Disbalance of the macro and micro elements in HIV infected patients

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ABSTRACT

Background: Microelemental content of the hair reflects the status of microelements in whole body and is an indicator of mineral metabolism. There is no sufficient literature on study of macro and microelements in HIV/AIDS. We study macro and micro elements in hair samples of HIV infected patients and healthy individuals.

Materials and methods: We collected samples from 100 people aged 21 – 55. 40 persons were healthy, 46 were HIV infected. HIV infected patients have been divided into 3 groups according to CD4 cells count: more than 500, 200 – 499, less than 200. Neutron activation analysis (NAA) was used to detect microelements in the hair.

Results: Our study revealed the following results: in HIV infected women levels of Cl, Fe , Co, Ni, Cu, K, Se, Br, Rb, Ag, Cd, Sb, Ba, As were lower than in healthy persons. Levels of I, Au, Hg, Sr were higher than in healthy persons, Cr, Mn, Zn, U levels were normal. Levels of K was decreased 5 times and Ni was decreased 2 times compare to norm.

In male HIV patients, the results were different: the levels of , Cr, Mn, Zn, Se, Br, Au, Sb, Ba were normal, levels of Cl, Ca, Fe, Co, Ni, Cu, K, Rb, Ag, Cd, Hb, U were lower compare to healthy people. Only Iodine (I) and Strontium (Sr) were higher than norm.

Conclusion: Analysis of our data revealed that HIV infected patient develop deficiency of some macro and micro element (Sc, Cr, Fe, Cu, K, Se, Rb, Sb, Cd, Hg, As). The causes of such disbalance are due to changes in microbiocenosis of intestines and an impaired absorption in progression of HIV/AIDS. Found disbalance of microelements in hair samples of HIV infected patients defines necessity of correction of deficiency of macro and micro elements in treatment of such patient. It necessitates further detailed research of such disturbances to better understand immunopathochemical nature of HIV/AIDS and goal oriented therapy.

Keywords: Microelements, HIV/AIDS, hair content, disbalance
Disbalance of the macro and micro elements in HIV infected patients.

Introduction
Micro elemental content of hair reflects the status of microelements in the whole body and is an indicator of mineral metabolism. Disbalance in micro elemental content of hair helps to diagnose the chronic disease on the clinically asymptomatic stages. Even small disbalance of microelements may lead to critical conditions.

There is a special group of essential microelements which are a part of enzymes, vitamins, hormones and other bioactive substances. Regular intake of essential microelements with food or water is absolutely necessary for normal function of the organism. Essential microelements are: Iron (Fe), Iodine (I), Copper (Cu), Manganese (Mn), Zink (Zn), Cobalt (Co), Molybdenum (Mo), Selenium (Se), Chrome (Cr), Fluorine (F).

The analysis of microelements in the human hair is an informative method with a number of considerable advantages. Firstly, concentration of elements in blood and urine not always reflects the true quantity of microelements in the body. Blood concentration of microelements in the blood depends on the recent diet, physical work out, emotional stress or consumption of medications. Hair doesn’t participate in direct body metabolism. Ecological and polluting factors do not impact the chemical content of hair and accumulation of any substances in hair happens over a long period of time.

Secondly, hair samples, unlike other biological substances in the organism (blood, urine, lymph) do not require additional measures for conservation before analysis. Hair is not affected by temperature. As the result the analysis can be done electively and without expenses for additional measures for storage of the samples (reactants, refrigerators).

Aim of study
Analysis of macro and micro elements in HIV infected patients.

Ethics
All patients were registered in the Republic Centre of AIDS. The diagnoses of all patients were confirmed clinically and by the laboratory methods of immuno-fermentative analysis and immunoblotting. Written consent was given by all participants in the study. Study was approved by the ethical committee of Republic Centre of AIDS, Uzbekistan.

Data Analysis
Statistical analysis of data was done on IBM computers using a Microsoft special set of programs and functions. The strength of correlation was described by normal distribution. Student t-test was used to analyze the data.

Materials and methods
We collected samples from 100 people aged 21 – 55. 40 persons were healthy, 15 with allergy and 46 HIV infected patients (28 females, 26 male). All patients had the following investigations: Complete Blood Count, Urinalysis, Blood Sugar, Biochemistry including BUN, LFT. Neutron activation analysis (NAA) was used to detect microelements in the hair samples of participants. NAA was conducted at the Institute of Nuclear Physics, Academy of Science, Republic of Uzbekistan was used to detect microelements in the hair.

Hair samples for the analysis were cut with the scissors from 3-5 places of an occipital part of a head, according to International Atomic Energy Agency (IAEA) recommendations. The length of hairs from the root to distal part was 2-4 cm. The prepared samples underwent to the neutron-activation analysis. The following 25 elements were detected in the hair samples: Na, Cl, Ca, Sc, Cr, Fe, Mn, Co, Ni, Cu, Zn, K, Se, Br, Rb, Ag, Cd, Sb, La, Au, Hg, U, As, Ba, Sr.
All HIV infected patients have been divided into 3 groups according to CD4 cells count: more than 500, 200 – 499, less than 200.

**Results**

The following data was found: the level of barium (Ba) has been low in all three groups. However, some women had an increased level of barium due to the usage of chemicals for colouring their hair. Iron (Fe) level was almost half of the norm (23.5+6.3 mcg/g) in all three groups and copper (Cu) was 5 times less (5.6+2.4 mcg/g) in all the groups. Level of strontium (Sr) was increased in all three groups.

**Level of Ba, Fe, Sr, Cu according to CD4 cells count in HIV infected patients.**

Levels of Cl, Ca, K were changed in all three groups. The lowest level of K (138.1+14.8 mcg/g) was noticed in patients with CD4 more than 500. Levels of Cl and Ca were increased in patients with CD4 cell count from 200 – 499. Level of sodium was lower than norm in patients with CD4 more than 500 and CD4 from 200-499 and was higher than norm in patients with CD4 lower than 200. Zink level was slightly decreased in all three groups.

**Levels of Cl, Ca, Na, K, Zn according to CD4 cells count in HIV infected patients.**
Analysis of the next group of the elements revealed that mercury (Hg) was three times less than norm in all three groups with the least level in patients with CD4 cells level less than 200 (0.06+0.03 mcg/g). Similar picture was observed in Silver (Ag) (0.01+0.006 mcg/g). The levels of antimony (Sb) (0.05+0.035 mcg/g) and cadmium (Cd) (0.03+0.1 mcg/g) were 5 times less than norm in all three groups. Levels of Co, La, Sc, As were decreased in all three groups. The lowest levels of Cobalt (Co) (0.01+0.004 mcg/g) and arsenic (As) (0.03+0.015 mcg/g) were in the group with CD4 less than 200.

Levels of Hg, Ag, Sb, As, Au, Co, La, Sc according to CD4 cells count in HIV infected patients.

We found following data in the next group of elements: the level of nickel (Ni) was three times equally decreased (2.5+0.1 mcg/g) in all 3 groups of CD4 level. Bromine (Br) level was two times higher the norm in patients with CD4 more than 500 and about half of the norm in other two groups of patients. Similarly, the level of Iodine (I) was 6 times higher the norm in the group with CD4 more than 500. Levels of Cr, Se, U, Mn were decreased in all three groups. Level of rubidium (Rb) was significantly decreased in all three groups; in particular, patients with CD4 higher than 500 had Rb level 20 times lower the norm (0.1+0.05 mcg/g).
Levels of Ni, Br, I, Mn, Cr, Se, U, Rb according to CD4 cells count in HIV infected patients.

The analysis of microelements in the hair sample according to gender revealed the following differences: the level of Cl, K, Na was lower in women. Calcium (Ca) level was three times less in women compare to men and zinc level was the same in both sexes.

Comparison of the levels of Cl, Ca, Na, K, Zn according to gender in HIV infected patients.

The levels of iodine (I) and bromine (Br) were low in female compare to men. Levels of nickel (Ni) and chrome (Cr) were the same in both genders. Level of manganese (Mn) was higher than norm in women and below the norm in men. Selenium (Se) and rubidium (Rb) were lower in females in particular Rb level was significantly below the norm (p<0.001). Uranium (U) was high in females.
Comparison of the levels of Ni, Br, I, Mn, Cr, Se, U, Rb according to gender in HIV infected patients.

Levels of Hg, Sb, As were lower in females and levels of Ag, Au, Co were higher. Cd, La, Sc levels were the same in both females and males.

Comparison of the levels of Hg, Ag, Sb, As, Cd, Au, Co, La, Sc according to gender in HIV infected patients.

Amount of barium (Ba) was lower in males, however, some women had increased amount of Ba due to colouring of their hair. Fe and Cu levels were decreased equally in both genders. Level of Sr was increased more significantly in females.

Comparison of the levels of Ba, Fe, Sr, Cu according to gender in HIV infected patients.
According to our study, in HIV infected women levels of Cl, Fe, Co, Ni, Cu, K, Se, Br, Rb, Ag, Cd, Sb, Ba, As were lower than in healthy persons. Levels of I, Au, Hg, Sr were higher than in healthy persons, Cr, Mn, Zn, U levels were normal. Levels of K was decreased 5 times and Ni was decreased 2 times compare to norm.

In male HIV patients, the results were different. The levels of Cr, Mn, Zn, Se, Br, Au, Sb, Ba were normal, levels of Cl, Ca, Fe, Co, Ni, Cu, K, Rb, Ag, Cd, Hb, U were lower compare to healthy people. Only iodine (I) and strontium (Sr) were higher than norm. Comparison of the levels of the microelements in males and females revealed following differences: levels of Na, Sc, As are normal in males and decreased in females. Level of Calcium (Ca) was 4 times in males compare to norm, and level of iodine (I) was 3 times higher compare to norm.

**Discussion**

Our study has shown that HIV infected patients have a disbalance in macro and micro element metabolism. There are differences in macro and micro element content in hair samples in males and females. The revealed disbalance defines the necessity of correction of deficiency of micro elements during the treatment of HIV patients.

The analysis of literature has shown data on metabolism of essential microelements in more than 100 pathological conditions. Some microelements and metals activate the enzymes which play a significant role in biochemical processes (3,6,12,22). Significant data on mechanisms of activation, differentiation and regulation of some of the populations of T and B lymphocytes leads to necessity of studying the role of microelements in normal immunological responses. This data allows to define the influence of microelements on metabolism and subpopulation of lymphocytes (1,4,7,17).

Our study revealed that scandium (Sc) level is decreased (p<0.05) in the group of infected patients with CD4 level lower than 200 and CD4 level 200-499.

According to literature, low level of chrome (Cr) in the body leads to pain in different locations, ulcers, cardiovascular pathology, canceromatosis, hypercholesterolemia, pathology of pancreas and intestines, diabetes, renal pathology (hematuria and albuminuria); various neurological pain syndromes and itchiness. In our study the level of chrome (Cr) was decreased (p<0.05) in the group of infected patients with CD4 level higher than 500 and CD4 level 200-499. The level of chrome increases in patients with CD4 level lower than 200.
Iron is an important microelement, part of haemoglobin. The iron metabolism changes at a number of physiological and pathological conditions, inflammation, infectious diseases, tumours, bleeding, and helminthiasis. Presence of phosphates, oxalates, calcium, zinc, vitamin E, etc... (10,11,18) affect the absorption of iron. Level of iron (Fe) was decreased in all three groups of HIV patients (P<0.05) and respectively affects the condition of infected persons.

It is well known that cobalt (Co) is a component of vitamin B12 which is necessary for DNA synthesis, hemopoesis, functioning of nervous system and other processes. Deficiency of cobalt leads to some serious pathological conditions such as: pernicious anaemia, myelosis funicularis, and megaloblastic anaemia (9). Our data revealed decreased level of cobalt (p<0.001) in HIV infected patients with CD4 more than 500 as well as with CD4 less than 200. Furthermore, in the latter group the level was decreased significantly and could explain the above listed disturbances in hemopoesis, anaemia and central nervous system functioning.

Our study revealed significantly low level of copper (Cu) in all groups of HIV infected patients. Symptoms of copper deficiency include: neutropenia, anaemia (resistant to iron), osteoporosis, different pathology of bones and joints, decreased pigmentation of skin, neurological symptoms and cardiovascular impairment. Deficiency of an absorption of cobalt can be observed in the pathology of small intestines which occurred in our patients (23,24).

According to our data, level of potassium (K) was decreased in all groups of HIV infected patients, in particular in a group of CD4 level 200-499. Potassium is necessary for normal functioning of all body tissues: vessels, muscles, and especially heart muscles, brain cells, liver, kidneys, and other organs. Potassium is a part of intra cellular fluid (50% of all salts in the organism contain potassium).

Selenium (Se) is a vital microelement. It is important for normal functioning of thyroid gland, immune, reproductive, cardiovascular, and nervous system. There are 30 biologically active proteins described in the literature that contain selenium. Selenium functionally connected with vitamin E. The level of selenium in plasma decreases during the acute stage response of organism to inflammation and infection (9,20,21). Our patients expressed the deficit of selenium which correlated with immune insufficiency in all groups of patients.

Rubidium (Rb), antimony (Sb), mercury (Hg), and arsenic (As) levels were also decreased in all our groups. Moreover, the most decreased level of rubidium was observed in the group of patients with CD4 cell count more than 500. Literature data shows that 90% of mercury is connected with erythrocytes. Non organic mercury is excreted with the urine. Organic mercury is secreted to bile, and then reabsorbed to blood from gastro-intestinal system. Toxic properties of mercury are caused by the ability to connect with sulphohydryl group of proteins. It changes protein structure and properties, in particular, antigen characteristic in autoimmune reaction. Antimony as well as arsenic in small quantities can act as stimulators of physiologic processes. Chronic intoxication with these elements can cause arrhythmias, inflammation of respiratory tract and eyes, dermatitis (20,21).

There is about 10 mg of gold (Au) in the human body with 50% in the bones. According to literature gold toxicity can cause dermatitis with eosinophilia. Other side effects include autoimmune reaction, toxic action of kidneys and liver and suppression of hemopoesis. Direct correlation between therapeutic doses, gold concentration in urine and plasma and clinical symptoms is not clear. However, skin allergic reactions appear in the patients with high concentration of gold in the blood. Mechanism of toxic action of gold is related to its affinity to thiol groups and inhibition of thiol enzymes (13). We found decreased level of gold in hair samples of HIV infected patients.

Iodine (I) in hair samples correlate with its consumption. However, it is not very clear. Decreased level of iodine in hair samples were revealed in 59% of residents of iodine deficient areas. In thyroid gland pathology iodine level in hair and nails samples can be decreased (more often) as well as increased (5,9).
More than 95% of cadmium is in erythrocytes. Toxic effects of cadmium are due to competition with other metals for connection with enzymes and consequent impairment of the enzymes activity. Cadmium also connects with different proteins with subsequent changes of proteins’ properties. The disbalance of cadmium can lead to anaemia, liver pathology, cardiopathy and hypertension. Level of cadmium in hair sample of HIV infected patients was decreased in all groups of our patients.

Experimental research had shown that microelements are capable to reduce immune response 100 times. Many microelements appear to be selective in their effect on certain part of immune response. The above makes study of microelements in HIV infected patients is very important. Results of our study allow us to think of participation of microelements in regulation of the immunity in HIV infected patients.

**Conclusion**

Analysis of our data revealed that HIV infected patients develop deficiency of some macro and micro elements (Sc, Cr, Fe, Cu, K, Se, Rb, Sb, Cd, Hg, As). The causes of such disbalance are due to changes in microbiocenosis of intestines in progression of HIV/AIDS, impaired absorption due to pathological processes in these conditions. Almost all microelements participate in immune-poiesis. Their deficiency or excess directly or non-directly influence the condition of immune system. The performed study has shown the deficiency of microelements in hair samples depending on CD4 cell count in HIV infected patients. Found disbalance of microelements in hair samples of HIV infected patients defines necessity of correction of deficiency of macro and micro elements in treatment of such patient. It necessitates further detailed research on such disturbances to better understand immunopathochemical nature of HIV/AIDS and goal oriented therapy.

**References**