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# DIAGNOSTIC VALUE OF NEUROSPECIFIC MARKERS NSE, S-100, GFAP, MBP AND BDNF IN CEREBROSPINAL FLUID IN PATIENTS WITH VIRAS MENINGITIS

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***The aim of the work*** *– to determine the diagnostic value of the levels of neurospecific markers NSE, GFAP, S-100, MBP, and BDNF in the CSF of adult patients with viral meningitis.*

***Patients and Methods****. 50 cases of acute viral meningitis were analyzed. There were 21 patients with HSV 1,2 infection, 19 patients with EBV infection, 10 patients with enteroviral meningitis. The CSF level of neuro-specific markers was determined in the first and 10–12 days of treatment using the ELISA method.*

***Results.*** *The most significant changes were identified in patients with severe illness. On the first day of treatment, the levels of NSE, S-100, GFAP, MBP, and BDNF in patients with moderate severity of the disease were lower in patients with enteroviral meningitis (P<0.001). In severe cases NSE, GFAP and BDNF were higher (P<0.05) in patients with HSV neuroinfection. The neuro-specific markers NSE, S-100, GFAP and MBP on the first day of treatment were in direct strong correlation with the severity of neurological symptoms. The strongest (r=0.712) direct correlation is observed between the severity of neurological symptoms and the level of NSE and GFAP. At the same time, we found a strong reverse correlation (r=-0.727) between the level of BDNF and the duration of neurological symptoms.*

***Conclusions.*** *Increased levels of NSE, S-100, GFAP and MBP indicate presents damages of neurons astroglia and myelin nerves in all cases of viral meningitis. Major changes are observed in patients with severe neuroinfection. In patients with severe herpes viral meningitis/meningoencephalitis, the activity of regenerative processes in the tissues of the central nervous system decreases due to a decrease of CSF BDNF level (P<0.05).*

***Key words:*** *HIV-infection; β2-microglobulin; hematological parameters; platelets; ESA.*

Neuroinfection is a worldwide problem and an important cause of morbidity and mortality [1, 2]. Viral infections are the main cause of infection in the central nervous system (CNS) worldwide, surpassing the frequency of bacterial, fungal and protozoal agents [1]. At present, it is believed that most of the viral lesion of the CNS is due to enteroviruses, herpes viruses and some arboviruses. It is estimated that 39 % of infections caused by these viruses lead to serious neurological disorders [1]. Herpesvirus neuroinfections are some of the most severe among the all viral lesion of the CNS, most often cause neurological disorders and have the highest mortality [2].

Analysis of cerebrospinal fluid (CSF) with the determination of the content of total protein, leukocytes, chlorides and glucose is the basis of diagnostics of neuroinfections, which allows determining the presence of inflammation of the meninx. However, these indicators do not allow to determine the degree of brain damage and predict the course of the disease.

At the present stage, much attention is paid to determination of the neuro-specific markers (NSM) levels that are specific for the nervous system tissues. In recent years, more than 60 different NSM of the CNS have been investigated. It is proved that the increase of NSM levels in the CSF corresponds to the degree of defeat of the corresponding CNS cells. Therefore, the determination of NSM levels in CSF in patients is an important direction in the study of pathogenesis and diagnosis of CNS lesions. Some of the most studied NSM are neuron specific enolase (NSE), glial fibrillary acidic protein (GFAP), S-100 protein, myelin basic protein (MBP) and brain-derived neurotrophic factor (BDNF). GFAP is one of the main immunocytochemical markers of astrocytes, the most important representative of microglia in the CNS of mammals [3, 4]. Protein S-100 is a specific protein for the cells of the astrocytic glory of the CNS, and the NSE is an intracellular cytoplasmic enzyme of the neurons that catalyzes the transformation of 2-phosphoglycerate to 2-phosphoenolpyruvate [5]. It is widely used for diagnostic purposes and in experimental works in the study of the functions of the nervous system in norm and in pathology as a marker of astrocytes [5, 6].

BDNF plays a major role in neuronal growth and survival, serves as a neurotransmitter modulator, and

contributes to neuronal plasticity. BDNF stimulates and controls the growth of new neurons from neural stem cells (i.e., neurogenesis), and BDNF protein and matrix ribonucleic acid (mRNA) have been detected in various regions of the brain, including the olfactory bulb, cortex, hippocampus, basal forebrain, mesencephalon, hypothalamus, brainstem, and spinal cord [7].

MBP is a component of central nervous system myelin. Cerebrospinal fluid MBP levels increase in acute demyelination [8, 9]. Thus, the diagnostic and prognostic value of increasing of NSE, the MBP, GFAP, BDNF, S-100 protein levels in stroke, craniocerebral trauma, and CNS defects in newborns has been proven [4-10]. During viral neuroinfections, damage to the cells of the brain occurs, and determining of the levels of neuro-specific markers may have a diagnostic value. However, both in Ukraine and abroad, studies on determining of the levels of NSM in the CSF in patients with acute viral meningitis are practically absent.

**The aim** of the work is to determine the diagnostic value of the levels of neurospecific markers NSE, GFAP, S-100, MBP, and BDNF in the CSF of adult patients with viral meningitis.

## Materials and methods

Potential study participants were treated at the Kharkiv Regional Clinical Infectious Diseases Hospital (Kharkiv, Ukraine). The work was carried out in accordance with the Helsinki Declaration. The study period (2012-2016) was approved by the local Ethics Committee of Kharkiv National Medical University, Kharkiv, Ukraine.

Informed consent was obtained from patients to use their biological samples and clinical data for research purposes. Inclusion of patients in the research program was carried out using selection criteria. Inclusion criteria: clinical symptoms typical for acute meningitis, etiological confirmation etiology of disease by PCR, age of patients from 18 to 65 years, voluntary consent of the patient to participate in the study. Patients were excluded in the following cases: presence of disease of the nervous system in the anamnesis, HIV, cancer. When entering the hospital, demographic data were obtained from patients, clinical indicators were evaluated, and studies were conducted. An anamnesis of the disease, complaints and neurological status was recorded. All significant events were recorded until discharge from the hospital or death.

We decided to include in the study patients with the most common acute viral neuroinfections caused by enterovirus, HSV 1.2 and EBV.

Patients were divided into groups depending on the etiology and severity of the disease. 50 cases of acute viral meningitis were analyzed.

CSF was aspirated by lumbar puncture. Performing of lumbar puncture was conducted according to standard protocols of diagnostics and treatment of patients with signs of meningitis. Patients involved in the study were not been exposed to additional invasive procedures. The CSF samples were immediately refrigerated at -20 °C until analysis conducting. Levels of GFAP, S-100, NSE, BDNF and MBP in CSF were identified on admission and after 10-12 days of treatment. Commercially available enzyme-linked immunoassays were used to analyze neuromarker S-100 (CanAg, Sweden), NSE (XEMA, Russian Federation), MBP (AnshLabs, USA), BDNF (Merck Millipore, Germany) and GFAP (BioVendor, Czech Republic) according to manufacturer instructions, in Central scientific-research laboratory of Kharkiv National Medical University. All data were analyzed using “BioStat Pro” and «Microsoft Excel» programs. Differences in the values of neurospecific markers in the CSF and clinical variables were estimated using the Mann Whitney U test. The value of $P<0.05$ was used for significance.

## Results and discussion

50 cases of acute viral meningitis were analyzed. There were 21 patients with HSV 1,2 infection, 19 patients with EBV infection, 10 patients with enteroviral meningitis.

The average age of patients with HSV and EBV neuroinfections was significantly higher than in patients with enteroviral meningitis ($P<0.01$). (Table 1).

Table 1

Baseline characteristics of groups

| Criterion | HSV meningitis (n=21) | EBV meningitis (n=19) | Enterovirus meningitis (n=10) |
|---|---|---|---|
| Age (Mean ± SD) | 35,47±14,71 | 36,43±16,09 | 23,31±5,47 |
| Male, n/% | 5/23,81 | 7/36,84 | 6/60,00 |
| Female, n/% | 16/76,19 | 12/63,16 | 4/40,00 |
| Moderate meningitis, n/% | 15/71,43 | 10/52,63 | 10/100 |
| Severe meningitis/ meningoencephalitis n/% | 6/28,57 | 9/47,37 | 0/ |
| Non survivors, n/% | 1/4,76 | 2/10,53 | 0/ |

The quantity of women and men was the same in patients with enteroviral meningitis, however, among patients with HSV 1,2 and EBV neuroinfection, women significantly predominated – 76.9 % and 63.16 %. The highest number of severe patients was observed in the group with EBV meningitis – 47.37 % (Table 1). Severity of the condition was caused by development of focal lesions of the brain symptoms and brain edema.

The disease of moderate severity was observed in 15 (71.43 %) patients with HSV 1,2 infection, 10 (52.63 %) with EBV meningitis. All patients with enteroviral meningitis had a moderate disease. It should be noted that during 5 years of observation we have not registered any severe meningitis or encephalitis of enteroviral etiology. The largest quantity of patients with severe course was observed with EBV meningitis – 47.37 %, the disease ended lethally in 2 (10.53 %) patients with EBV infection. The lethal outcome occurred within 5–14 days of treatment.

The levels of NSE, S-100, GFAP, BDNF and MBP in the CSF in patients with HSV, EBV and enteroviral meningitis on the first day of treatment are summarized in Table 2. The levels of defined indicators for 10–12 days of treatment are summarized in Table 3. The data show the dependence of the determined neurospecific markers levels both of the etiology and of the disease severity. The most significant changes were determined in patients with severe course. The least changes were detected in patients with enteroviral meningitis (P<0.001) (Table 2).

Table 2

CSF level of NSE, S-100, GFAP, MBP and BDNF in patients with viral meningitis on the first day of treatment, Me (Q25: Q75)

| Indicator | HSV meningitis | | EBV meningitis | | Enterovirus meningitis |
|---|---|---|---|---|---|
| | moderate (n=15) | severe (n=6) | moderate (n=10) | severe (n=9) | moderate (n=10) |
| NSE mg/l | 21,67 (19,05:24,42) [1, 3] | 47,98 (42,98:52,98) [2, 3] | 22,05 (18,50:34,31) [1, 3] | 39,54 (23,08:47,18) [2, 3] | 15,64 (14,93:16,95) |
| S-100 ng/l | 453,97 (435,97:501,57) [1, 2, 3] | 754,91 (746,97:762,13) [3] | 365,87 (313,28:455,30) [1, 2, 3] | 743,54 (533,80:902,87) [3] | 331,78 (321,23:394,38) |
| GFAP ng/ml | 3,07 (2,42:4,63) [1, 3] | 13,35 (12,80:14,03) [2, 3] | 3,43 (2,97:3,59) [1, 3] | 9,62 (8,24:10,92) [2, 3] | 2,01 (1,81:2,29) |
| MBP ng/ml | 3,72 (3,44:4,78) [1, 3] | 9,54 (8,04:9,65) [3] | 4,03 (3,16:4,90) [1, 3] | 10,35 (8,39:13,50) [3] | 1,87 (1,77:2,02) |
| BDNF pg/ml | 72,89 (69,54:74,80) [1] | 68,35 (66,97:69,54) [2] | 70,04 (68,98:74,23) [1] | 65,08 (64,13:67,22) [2, 3] | 69,45 (66,19:73,66) |

[1]: statistically significant difference between patients with moderate severity and severe course accordingly of the etiology of the disease (P<0.05);

[2]: statistically significant difference between patients with moderate severity and between patients with severe HSV and EBV meningitis (P<0.05);

[3]: statistically significant difference between patients with enteroviral meningitis and patients with HSV and EBV of neuroinfection of moderate and severe course (P<0.05).

On the first day of treatment, NSE, S-100, GFAP, MBP, and BDNF levels in patients with moderate severity were significantly lower in patients with enteroviral meningitis (P<0.001). At comparing the parameters of the moderate severity of HSV and EBV neuroinfection, a significant difference was found only at the S-100 level (P<0.05). However, in severe cases, NSE, GFAP and BDNF were significantly higher (P<0.05) in patients with HSV meningitis compared with EBV meningitis (Table 2). Moreover, the level of BDNF in severe EBV meningitis was significantly lower in comparison with all other groups of patients (P<0.05). NSE, S-100, GFAP and MBP levels on the first day of treatment were in direct strong correlation with the development and severity of focal neurological symptoms. The strongest (r=0.712) direct correlation is observed between the severity of neurological symptoms and the level of NSE and GFAP. At the same time, we revealed a strong inverse correlation (r=-0.727) between the level of BDNF and the duration of neurological symptoms.

The revealed changes confirm that in the pathogenesis of herpes virus viral neuroinfections the damage of neurons, glial cells and myelin nerves, the demyelinating process

Table 3

CSF level of NSE, S-100, GFAP, MBP and BDNF in patients with viral meningitis for 10-12 days of treatment, Me (Q25: Q75)

| Indicator | HSV meningitis | | EBV meningitis | | Enterovirus meningitis |
|---|---|---|---|---|---|
| | moderate (n=14) | severe (n=5) | moderate (n=10) | severe (n=7) | moderate (n=10) |
| NSE mg/l | 18,12 (17,46:19,68) [1, 2, 3, 4] | 31,88 (30,46:35,96) [2, 3, 4] | 15,16 (13,01:17,84) [1, 3, 4] | 29,65 (24,71:36,11) [3, 4] | 13,05 (12,64:14,95) [2, 4] |
| S-100 ng/l | 598,12 (510,57:682,80) [1, 3, 4] | 985,96 (901,57:1159,46) [3, 4] | 602,33 (519,36:609,06) [1, 3, 4] | 956,23 (756,02:1248,02) [3, 4] | 201,23 (176,05:228,11) [2, 4] |
| GFAP ng/ml | 2,67 (2,43:3,41) [1, 3, 4] | 7,96 (7,32:8,93) [3, 4] | 2,64 (2,63:3,02) [1, 3, 4] | 7,02 (6,21:8,34) [3, 4] | 1,83 (1,62:2,01) [2] |
| MBP ng/ml | 6,35 (5,92:6,90) [1, 2, 3, 4] | 8,44 (7,89:8,68) [3] | 4,73 (4,14:6,02) [1, 3] | 8,45 (5,66:10,02) [3, 4] | 1,65 (1,32:1,84) [2] |
| BDNF pg/ml | 73,79 (70,35:74,92) [1 ,3] | 66,96 (65,79:67,57) | 73,05 (69,87:73,42) [1, 3] | 64,84 (63,33:67,01) | 66,21 (64,02:68,25) [2] |

[1]: statistically significant difference between patients with moderate severity and severe course accordingly of the etiology of the disease (P<0.05);

[2]: statistically significant difference between patients with moderate and severe course of disease (P<0.05);

[3]: statistically significant difference between patients with enteroviral meningitis and patients with HSV and EBV neuroinfection of moderate and severe course (P<0.05);

[4]: statistically significant difference between the indicators for 1 and 10-12 days of treatment (P<0.05).

occur. Interestingly, even in patients with moderate meningitis who did not show symptoms of CNS tissue damage, levels of NSE, GFAP, MBP, and S-100 increased. This indicates about the presence of encephalitis in patients without neurological symptomatology. Enteroviral meningitis, characterized by favorable course and extremely low risk of developing CNS affection symptoms, demonstrates significantly lower levels of neurospecific markers. This does not exclude the presence of CNS cells lesions, but it can be said with certainty that these phenomena are significantly less pronounced compared with herpesvirus neuroinfections (P<0.05).

On the 10th to 12th days of treatment, the levels of NSE, GFAP and MBP have been significantly lowered, however, in patients with severe course of disease, they remained higher compared with moderate cases (P<0.05) (Table 3). Such changes indicate about preservation of the pathological process after the disappearance of the main clinical symptoms of neuroinfection, especially in severe cases.

However, the level of S-100 on the contrary has increased significantly in the dynamics of meningitis in all groups (P<0.05) (Table 3). This dynamic is not entirely clear, and given that the S-100 protein has neurotrophic properties and stimulates of proliferation and differentiation of nerve cells [10], it is possible that its increase is the activation of regeneration in response on damage in the reconvalescence of neuroinfection. On the other hand, the neurotoxic effects of high levels of the S-100 protein [8] have been proved, and possibly an increase of the level of this marker is a reflection of continued myelin nerves damage.

BDNF level tended to increase in patients with moderate course, and declined in severe cases. BDNF stimulates and controls the growth of new neurons from neural stem cells [7], and decrease of its level in the dynamics of the disease in severe patients suggests about disturbance of the compensatory and adaptive mechanisms of the brain tissue. Possibly it reduces the recovery of the function and increase the risk of chronic residual events after a severe viral neuroinfection.

Evidently, usage of these neuro-specific markers will allow the practitioner to expand the diagnostic capabilities of acute neuroinfections and to individualize the treatment until the development of neurological phenomena. At the same time, comparison of levels of neuro-specific markers in the dynamics of treatment may be an objective criterion for assessing the effectiveness of treatment.

**Conclusions**

1) Increase of NSE, S-100, GFAP and MBP levels shows the presence of damage of neurons, astroglia and

myelin nerves in patients with severe viral meningitis both severe and moderate courses.

2) The level of neuro-specific markers NSE, S-100, GFAP and MBP is directly related to the severity of the disease and highest in patients with severe herpes viral meningitis (P <0.05), which confirms the diagnostic and prognostic value of neurospecific markers in patients with acute viral neuroinfection.

3) In patients with severe herpes viral meningitis, the activity of regenerative processes in the CNS tissues decreases due to reduction of the BDNF level in the CSF (P<0.05).

4) NSE, S-100, GFAP and MBP levels on the first day of treatment were in direct strong correlation with the development and severity of focal neurological symptoms. The strongest (r=0.712) direct correlation is observed between the severity of neurological symptoms and the levels of NSE and GFAP. At the same time, we revealed a strong inverse correlation (r=-0.727) between the level of BDNF and the duration of neurological symptoms.

## Література


1. Review of the etiologies of viral meningitis and encephalitis in a dengue endemic region / C.N. Soares, M.J. Cabral-Castro, J.M. Peralta [et al.] // J. Neurol. Sci. – 2011. – Vol. 4. – P. 75-79.

2. Lee B.E. Aseptic meningitis / B.E. Lee, H.D. Davies // Curr. Opin. Infect. Dis. – 2007. – Vol. 20. – P. 272-277.

3. Cerebrospinal fluid levels of brain specific proteins in optic neuritis / E.T. Lim, D. Grant, M. Pashenkov [et al.] // Mult. Scler. – 2004. − Vol. 10. – P. 261-265.

4. Glial fibrillary acidic protein (GFAP) immunoreactivity correlates with cortical perfusion parameters determined by bolus tracking arterial spin labelling (bt-asl) magnetic resonance (MR) imaging in the wistar kyoto rat / S. Gormley, J. Rouine, A. Mcintosh, C. Kerskens // Physiology & Behavior. – 2016. − Vol. 4. – P. 66-79.

5. Effects of enriched environment on alterations in the prefrontal cortex GFAP- and S100B-immunopositive astrocytes and behavioral deficits in MK-801-treated rats / M. Rahati, M .Nozari, H. Eslami [et al.] // Neuroscience. – 2016. − Vol. 326. – P. 105-116.

6. Astrocytic damage is far more severe than demyelination in NMO: a clinical CSF biomarker study / R. Takano, T. Misu, T. Takahashi [et al.] // Neurology. − 2010. – Vol. 75. – P. 208-216.

7. Bathina S. Brain-derived neurotrophic factor and its clinical implications / S. Bathina, U.N. Das // Arch. Med. Sci. − 2015. − Vol. 11. – P. 1164-1178.

8. Acute axonal damage predicts clinical outcome in patients with multiple sclerosis / E.T. Lim, F. Sellebjerg, C.V. Jensen [et al.] // Mult. Scler. − 2005. – Vol. 11. – P. 532-536.

9. Brunkhorst R. Astroglial Proteins as Diagnostic Markers of Acute Intracerebral Hemorrhage-Pathophysiological Background and Clinical Findings / R. Brunkhorst, W. Pfeilschifter, C. Foerch // Translational Stroke Research. − 2010. − Vol. 1. – P. 246-251.

10. Effects of hypothermia on NSE and S-100 protein levels in CSF in neonates following hypoxic/ischaemic brain damage / J. Sun, J. Li, G. Cheng [et al.] // Acta Paediatr. − 2012. − Vol. 101. – P. 316-320.


## References


1. Soares, C.N., Cabral-Castro, M.J., Peralta, J.M., de Freitas, M.R.G., Zalis, M., Puccioni-Sohler, M. (2011). Review of the etiologies of viral meningitis and encephalitis in a dengue endemic region. *J. Neurol. Sci*., (4), 75-79.

2. Lee, B.E., & Davies, H.D. (2007). Aseptic meningitis. *Curr. Opin. Infect. Dis*., 20, 272-277.

3. Lim, E.T., Grant, D., Pashenkov, M., Keir, G., Thompson, E.J., & Söderström, M. (2004). Cerebrospinal fluid levels of brain specific proteins in optic neuritis. *Mult. Scler., 10*, 261-265.

4. Gormley, S., Rouine, J., Mcintosh, A., & Kerskens, C. (2016). Glial fibrillary acidic protein (GFAP) immunoreactivity correlates with cortical perfusion parameters determined by bolus tracking arterial spin labelling (bt-asl) magnetic resonance (MR) imaging in the wistar kyoto rat. *Physiology & Behavior*, (4), 66-79.

5. Rahati, M., Nozari, M., Eslami, H., Shabani, M., & Basiri, M. (2016). Effects of enriched environment on alterations in the prefrontal cortex GFAP- and S100B-immunopositive astrocytes and behavioral deficits in MK-801-treated rats. *Neuroscience,* 326, 105-116.

6. Takano, R., Misu, T., Takahashi, T., Sato, S, Fujihara, K., & Itoyama, Y. (2010). Astrocytic damage is far more severe than demyelination in NMO: a clinical CSF biomarker study. *Neurology,* 75, 208-216.

7. Bathina, S., Das, U.N. (2015). Brain-derived neurotrophic factor and its clinical implications. *Arch. Med. Sci.,* 11, 1164-1178.

8. Lim, E.T., Sellebjerg, F., Jensen, C.V., Altmann, D.R., Grant, D., & Keir, G. (2005). Acute axonal damage predicts clinical outcome in patients with multiple sclerosis. *Mult. Scler*., 11, 532-536.

9. Brunkhorst, R., Pfeilschifter, W., & Foerch, C. (2010). Astroglial Proteins as Diagnostic Markers of Acute Intracerebral Hemorrhage-Pathophysiological Background and Clinical Findings. *Translational Stroke Research,* 1, 246-251.

10. Sun, J., Li, J., Cheng, G., Sha, B., Zhou, W. (2012). Effects of hypothermia on NSE and S-100 protein levels in CSF in neonates following hypoxic/ischaemic brain damage. *Acta Paediatr.*, 101, 316-320.

# ДІАГНОСТИЧНЕ ЗНАЧЕННЯ НЕЙРОСПЕЦИФІЧНИХ МАРКЕРІВ NSE, S-100, GFAP, MBP І BDNF У ЦЕРЕБРОСПІНАЛЬНІЙ РІДИНІ ХВОРИХ НА ВІРУСНИЙ МЕНІНГІТ

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***РЕЗЮМЕ**. Мета роботи – визначити діагностичну цінність рівнів нейроспецифічних маркерів NSE, GFAP, S–100, MBP та BDNF у ЦСР дорослих хворих на вірусні менінгіти.*

***Пацієнти і методи.** Для дослідження були залучені 50 пацієнтів з вірусними менінгітами віком від 18 до 65 років. Пацієнти з менінгітом, що викликаний вірусом простого герпесу 1,2, склали 1-у групу (n=21), з Епштейна-Барр менінгітом − 2-у групу (n=19), з ентеровірусним менінгітом – 3-ю групу дослідження (n=10). Рівень нейроспецифічних маркерів визначався у ЦСР хворих на першу та 10-12-у добу лікування за допомогою методу ІФА.*

***Результати.** Найбільш суттєві зміни були визначені у пацієнтів з тяжким перебігом. У перший день лікування рівень NSE, S-100, GFAP, MBP та BDNF у хворих із середньою тяжкістю хвороби був нижчим у групі ентеровірусного менінгіту (p<0,001). У тяжких випадках NSE, GFAP та BDNF були вищими (p<0,05) у пацієнтів з ВПГ менінгітом. Нейроспецифічні маркери NSE, S-100, GFAP та MBP у перший день лікування були в прямій сильній кореляції з тяжкістю неврологічних симптомів. Найбільш сильна (r=0,12) пряма кореляція спостерігається між тяжкістю неврологічних симптомів і рівнем NSE та GFAP. У той же час виявлено сильну зворотну кореляцію (r=-0,27) між рівнем BDNF і тривалістю неврологічних симптомів.*

***Висновки.** Збільшення рівнів NSE, S-100, GFAP та MBP свідчить про наявність пошкодження нейронів, астроглії та мієлінових нервів у всіх випадках вірусних менінгітів. Найбільші зміни визначених показників спостерігаються у хворих з тяжким перебігом. У пацієнтів з тяжким герпесвірусним менінгітом/менінгоенцефалітом знижується активність регенеративних процесів у тканинах ЦНС через зниження рівня BDNF у ліквор (p<0,05).*

***Ключові слова:** ВІЛ-інфекція, β2-мікроглобулін, гематологічні показники, тромбоцити, ШОЕ.*

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