



THE RELATIONSHIP BETWEEN THE LEVEL OF CERTAIN CYTOKINES AND THE CHARACTER OF DEXAMETHASONE SENSITIVITY IN BRONCHIAL ASTHMA

Suyarov A. A.1.

Musakhodgaeva D. A1.

Kireev V. V. 1.

Yuldashev I. R. 2,

Abdullaev N. Ch. 2

Ochilov S. N. 1.,

Erkinov N. G.1.

1 Institute of Immunology and Human Genomics of the
Academy of Sciences of the Republic of Uzbekistan

2 Tashkent State Medical University

Abstract

The study aimed: to study the level of cytokines in bronchial asthma (BA) depending on the nature of sensitivity to dexamethasone.

Materials and methods: 67 patients with BA were examined. The diagnosis of asthma was established according to the GINA classification (2025), the average age was 38.57 ± 1.26 years, and the average duration of the disease was 3.0 ± 0.3 years. Sensitivity to glucocorticoids was determined using an original method developed and patented for the simultaneous determination of sensitivity to glucocorticoids. The level of cytokines IL-1 β , IL-4, IL-6 and TNF- α was determined by the ELISA method according to the manufacturer's instructions (Vector-Best).

Results: in all the studied groups, there was a significant increase in the level of IL-1 β in all groups compared with the control. Thus, the level of the very highly sensitive was increased 2.4 times, the highly sensitive 2.53 times, the medium-sensitive by 3.25 times, the low-sensitive by 2.54 and the very low-sensitive 2.39 times. The levels of IL-4, IL-6, and TNF- α were significantly elevated in



comparison with healthy individuals without significant differences between sensitivity groups.

Conclusion. Thus, the difference in the levels of IL-1 β , IL-4, IL-6, and TNF- α cytokines is revealed depending on the degree of sensitivity to dexamethasone, which allows for a better understanding of the mechanisms of sensitivity to it.

Keywords: bronchial asthma, dexamethasone, cytokines, glucocorticoid sensitivity.

Introduction

Bronchial asthma (BA) is a widespread disease that currently affects about 336 million people worldwide [1]. Despite all the advances in pharmacology, including the emergence of biosimilars (biological genetically engineered drugs), glucocorticoids (GC), both inhaled and systemic, remain one of the main means in the treatment of this disease. Despite the fact that GC has been used for 70 years in the treatment of asthma, there are enough facts that indicate the presence of resistance to it. The frequency of GC development in asthma can reach from 5-10% to 30% among all patients with asthma [2], [3]. Among systemic GC, dexamethasone is widely used in the treatment of asthma, especially in severe, difficult-to-control asthma. However, the situation is aggravated by the fact that until recently, there were no acceptable methods for determining sensitivity to GC (including dexamethasone), and the occurring glucocorticoid resistance is not always accompanied by obvious clinical manifestations. All this significantly complicates the diagnosis of glucocorticoid resistance. As the disease progresses, asthma is accompanied by progressive remodeling of the respiratory tract, and at a late stage of the disease, this becomes irreversible. This is a complex change in the structural and functional organization of parenchymal and stromal elements of the bronchi, the induction factors of which are damage and disruption of the restoration of the epithelial barrier, which are based on the effects of various trigger factors - allergens, viruses, aeroallergens, cold, which initiates inflammatory signaling pathways involving immunocompetent cells. IL1 β , IL-4, IL-6, and TNF- α are involved in the pathogenesis of this condition, and are



responsible for the activation of the Th1 variant of the immune response [4]. Their distribution is well studied in this disease. However, the relationship between cytokine levels and the nature of glucocorticoid sensitivity in asthma has not been sufficiently studied.

The study aimed: to study the level of cytokines in asthma, depending on the nature of sensitivity to dexamethasone.

Materials and methods: 67 patients with bronchial asthma were examined. The diagnosis of asthma was established according to the GINA classification (2025) after a complete clinical and instrumental examination. Previously, patients received inhaled glucocorticoids, systemic corticosteroids (dexamethasone, prednisone), and bronchodilators. Table 1 shows the clinical characteristics of the examined patients.

Table 1. Clinical characteristics of the examined patients with asthma (M±m).

Indicators	number of patients
Male/Female	27/40
Average age, years	38,57±1,26 (18-72 years)
Average duration of the disease, years	3,0±0,3 (2-25 years)
3rd stage/4th stage	43/24
Phenotypes of BA, atopic	67
hormone -dependent	36
with late onset (≥ 40 years)	8
in combination with COPD	23
Eosinophils,%	6,17±0,25
Eosinophils 10 ⁶ ,abs	0,49±0,02
Frequency of seizures per month	2,8±0,13 (1-5)
Number of emergency calls, month	2,49±0,14 (1-4)
Number of hospitalizations in the last 12 months	2,8±0,2 (1-4)
Smoking,%	45 (30 person)
BMI*, kg/m ²	27,49±0,12
FEV,%	49,7±4,2
S0 ₂ ,%	91,5±4,3
Peak flowmetry, l/min	362,7±16,3



The criteria for inclusion in the study were patients with BA with grades III-IV who had previously received various GC (both systemic and inhalation) during the last 2 weeks preceding the study and had not produced a significant clinical effect, including spirometry, and met the criteria for glucocorticoid-resistant BA. The exclusion criteria were:

Grades 1-2 BA;

The presence/history of tuberculosis and oncological diseases of all localizations;

Patients with asthma who had not previously received GC;

Patients with asthma who developed after suffering from COVID-19;

Professional BA;

Asthma associated with medications (NSAIDs and IACF);

Associated with allergic and endocrinological diseases (except diabetes mellitus);

Somatic diseases in the stage of severe decompensation;

Under the age of 18;

Refusal to give informed consent.

Patients were recruited at the Institute of Immunology and Human Genomic in Tashkent from April 2023 to March 2025. All participants signed an informed consent. The study was approved by the Ethics Committee of the Ministry of Public Health of the Republic of Uzbekistan (Protocol No. 9 dated December 3, 2022) and conducted in accordance with the principles of the Helsinki Declaration. Determination of sensitivity to glucocorticoids was carried out using an original technique developed and patented for simultaneous determination of sensitivity to glucocorticoids [5].

The principle of the method: the determination of sensitivity to glucocorticoids was carried out using an original patented technique for determining sensitivity to glucocorticoids (hydrocortisone, prednisone, methylprednisolone, dexamethasone, triamcinolone, and betamethasone). 1 ml of venous blood is taken from the patient, regardless of food intake, into a sterile heparinized centrifuge tube. After centrifugation for 10 minutes at 1500 rpm, lymphocytes are isolated using the Boum method at 76% gledol and the number of lymphocytes in the Goryaev chamber is calculated under a microscope at a magnification of 250 (approx.5, vol.50). Then 500 ml of lymphocyte suspension is added to the



test tube using a measuring pipette and 100 ml of glucocorticoid solution is added using a separate measuring pipette. Taking into account the bioequivalence of glucocorticoids, standard ampoules glucocorticoid solutions are diluted: dexamethasone (1 ml) is diluted with saline solution in the amount of 26.6 ml of sterile saline solution (0.9% sodium chloride solution), triamcinolone, methylprednisolone) in 4 ml of sterile saline solution, prednisone and betamethasone in 22 ml of solution, respectively. These solutions are stable for a month when stored in sterile conditions in the dark in a refrigerator at a temperature of 8 °C. The resulting mixture is incubated in a thermostat at 37 °C for 1 hour, then stained with trypan blue and fixed with glutaraldehyde, after which the remaining lymphocytes are counted in the Goryaev chamber under a microscope. If the number of lymphocytes decreased by -20%, then the sensitivity result is estimated as very low sensitivity, 21-40% low sensitivity, 41-60% sensitive, 61-80% highly sensitive, and over 80% very highly sensitive.

The level of cytokines IL-1 β , IL-4, IL-6 and TNF- α was determined by the ELISA method according to the manufacturer's instructions (Vector-Best). The control group consisted of 30 practically healthy patients of comparable age and gender. Blood sampling to determine dexamethasone sensitivity and cytokine levels was performed in the morning on an empty stomach on the second day of admission. Statistical processing of the obtained data was performed using the software package "Statistica 12.0". The statistical analysis of the obtained results was checked for the normality of the distribution according to the Kolmogorov–Smirnov criteria. The reliability of the obtained values was determined using the Student's t-test and the Mann-Whitney U-test. The level of trustworthiness $p < 0.05$ was taken as a statistically significant change.



Results.

Table 2. Changes in cytokine levels depending on the nature of dexamethasone sensitivity in asthma ($M \pm m$).

Cytokines degree of sensitivity	IL-1 β , pg/ml	IL-4, pg/ ml	IL-6, pg/ ml	TNF α , pg/ ml
very highly sensitive (n=27)	58,32 $\pm$ 3,12	23,40 $\pm$ 1,36	32,45 $\pm$ 1,88	54,79 $\pm$ 3,69
highly sensitive (n=7)	61,29 $\pm$ 7,29	18,69 $\pm$ 2,73	31,95 $\pm$ 5,72	54,45 $\pm$ 7,16
sensitive (n=3)	78,63 $\pm$ 4,42*	21,19 $\pm$ 5,35	36,13 $\pm$ 10,68	66,95 $\pm$ 5,48
low sensitivity (n=18)	61,58 $\pm$ 3,71	25,70 $\pm$ 2,35	29,0 $\pm$ 2,82	57,51 $\pm$ 4,18
very low sensitivity (n=12)	57,91 $\pm$ 2,83	21,38 $\pm$ 1,84	26,0 $\pm$ 3,15	50,61 $\pm$ 5,45
control group (n=30)	24,2 $\pm$ 0,9	7,9 $\pm$ 0,2	12,9 $\pm$ 0,5	20,3 $\pm$ 0,8

Note: - confidence between the moderately sensitive and the rest of the groups and healthy ($p < 0.05$).

From the data in the table, it can be seen that there is a significant increase in the level of IL-1 β in sensitive patients compared with other groups. It should be noted that there was a significant increase in the level of IL-1 β in all groups in comparison with the control. In the very highly sensitive, the level increased 2.4 times, in the highly sensitive 2.53 times, in the medium-sensitive 3.25 times, in the low-sensitive 2.54 times, and in the very low-sensitive 2.39 times compared to the control group. An interesting pattern is noted in all cases (except IL-4), the highest increase is observed in the group of medium-sensitive compared with the control, and the lowest in the low-sensitive.

It should be noted that the levels of other cytokines (IL-4, IL-6, and TNF α) were significantly increased compared with healthy individuals, but there were no significant differences between the dexamethasone sensitivity groups.



Discussion

High levels of pro-inflammatory cytokines (IL-4, IL-5, IL-13, TNF- α) in asthma are directly associated with a decrease in sensitivity to GC, causing persistent inflammation and an uncontrolled course of the disease. They promote eosinophilic inflammation and reduce the ability of GC to suppress the activity of inflammatory cells, thereby leading to a decrease in sensitivity to GC, and, in our case, to dexamethasone, and also suppress the anti-inflammatory mechanisms of GC, which leads to the formation of GC resistance. TNF- α and IL-1 β are known to promote bronchospasm and support inflammation, which is difficult to treat with standard doses of GC, meaning varying degrees of resistance to GC [6]. Pro-inflammatory cytokines can reduce the ability of GC to stabilize membranes and suppress destructive processes in tissues, which, in turn, interferes with normal lung function, despite ongoing GC treatment [7]. It is known that Th cells produce pro-inflammatory cytokines involved in the immune response, and GCs inhibit their secretion and limit the degree of immune response. Currently, it is known that Th1, Th2, and Th17 cells have different sensitivities to GC. Th1 cells are sensitive to GC -induced apoptosis and cytokine suppression, while Th2 cells are sensitive only to cytokine inhibition. Th17 cells are resistant to both apoptosis and cytokine inhibition. This phenomenon causes a gradient in the sensitivity of Th cells to GC in the treatment of diseases and, thus, a difference like sensitivity to GC [8], [9]. Thus, Th1 cells are sensitive to GC inhibition, and accordingly, GC reduces the level of Th2 cytokines IL-4, IL-5, and IL-13 in vitro. The different sensitivity to GC for T-lymphocyte subgroups helps explain the varying degrees of resistance to GC in autoimmune diseases, asthma, and a number of other inflammatory diseases.

Currently, dexamethasone has been found to effectively inhibit IL-6 secretion in grade 1-2 asthma, but not in severe asthma, which indicates impaired sensitivity to GC. It was found that combinations of cytokines IL -2 and IL - 4, TNF α and IFN- γ , or IL - 3, GM-KSF and IL - 5, or separately significantly reduced the proapoptotic response to dexamethasone. It was previously revealed that the combination of IL -2 and IL - 4 led to impaired phosphorylation and function of the nuclear glucocorticoid receptor (GCR) [10].



Currently, there are several groups of laboratory methods for determining sensitivity to GC in the blood, which are divided into two main groups. The first group, cellular methods (in vitro), makes it possible to assess the sensitivity of patient cells to GC in the laboratory, divided into a number of subgroups.

1. Assessment of inhibition of lymphocyte proliferation: GC has an immunosuppressive effect by inhibiting lymphocyte proliferation. Culturing of the patient's lymphocytes with different concentrations of GC and assessment of their proliferation (for example, by the inclusion of tritiated thymidine) makes it possible to determine individual sensitivity. The lower the concentration of GC required to inhibit proliferation by a certain percentage, the higher the sensitivity [11].

2. Evaluation of cytokine production inhibition: GC inhibits the production of pro-inflammatory cytokines (e.g., IL - 6, TNF- α , IL - 8) by immune cells. This is an indirect method, because cytokine production by cells is variable and depends on many conditions. Cultivation of peripheral blood mononuclear cells or other immune cells of the patient, their stimulation to cytokine production and subsequent addition of GC makes it possible to assess the degree of inhibition. A decrease in cytokine production in response to GC indicates sensitivity [12].

3. Evaluation of the induction of eosinophil apoptosis: GC causes apoptosis (programmed cell death) of eosinophils, which play a key role in the pathogenesis of asthma. Incubation of eosinophils in a patient with GC and subsequent assessment of apoptosis (for example, by flow cytometry using annexin V) can serve as an indicator of sensitivity [13].

4. Evaluation of glucocorticoid receptor (GR) expression: GC realize their effects by binding to cytoplasmic GR. Changes in the amount or affinity of GR on the surface or inside cells can affect sensitivity. Flow cytometry or Western blotting can be used to evaluate GR expression in various cell populations. However, the results depend on the brand of cytometer and the type of cells studied [14].

5. Evaluation of GR translocation to the nucleus: After binding to GC, GR is translocated to the nucleus, where it regulates gene expression. Disruption of this process can lead to resistance. Immunofluorescence analysis or cell fractionation



followed by Western blotting can be used to evaluate the nuclear translocation of GR [15].

Limitations of this group: cellular methods require time for cell cultivation, expensive equipment and reagents, adherence to a single disease and a glucocorticoid drug, in several techniques, the complexity of the results obtained for interpretation. May depend on the conditions of cultivation and the type of cells used, as well as the software used for cytometers and immunoblotting devices. Also, in vitro results do not always fully correlate with the in vivo clinical response.

The second group, molecular methods are aimed at identifying genetic or epigenetic factors that affect sensitivity to GC, which are also divided into a number of subgroups.

1. Polymorphisms of the glucocorticoid receptor (NR3C1) gene: In the NR3C1 gene encoding GR, there are many single-nucleotide polymorphisms (SNPs) that affect the expression, binding affinity, or function of GR itself. Some SNPs are associated with altered sensitivity to GC. Genotyping methods (for example, real-time PCR, sequencing) can be used to identify these polymorphisms. It is important to note that genetic factors influencing sensitivity to GC are involved in predisposition to certain diseases, the phenotype of inflammatory reactions, as well as the clinical response to GC therapy, which may limit the interpretation of the results obtained [16].

2. Polymorphisms of GC target genes: GC regulate the expression of multiple genes involved in inflammation and the immune response. Polymorphisms in the promoter regions or coding parts of these genes (for example, the genes of cytokines, enzymes of GC metabolism) affect their response to GC. However, the expression of genes can be different, which causes the difference in the results obtained and has a complex interpretation [17].

3. Epigenetic modifications: DNA methylation and histone modifications also affect the expression of genes related to GC sensitivity. It is known that hypermethylation of the promoter region of the GR gene can reduce its expression and lead to resistance. Methods such as bisulfite sequencing or ChIP sequencing



can be used to analyse epigenetic changes. However, the technique depends on the type of epigenetic mutation and the brand of the sequencer [18].

4. Gene expression analysis (transcriptomics): Studying the gene expression profile in patient cells before and after GC exposure can reveal genes that are regulated differently in sensitive and resistant patients. Methods such as microarrays or RNA sequencing provide extensive information about transcriptomic changes. The limitation is the presence of various genes responsible for resistance, and the significance of certain genes remains the subject of further study and the complexity of interpretation [19].

5. Study of microRNA profiles: microRNAs are small non-coding RNAs that regulate gene expression. Some microRNAs can affect sensitivity to GC by modulating the expression of GR or its target genes. MicroRNA profile analysis may be a promising method for determining sensitivity. The limitation is the expression of microRNAs [20].

The limitations of molecular methods are that they require complex equipment, expensive reagents, are time-consuming, involve several specialists, are tied to a single GC (most often prednisolone and dexamethasone), require bioinformatic analysis, are difficult to interpret and cannot be used simultaneously to determine sensitivity to multiple GC. The correlation between individual genetic polymorphisms and clinical sensitivity is not always unambiguous and requires further research.

The technique developed and patented by the authors is characterized by simplicity of execution, allows simultaneous determination of sensitivity to six systemic GC (prednisone, hydrocortisone, methylprednisolone, triamcinolone, betamethasone and dexamethasone), has degrees of sensitivity to GC and can be used for any disease requiring the appointment of glucocorticoid therapy. In its essence, it is cellular, based on the sensitivity of lymphocytes to GC and is based on the phenomenon of cortisol-resistant lymphocytes, and allows us to assess sensitivity to GC (in our study to dexamethasone) at the receptor level. Using this technique, a correlation of cytokine levels is revealed depending on the degree of sensitivity to dexamethasone, which makes it possible to uncover the mechanisms of sensitivity to GC.



Conclusion

In this study, a clear relationship between cytokine levels and sensitivity to dexamethasone in patients with BA was identified. The findings demonstrated that pro-inflammatory cytokines, particularly IL-1 β , were significantly elevated across all patient groups compared to healthy controls, with the highest increase observed in moderately sensitive individuals. Although IL-4, IL-6, and TNF- α levels were also elevated, their variation between sensitivity groups was not statistically significant, suggesting a more complex and less direct role in glucocorticoid responsiveness. These results highlight that IL-1 β may serve as a more sensitive biomarker for assessing glucocorticoid sensitivity, especially in cases of partially resistant asthma. The study also emphasizes that persistent elevation of cytokines contributes to ongoing inflammation and may reduce the therapeutic effectiveness of dexamethasone. Importantly, the use of a novel, patented method for evaluating glucocorticoid sensitivity provides a practical and clinically applicable approach for personalized treatment strategies. Overall, the study contributes to a deeper understanding of the immunological mechanisms underlying glucocorticoid sensitivity and resistance in bronchial asthma. This knowledge can support the development of targeted therapeutic interventions and improve disease management by enabling more individualized treatment approaches based on cytokine profiling and sensitivity assessment.

References

1. Dharmage SC, Perret JL, Custovic A. Epidemiology of Asthma in Children and Adults. *Front Pediatr*. 2019 Jun 18;7:246. doi: 10.3389/fped.2019.00246. PMID: 31275909; PMCID: PMC6591438.
2. Liu JH, Li C, Zhang CH, Zhang ZH. LncRNA-CASC7 enhances corticosteroid sensitivity via inhibiting the PI3K/AKT signaling pathway by targeting miR-21 in severe asthma. *Pulmonology*. 2020 Jan-Feb;26(1):18-26. doi: 10.1016/j.pulmoe.2019.07.001. Epub 2019 Aug 11. PMID: 31412983
3. Barnes PJ. Corticosteroid resistance in patients with asthma and chronic obstructive pulmonary disease. *J Allergy Clin Immunol*. 2013;131(3):636–645.



-
4. Dorscheid D, Gauvreau GM, Georas SN, Hiemstra PS, Varricchi G, Lambrecht BN, Marone G. Airway epithelial cells as drivers of severe asthma pathogenesis. *Mucosal Immunol.* 2025 Jun;18(3):524-536. doi: 10.1016/j.mucimm.2025.03.003. Epub 2025 Mar 26. PMID: 40154790.
 5. Aripova T.U., Mukhtarov Sh.M., Suyarov A.A., Khatamov H.M. Kireev V.V. Utility model patent "Method for determining sensitivity to glucocorticoids in bronchial asthma" No. FAP 02183 dated 12.26.2022.
 6. Plewa P, Pokwicka J, Bakinowska E, Kielbowski K, Pawlik A. The Role of Alarmins in the Pathogenesis of Asthma. *Biomolecules.* 2025 Jul 11;15(7):996. doi: 10.3390/biom15070996. PMID: 40723867; PMCID: PMC12293062.
 7. Xue Y, Nie Y, Zhang H, et al. STAT3 and IL-6 contribute to corticosteroid resistance in a molecular bioscience model. *//Front Mol Biosci.* 2021;8:717962. doi:10.3389/fmolb.2021.717962.
 8. Mjösberg J, Emgård J. Immunologi vid astma [The immunopathology of asthma]. *Lakartidningen.* 2025 May 15;122:24151. Swedish. PMID: 40371567.
 9. Banuelos J, Lu NZ. A gradient of glucocorticoid sensitivity among helper T cell cytokines. *//Cytokine Growth Factor Rev.* 2016 Oct;31:27-35. doi: 10.1016/j.cytogfr.2016.05.002. Epub 2016 May 13. PMID: 27235091; PMCID: PMC5050075.
 10. Pazdrak K, Straub C, Maroto R, Stafford S, White WI, Calhoun WJ, Kurosky A. Cytokine-Induced Glucocorticoid Resistance from Eosinophil Activation: Protein Phosphatase 5 Modulation of Glucocorticoid Receptor Phosphorylation and Signaling. *//J Immunol.* 2016 Nov 15;197(10):3782-3791. doi: 10.4049/jimmunol.1601029. Epub 2016 Oct 14. PMID: 27742828; PMCID: PMC5098561
 11. Gu W, Lei J, Zhu H, Xiao Y, Zhang Z, Zhao L. Effect of the BMPR-II-SMAD3/MRTF pathway on proliferation and migration of ASMCs and the mechanism in asthma. *//Mol Biol Rep.* 2022 Oct;49(10):9283-9296. doi: 10.1007/s11033-022-07764-9. Epub 2022 Aug 25. PMID: 36008606; PMCID: PMC9515032.
 12. Perrin AJ, Horowitz MA, Roelofs J, Zunszain PA, Pariante CM. Glucocorticoid resistance and cytokine production in depression: a systematic



-
- review and meta-analysis. //Front Psychiatry. 2019;10:423. doi:10.3389/fpsy.2019.00423.
13. Zustakova M, Kratochvilova L, Slama P. Apoptosis of Eosinophil Granulocytes. //Biology (Basel). 2020 Dec 10;9(12):457. doi: 10.3390/biology9120457. PMID: 33321726; PMCID: PMC7763668.
14. Reddy A. T, Lakshmi S. P, Banno A., Reddy R. C. Glucocorticoid receptor α mediates roflumilast's ability to restore dexamethasone sensitivity in COPD. // International journal of chronic obstructive pulmonary disease 2020;15 125–134.
15. Abe K., Ishikawa Y., Kita Y., Yajima N. et al. Association of low-dose glucocorticoid use and infection occurrence in systemic lupus erythematosus patients: a prospective cohort study. // Arthritis Res Ther 2022 Jul 28;24(1):179. P.2-8. doi: 10.1186/s13075-022-02869-9.
16. Olnes M. J., Kotliarov Y., Biancotto A., Cheung F., Chen J. et al. CHI Consortium effects of systemically administered hydrocortisone on the human immunome // Sci. Rep. 2016; 6: 23002.P.1-15.
17. Omraninava M, Eslami MM, Aslani S, Razi B, Imani D, Feyzinia S. Interleukin 13 gene polymorphism and susceptibility to asthma: a meta-regression and meta-analysis. //Eur Ann Allergy Clin Immunol. 2022 Jul;54(4):150-167. doi: 10.23822/EurAnnACI.1764-1489.180. Epub 2020 Nov 16. PMID: 33191717.
18. Li Y. Modern epigenetics methods in biological research. //Methods. 2021 Mar;187:104-113. doi: 10.1016/j.ymeth.2020.06.022. Epub 2020 Jul 6. PMID: 32645449; PMCID: PMC7785612.
19. Mousa S. A., Dehe L., Aboryag N., Shaqura M., Beyer A., Schäfer M., Treskatsch S. Identification of glucocorticoid receptors as potential modulators of parasympathetic and sympathetic neurons within rat intracardiac ganglia //Front. Neuroanat. 2022; 16: 902738. doi: 10.3389/fnana.2022.902738 13P.
20. Ho PTB, Clark IM, Le LTT. MicroRNA-Based Diagnosis and Therapy. // Int J Mol Sci. 2022 Jun 28;23(13):7167. doi: 10.3390/ijms23137167. PMID: 35806173; PMCID: PMC9266664.



Conflict of interests: The authors declare that there is no conflict of interest. The handwriting has been reviewed and approved by all authors before publication.

Source of funding: the research was carried out within the framework of the topic «Improving personalising methods for the diagnosis and treatment of bronchial asthma» within the framework of funding from the Institute of Immunology and Human Genomics from the Academy of Sciences of the Republic of Uzbekistan

Contribution of the authors:

Suyarov A.A. - general idea, editing

Kireev V.V. - writing a paper, statistical processing

Yuldashev I.R., Abdullaev N.Ch. - participation in the development of the method

Erkinov N.G. - selection of patients

Ochilov S.I. – selection of patients.

Akram Amirkulovich Suyarov Doctor of Medical Sciences, Professor, Head of the Laboratory of Allergo-and Immunopharmacology at the Institute of Immunology and Human Genomics of the Academy of Sciences of the Republic of Uzbekistan Email: e-mail: akram_amirkulovich@mail.ru ORCID: 0000-0002-2909-9820

Vadim Vladimirovich Kireev Doctor of Medical Sciences, Leading Researcher at the Laboratory of Allergo-and Immunopharmacology at the Institute of Immunology and Human Genomics of the Academy of Sciences of the Republic of Uzbekistan Email: xabaas@yandex.ru ORCID:0000-0003-1793-980X

Ilkhom Ruzievich Yuldashev - Doctor of Medical Sciences, Professor, Head of the Department of Allergology, Clinical Immunology and Microbiology at Tashkent Medical University. e-mail: yuldashov.ilkhom@mail.ru

Nurboy Chunnievich Abdullayev - Doctor of Medical Sciences, Associate Professor of the Department of Allergology, Clinical Immunology and Microbiology of Tashkent Medical University. e-mail: nurbay_abdullayev@mail.ru. <https://orcid.org/0000-0003-4725-5855>.

Ochilov Sardor Ilhom ugli - Researcher at the Laboratory Allergo-and Immunopharmacology at the Institute of Immunology and Human Genomics of



Modern American Journal of Medical and Health Sciences

ISSN (E): 3067-803X

Volume 2, Issue 10, October 2026

Website: usajournals.org

This work is Licensed under CC BY 4.0 a Creative Commons Attribution 4.0 International License.

the Academy of Sciences of the Republic of Uzbekistan Email: sardorochilov100@gmail.com ORCID: 0009-0000-0534-808X

Nodirbek Gayrat Ugli Erkinov - is a junior researcher at the Laboratory of Allergo- and Immunopharmacology at the Institute of Human Immunology and Genomics of the Academy of Sciences of the Republic of Uzbekistan E-mail: erkinov0205@gmail.com. <https://orcid.org/0009-0001-9667-3765>.