}; Std. Error of estimate: 1,4%.

	Beta	St. Err. of Beta	B	St. Err. of B	$t_{(39)}$	p-level
Intercpt			100,1	1,7	58,7	10^{-6}
Body Massa	-,471	,116	-,064	,016	-4,05	,0002
Oxalates Excr.	-,349	,115	-,989	,327	-3,03	,004
Chloride Conc.	,295	,117	,0224	,0089	2,51	,016
Na Concentrat.	,249	,121	,0131	,0064	2,05	,047

This negative correlation is found on body massa (r=-0,38) and oxaluria (r=-0,40), while positive on urine concentrations of chloride (r=0,41), sodium (r=0,27) and magnesium (r=0,28) as well as serum circulating immune complexes (r=0,25).

Take together Neural and Metabolic parameters determine the early Postprandial Volume of Gall-Bladder of 64% (Table 6, Fig. 4).

Table 6. Regression Summary for Dependent Variable V_5 and Neural and Metabolic Variables

R=0,840; R^2=0,706; Adjusted R^2=0,638; $F_{(8,3)}$=10,5; $\chi^2_{(8)}$=46,5; $p<10^{-6}$; Std. Error of estimate: 1,1%.

	Beta	St. Err. of Beta	B	St. Err. of B	$t_{(35)}$	p-level
Intercpt			96,5	1,8	52	10^{-6}
VLF	,224	,104	,00043	,0002	2,15	,039
Deviat. θ-Rhythm	,305	,098	1,54	,49	3,10	,004
Asymm. θ-Rhythm	-,166	,098	-,021	,012	-1,70	,098
Body Massa	-,378	,108	-,052	,015	-3,51	,001
Oxalates Excretion	-,282	,100	-,800	,283	-2,82	,008
Chloride Concentr.	,271	,099	,0206	,0075	2,74	,009
Na Concentration	,253	,101	,0133	,0053	2,49	,017
CIC	,275	,102	,0290	,0108	2,68	,011

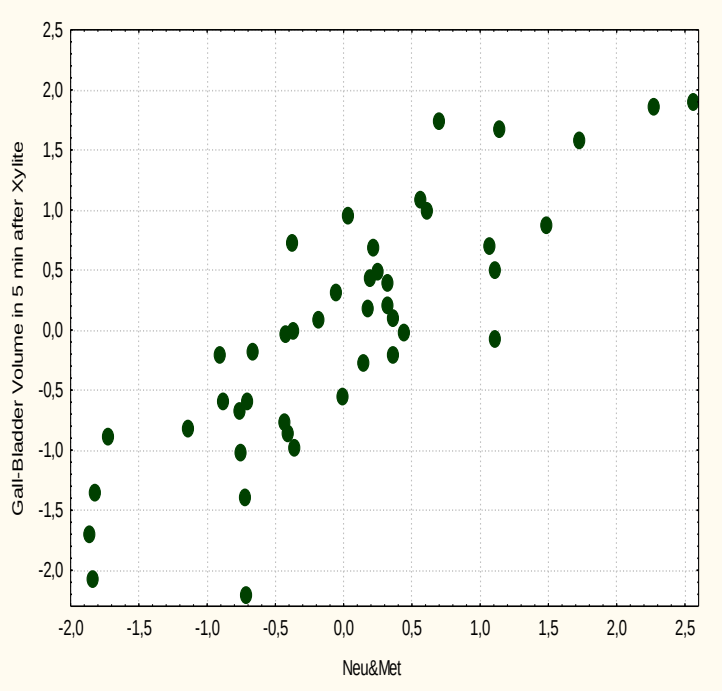

Fig. 4. Canonical correlation between Neural and Metabolic parameters (X-line) and Postprandial (in 5 min) volume of Gall-bladder (Y-line)

The structure of correlation ties Gall-Bladder Volume 15 minutes after cholekinetic (V_{15}) firstly include Calcitonin Activity (r=-0,37), estimated by urinary excretion of Phosphates (r=-0,38) and Calcium (r=-0,28) as well as Index of Killing Staph. aur. (r=-0,37) and Glomerular

Filtration (r=-0,33). The influence of Asymmetry θ-Rhythm increases (r=-0,37) while vagal tone is weakened: r for VLF and HF is equal to 0,25.

Among metabolic parameters closely related to the V_{15} was Body Massa Index (r=-0,44), less Diurese (r=-0,34) as well as Excretion Oxalates (r=-0,37) and Creatinine (r=-0,28).

Canonical correlation between Neural and Metabolic parameters and V_{15} was slightly weaker compared to V_5 (Table 7, Fig.5).

Table 7. Regression Summary for Dependent Variable V_{15} and Neural, Immune and Metabolic Variables

R=0,783; R^2=0,613; Adjusted R^2=0,537; $F_{(7,4)}$=8,1; $\chi^2_{(7)}$=36,5; $p<10^{-5}$; Std. Error of estimate: 5,0%.

	Beta	St. Err. of Beta	B	St. Err. of B	$t_{(36)}$	p-level
Intercpt			113,0	8,1	14,0	10^{-6}
HF	,242	,119	,002	,001	2,03	,050
Asymmetry θ-Rhythm	-,300	,112	-,144	,054	-2,68	,011
Body Massa Index	-,286	,120	-,470	,197	-2,39	,022
Glomerular Filtration	-1,122	,453	-,263	,106	-2,47	,018
Oxalates Excretion	-,373	,107	-4,04	1,16	-3,48	,001
Creatinine Excretion	,952	,451	1,884	,893	2,11	,042
Killing Staph. aur. Ind	-,204	,118	-,226	,131	-1,73	,092

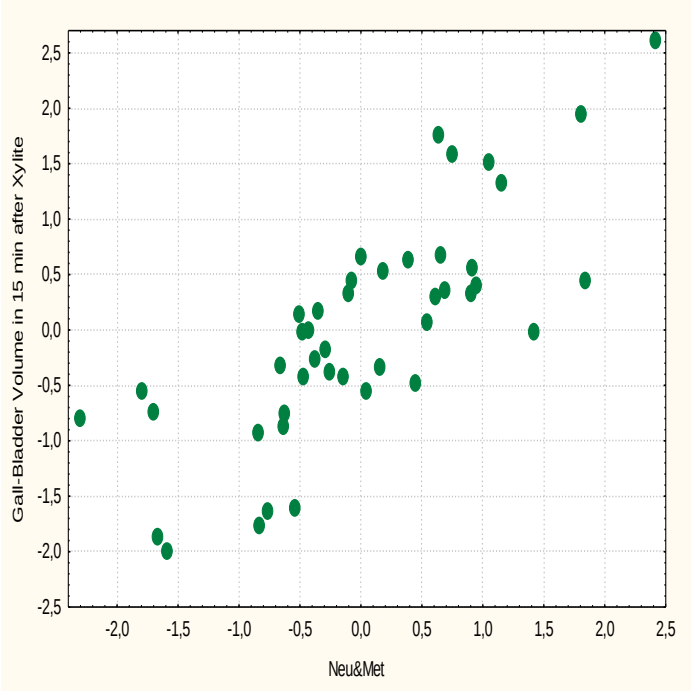

Fig. 5. Canonical correlation between Neural and Metabolic parameters (X-line) and Postprandial (in 15 min) volume of Gall-bladder (Y-line)

Of particular interest are links Gall-bladder Volume in 30 minutes after use cholekinetic, ie the peak postprandial contractile response.

The close relationship found with daily urine output (Fig. 6). This is the first time we have documented the reality of the current idea of combining balneotherapy stimulating influence on excretion as urine and bile [2,6].

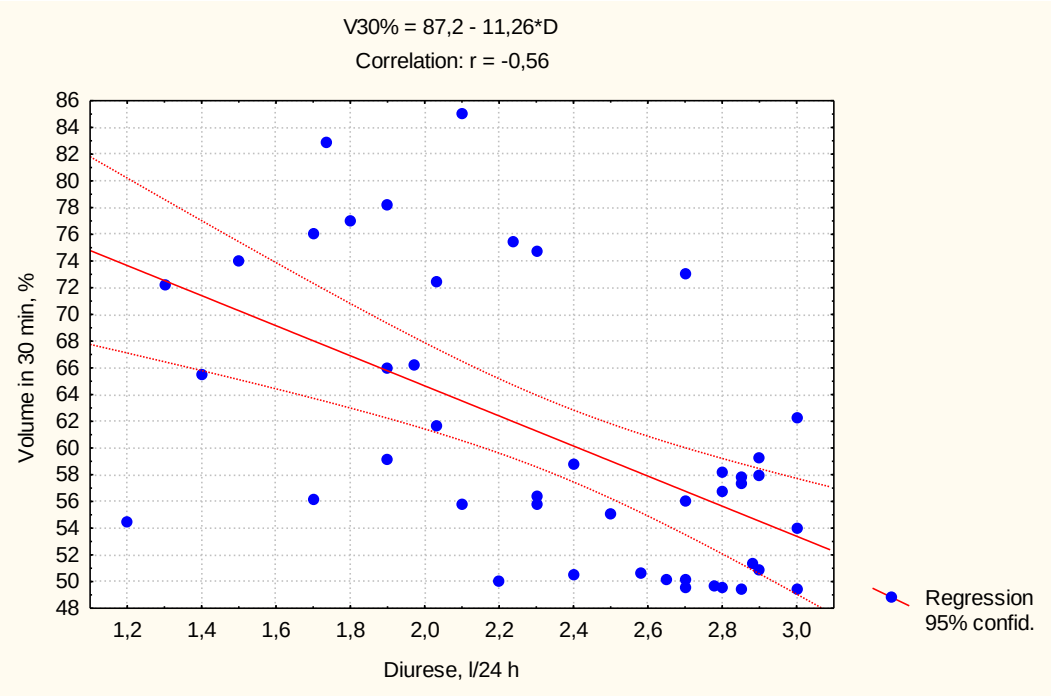

Fig. 6. Correlation between Diurese (X-line) and Postprandial (in 30 min) volume of Gall-bladder (Y-line)

For other urinary parameters detected correlation V_{30} with excretion of Oxalates (r=-0,50), Phosphates (r=-0,44) and Calcium (r=-0,27) as well as concentration of Chloride (r=0,33), Sodium (r=0,31) and Magnesium (r=0,28).

Canonical correlation between V_{30} and urinary parameters is strong (Table 8, Fig. 7).

Table 8. Regression Summary for Dependent Variable V_{30} and Metabolic Variables

R=0,681; R^2=0,463; Adjusted R^2=0,408; $F_{(4,4)}$=8,4; $\chi^2_{(4)}$=24,9; p<,00005 Std. Error of estimate: 8,0%.

	Beta	St. Err. of Beta	B	St. Err. of B	$t_{(39)}$	p-level
Intercpt			60,0	10,3	5,82	10^{-6}
Diurese	-,241	,164	-4,87	3,30	-1,47	,14
Phosphates Excret.	-,389	,170	-,235	,103	-2,28	,03
Na Concentration	,201	,119	,057	,034	1,69	,10
Mg Concentration	,338	,143	5,91	2,51	2,36	,02

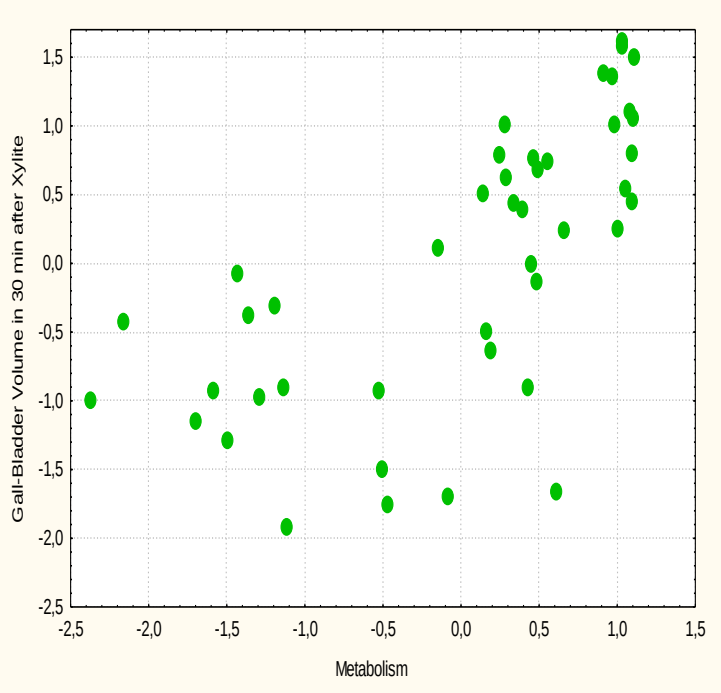

Fig. 7. Canonical correlation between Metabolic parameters (X-line) and Postprandial (in 30 min) volume of Gall-bladder (Y-line)

Calcitonin Activity, calculated as product $(Ca \bullet P)^{0,5}$, causes Gall-Bladder contraction positively (r=-0,38) while markers of Vagal tone negatively (r for pNN_{50} is 0,30; HF 0,27; VLF 0,26 and LF 0,25). Nevertheless in multiple regression model included marker with minimal size r (Table 9). Also included in the model α-Rhythm Laterality Index (r=0,33) and θ-Rhythm Asymmetry (r=-0,23), but not plasma Cortisol (r=0,24). Given the marker of biological age (EKIE) neuroendocrine determination gall-bladder contraction assessed as moderate (Table 9, Fig.8).

Table 9. Regression Summary for Dependent Variable V_{30} and Neuroendocrine Variables

R=0,622; R^2=0,387; Adjusted R^2=0,306; $F_{(5,4)}$=4,8; $\chi^2_{(5)}$=19,3; p<0,002; Std. Error of estimate: 8,6%.

	Beta	St. Err. of Beta	B	St. Err. of B	$t_{(38)}$	p-level
Intercpt			61,2	6,7	9,18	10^{-6}
Calcitonin Activity	-,328	,128	-,491	,192	-2,56	,01
α-Rhythm LI	,227	,131	,107	,062	1,74	,09
EKIE	,206	,140	,216	,146	1,47	,15
LF	,252	,143	,0036	,0020	1,76	,09
Asymm. θ-Rhythm	-,270	,135	-,184	,091	-2,01	,05

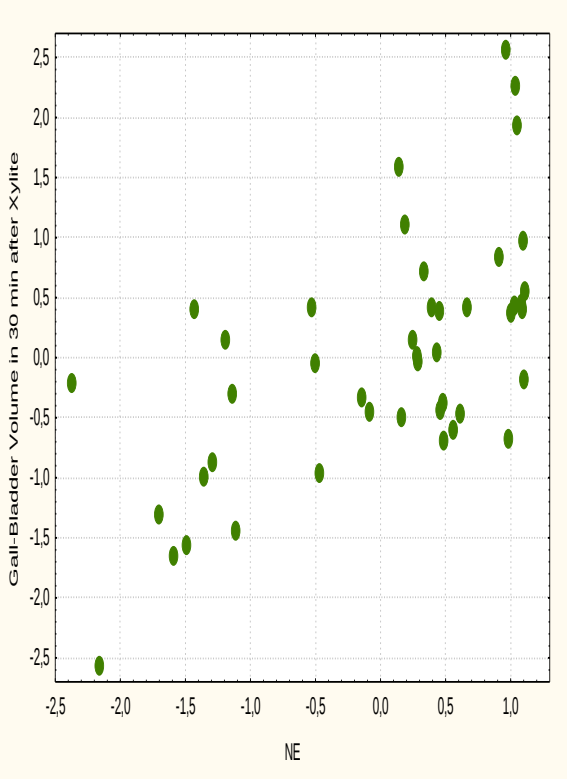

Fig. 8. Canonical correlation between Neural and Endocrine parameters (X-line) and Postprandial (in 30 min) volume of gall-bladder (Y-line)

In integrated multiple regression model with a turn except included also Body Massa Index. In total Neuroendocrine and Metabolic determination Gall-bladder assessed as strong (Table 10, Fig. 9).

Table 10. Regression Summary for Dependent Variable V_{30} and Neural and Metabolic Variables

R=0,789; R^2=0,623; Adjusted R^2=0,550; $F_{(7,4)}$=8,5; $\chi^2_{(7)}$=37,6; $p<10^{-5}$; Std. Error of estimate: 6,9%.

	Beta	St. Err. of Beta	B	St. Err. of B	$t_{(36)}$	p-level
Intercpt			75,3	11,0	6,82	10^{-6}
Diurese	-,251	,145	-5,06	2,93	-1,73	,092
Phosphates Excret.	-,343	,151	-,207	,091	-2,27	,029
Na Concentration	,260	,107	,074	,031	2,43	,020
Mg Concentration	,292	,128	5,10	2,24	2,27	,029
Body Massa Index	-,224	,117	-,521	,274	-1,90	,065
LF	,219	,120	,0031	,0017	1,82	,077
Asymm. θ-Rhythm	-,209	,115	-,142	,078	-1,83	,076

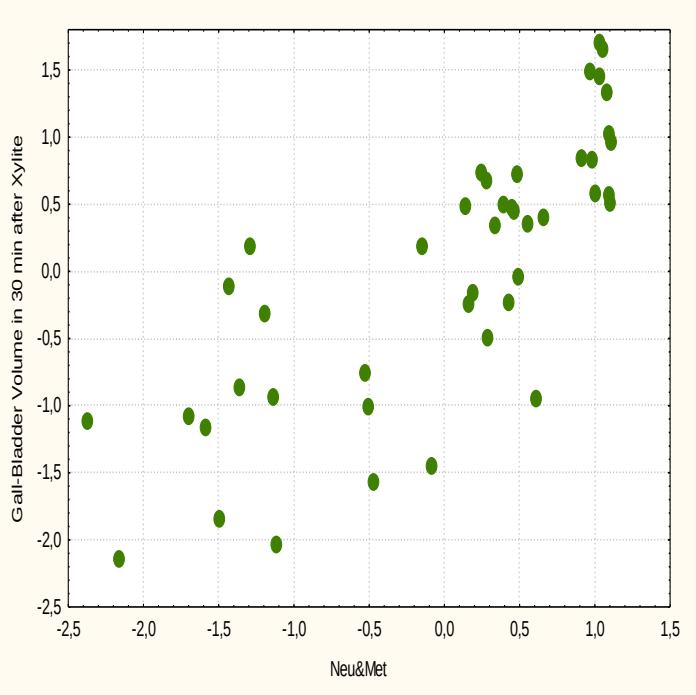

Fig. 9. Canonical correlation between Neural and Metabolic parameters (X-line) and Postprandial (in 30 min) volume of gall-bladder (Y-line)

Special attention is given the correlation between contractile reactivity gall bladder and neutrophil bactericidal regarding potential pathogens cholecystitis and pyelonephritis Staphylococcus aureus (r=-0,35) and Escherichia coli (r=-0,34) (Table 11). After all, known cholecystokinetic effect balneotherapy combined natural with anti-inflammatory effect.

Table 11. Regression Summary for Dependent Variable V_{30} and Immune Variables

R=0,397; R^2=0,157; Adjusted R^2=0,116; $F_{(2,4)}$=3,8; p=0,030; Std. Error of estimate: 9,7%

	Beta	St. Err. of Beta	B	St. Err. of B	$t_{(41)}$	p-level
Intercpt			94,6	12,6	7,51	10^{-6}
Killing Staph. aur. Index	-,241	,163	-,379	,256	-1,48	,15
Killing E. coli Index	-,221	,163	-,278	,205	-1,36	,18

The Table 12 contains Metabolic, Neural, Aging and Immune parameters included in the model canonical correlation with parameters due to Gall-bladder Motility. The information condensed into two pairs of canonical roots.

This the first cholekinetic root mainly reflects size fasting gall-bladder and its early response to the use of xylitol, while the second root shows late postprandial contractile response (Table 13).

Table 12. Correlations between parameters Gall-bladder Motility and Metabolic, Neural, Aging and Immune Variables currently in model

Metabolic, Neural, Aging and Immune Variables	GBV %B 30 min	GBV %B 15 min	GBV %B 5 min	GBV B 0 min
Diurese	**-0,56**	**-0,34**	-0,21	**-0,39**
Oxaluria	**-0,50**	**-0,37**	**-0,40**	**-0,48**
Phosphaturia	**-0,44**	**-0,38**	*-0,18*	-0,22
Glomerular Filtration	**-0,29**	**-0,33**	-0,25	*-0,11*
Body Massa Index	**-0,29**	**-0,44**	**-0,35**	**-0,33**
Body Massa	-0,24	**-0,43**	**-0,38**	-0,25
Creatinineuria	-0,25	-0,28	-0,22	*-0,13*
Chlorid Urina Concentration	**0,33**	*0,14*	**0,41**	*0,18*
Sodium Urina Concentration	**0,31**	*0,19*	0,27	*0,03*
Magnesium Urina Concentration	0,28	0,10	0,28	**0,29**
α-rhythm Laterality Index	**0,33**	0,27	*0,17*	**0,34**
pNN_{50} HRV	**0,30**	0,26	0,22	**0,41**
HF HRV	0,27	0,25	*0,18*	**0,33**
LF HRV	0,25	*0,19*	0,25	0,24
VLF HRV	0,26	0,25	**0,32**	0,28
θ-rhythm Deviation	*0,14*	0,24	0,27	*0,14*
Activity Regulatory Systems Index (O)	*0,00*	*-0,01*	*0,10*	**0,37**
θ-rhythm Asymmetry	-0,23	**-0,37**	-0,28	*-0,03*
α-rhythm Frequency	*-0,14*	*-0,07*	*-0,15*	-0,28
Age	**-0,31**	*-0,11*	*-0,16*	**-0,32**
Electrokinetic Index of Epitheliocytes	**0,29**	*0,10*	*0,14*	**0,45**
Killing of Staphylococcus aureus Index	**-0,35**	**-0,38**	-0,24	-0,03
Circulating Immune Complexes	*0,03*	*0,16*	0,25	0,21

Table 13. Factor Structure, left set

Cholecystokinetic Variables	Root 1	Root 2
Gall-Bladder Volume Basal (0 min)	**0,88**	-0,06
Gall-Bladder Volume % Basal in 5 min	**0,77**	0,53
Gall-Bladder Volume % Basal in 15 min	0,56	**0,75**
Gall-Bladder Volume % Basal in 30 min	0,53	**0,64**

The table 14 shows that basal and early postprandial volume determinated positively by HRV markers of vagal tone (pNN_{50}, HF, LF, VLF), Bayevskiy's activity regulatory systems index, α-rhythm laterality index, θ-rhythm deviation, circulating immune complexes, chloride and magnesium urina concentration and electrokinetic index buccal epithelium as marker of biological age, while negatively determinated by passport age as well as by α-rhythm frequency, oxaluria and body massa. Tardy postprandial volume determinated negatively by θ-rhythm asymmetry, killing index by neutrophils Staphylococcus aureus, glomerular filtration, diurese, creatinineuria, phosphaturia, while positively by sodium urina concentration.

Described ties visualized in Figures 10 and 11.

Table 14. Factor Structure, right set

Metabolic, Neural, Aging and Immune Variables	Root 1	Root 2
Oxaluria	**-0,51**	-0,21
Body Massa Index	**-0,37**	-0,27
Body Massa	**-0,33**	**-0,31**
α-rhythm Frequency	**-0,31**	0,12
Age	**-0,30**	0,00
Electrokinetic Index of Epitheliocytes	**0,40**	-0,14
Activity Regulatory Systems Index (O)	**0,40**	**-0,36**
pNN_{50} HRV	**0,39**	0,04
Magnesium Urina Concentration	**0,38**	-0,01
VLF HRV	**0,37**	0,12
Chlorid Urina Concentration	**0,36**	0,16
Circulating Immune Complexes	**0,32**	-0,04
LF HRV	**0,29**	0,10
HF HRV	**0,29**	0,09
α-rhythm Laterality Index	**0,28**	0,14
θ-rhythm Deviation	**0,23**	0,17
Killing of Staphylococcus aureus Index	-0,03	**-0,54**
θ-rhythm Asymmetry	-0,09	**-0,45**
Phosphaturia	-0,12	**-0,43**
Glomerular Filtration	-0,14	**-0,38**
Diurese	**-0,29**	**-0,30**
Creatinineuria	-0,15	**-0,29**
Sodium Urina Concentration	0,12	**0,34**

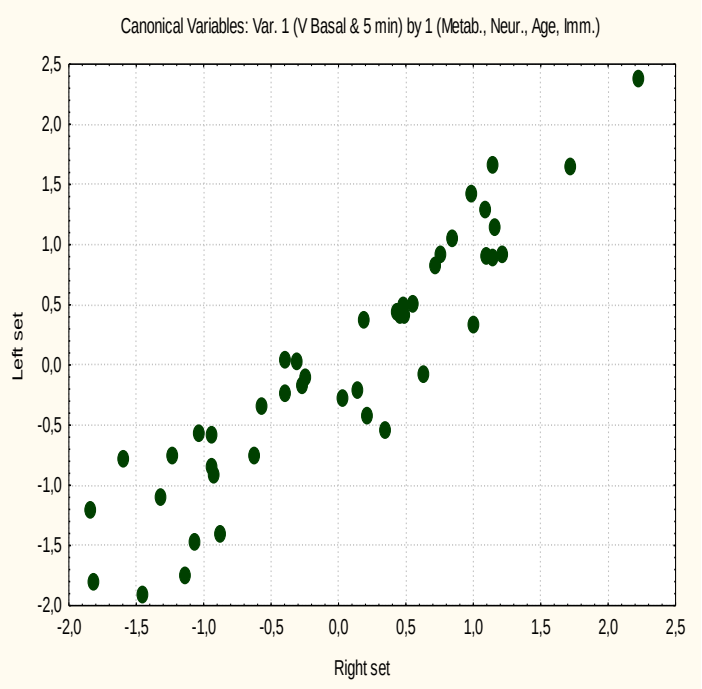

Fig. 10. Canonical correlation between Metabolic, Neural and Immune parameters (X-line) and Basal and Postprandial (in 5 min) volume of gall-bladder (Y-line)

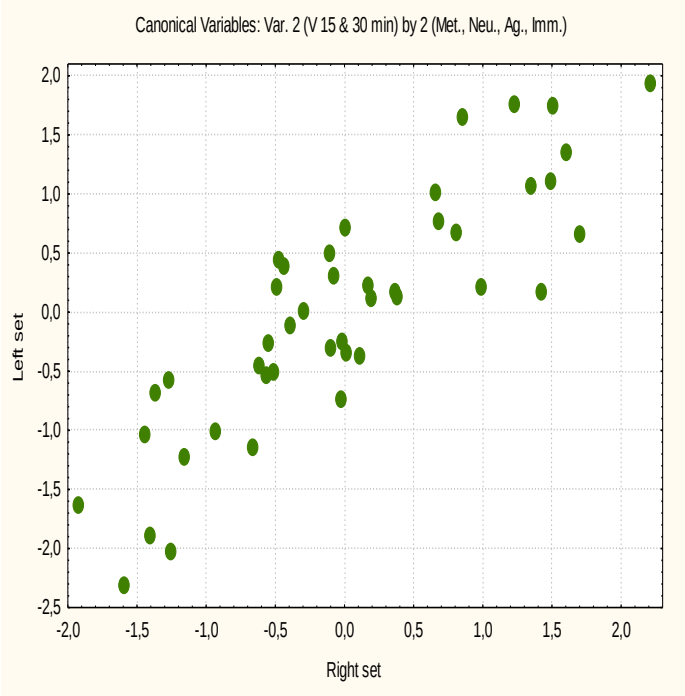

Fig. 11. Canonical correlation between Metabolic, Neural and Immune parameters (X-line) and Postprandial (in 15 and 30 min) volume of Gall-bladder (Y-line)

Table 15. Chi-Square Tests with Successive Roots Removed

Roots Removed	Canoni-cal R	Canoni-cal R^2	χ^2	Degree of Freedom	p-level	Lambda Prime
0	0,928	0,860	147	92	,0003	,006
1	0,864	0,747	89	66	,0292	,046

The foregoing gives grounds for concluding that cholecystokinetic effect balneotherapy on spa Truskavets' may be the result of modulation of neuroendocrine-immune complex.

References

1. Baevskiy RM, Ivanov GG. Heart Rate Variability: theoretical aspects and possibilities of clinical application [in Russian]. Ultrazvukovaya i funktsionalnaya diagnostika. 2001; 3: 106-127.
2. Chebanenko OI, Popovych IL., Bul'ba AYa, Ruzhylo SV. Cholekinetic Action of Water Naftussya [in Ukrainian]. Kyiv: Computerpress.1997. 103 p.
3. Douglas SD, Quie PG. Investigation of Phagocytes in Disease. Churchil. 1981. 110 p.
4. Ivanyts'ka OM, Popovych IL, Barylyak LG. The neuro-humoral regulation of pancreatic secretion [in Ukrainian]. Medical Hydrology and Rehabilitation. 2013; 11(4):97-109.
5. Goryachkovskiy AM. Clinical Biochemistry [in Russian]. Odesa: Astroprint. 1998. 608 p.
6. Gumega MD, Levyts'kyi AB, Popovych IL. Balneogastroenterology [in Ukrainian]. Kyiv: UNESCO-SOCIO. 2011. 243 p.
7. Immunological Methods / Ed. G. Frimel [Trans. from German in Russian]. Moskwa: Meditsina. 1987. 472 p.
8. Khaitov RM. Physiology of the Immune System [in Russian]. Moskwa: VINITI RAS. 2005. 428 p.
9. Kostyuk PG, Popovych IL, Ivassivka SV (editors). Chornobyl', Adaptive and Defensive systems, Rehabilitation [in Ukrainian]. Kyiv: Computerpress. 2006. 348 p.
10. Lapovets' LYe, Lutsyk BD. Handbook of Laboratory Immunology [in Ukrainian]. L'viv. 2002. 173 p.

11. Marfiyan OM, Korolyshyn TA, Barylyak LG, Kovbasnyuk MM, Yavors'kyi OV, Zukow W, Popovych IL. Neuroendocrine-immune and metabolic accompaniments of cholecystokinetic effects of balneotherapy on spa Truskavets'. Journal of Education, Health and Sport.-2015; 5(5): 21-30.
12. Pinchuk VG, Gluzman DF. Immunocytochemistry and Monoclonal Antibodies in Oncohematology [in Russian]. Kyiv: Naukova dumka. 1990. 230 p.
13. Popovych IL. Bioactive water Naftussya: *Guide for Physicians* [in Ukrainian]. Truskavets': Truskavets'kurort. 2013. 33 p.
14. Popovych IL. The concept of neuro-endocrine-immune complex (review) [in Russian]. Medical Hydrology and Rehabilitation. 2009; 7(3): 9-18.
15. Popovych IL. Stresslimiting adaptogene mechanism of biological and curative activity of water Naftussya [in Ukrainian]. Kyiv: Computerpress. 2011. 300 p.
16. Popovych IL, Kozyavkina OV, Kozyavkina NV, Korolyshyn TA, Lukovych YuS, Barylyak LG. Correlation between Indices of the Heart Rate Variability and Parameters of Ongoing EEG in Patients Suffering from Chronic Renal Pathology. Neurophysiology. 2014; 46(2): 139-148.
17. Popovych IL, Lukovych YuS, Korolyshyn TA, Barylyak LG, Kovalska LB, Zukow W. Relationship between the parameters heart rate variability and background EEG activity in healthy men. Journal of Health Sciences. 2013; 3(4): 217-240.
18. Shkorbatov YuG, Kolupayeva TV, Shakhbazov VG, Pustovoit PA. On the relationship between electrokinetic properties of human nucleated cells with some physiological parameters [in Russian]. Fiziologiya Cheloveka. 1995; 21(2): 25-27.