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## Heavy Metals in the Women's Breast Milk and the Health of Newborn Babies

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## Abstract

The comparative study of the chemical elements' concentration (mainly heavy metals) in the breast milk of 57 women and of the development of perinatal and neonatal pathology in their newborns is conducted. In newborns were diagnosed the following diseases: bronchitis, pneumonia, respiratory distress syndrome, aspiration syndrome, conjugated jaundice, edema syndrome, hemorrhagic syndrome, congenital malformations, morfofunctional immaturity. The concentration of the chemical elements was determined by atomic-emission plasma spectrometry method. The normal composition of the breast milk was in 7 women, and the increased content of the chemical elements from 1 to 9 were in 50 women. The newborns with different pathologies were fed with the breast milk and the concentration of heavy metals in this milk could exceed the upper normal limit on 7 - 580%. The detection' frequency of the increased concentration of certain chemical elements was from 8 to 100% in newborns with different pathologies. The high concentration of Ti (in 25-100% of infants), Pb (33-75%), Al (17-75%), Ba (17-67%) was met with the highest frequency at various pathologies. The high concentration of Pb, Al, Ti and Ba was found in the mothers' breast milk with newborn babies, who had various diseases (from 8 to 10 nosological units).

## **1. Introduction**

It is well-known fact that heavy metals may have toxic effect on the system of motherfetus-newborn [1, 2, 3]. In order to evaluate the anthropogenic impact in that system it is proposed to test the content of chemical elements in the blood of the mother, newborn, in the placenta, meconium and breast milk [2, 3]. A test of breast milk has the following advantages: a non-invasive method and availability of biological material. However, an important question is raised during the survey of the chemical composition of breast milk: the elements that contained in the milk are essential nutrients or toxins?

The role of micro and macro elements in the vital activity of the mother's body and her infant has to be examined in two ways. On the one hand, it is needed substance for biochemical processes. Their deficiency can lead to a number of diseases (distress of psychomotor development, mental retardation, dental caries, rickets, eczema, immune deficiencies and others). On the other hand, they can act as toxins (especially heavy metals), that have a negative impact on the mother and infant [3, 4, 5].

A number of scientific works are dedicated to the effect of heavy metals of breast milk on the state of newborns survey [5, 6, 7, 8]. However, they are related to examination of the relation of single (individual) heavy metals and one-two diseases in infants. Still there is a possibility that the breast milk may contain high content of several toxic chemicals, and they may be accompanied by the development of neonatal defect complex. In our opinion, it is advisable to continue research in this direction. It will be helpful in development of proved methods for newborns' protection and their mothers from toxic effects of heavy metals.

Therefore, there was no study about correlation between the consistence of wide spectrum of heavy metals in the breast milk and the development of heavy neonatal pathology till the present time.

The actuality of the theme determined the aim of this study.

The aim of the study as follows: To investigate the degree of incidence and concentration of the increased content of heavy metals in the women's breast milk which newborns were obtained with different perinatal and neonatal diseases.

#### 2. Materials and Methods

We determined the concentration of various chemical elements (Pb, Cr, Cu, Al, Mn, Sr, Ti, Si, Ba, Zn, Sn, Ni, B, Bi, As, Mo, Cd, In, Sb, Co, Ag, Au), mostly of heavy metals in 57 samples of breast milk by method of atomic-emission plasma spectrometry (using atomic emission spectrometry with inductive coupled plasma, the «Baird», USA company). The study of breast milk was conducted on 15-20 day after giving birth.

The examined women and infants lived in Moscow. Somatic and / or obstetric-gynecologic diseases were diagnosed among all women. None of examined women had occupational hazard, and they lived in different six districts of Moscow. Nutrition among all women was mostly the same.

Under clinical observation were 57 newborns (15 term babies and 42 preterm), who were treated in the city clinical hospital №13 in Moscow. Full-term infants were born with a body weight of 2650 g to 3500 g and 38 - 41 weeks of gestation. The weight of premature infants was 1200 - 2800 g and gestational age was from 27 to 37 weeks.

Analysis of the content of chemical elements in breast milk was conducted considering the presence of certain diseases in newborns. Non-infectious perinatal pathology and / or infectious-inflammatory diseases of different severity were revealed in all newborns. Infectious - inflammatory diseases of mild case (conjunctivitis, rhinitis, omphalitis) were in 4 infants, tracheobronchitis was in 4, "ventilatorassociated pneumonia" was in 13, conjugated jaundice of I degree (CJ I) was in 6 infants, conjugated jaundice of II-III degree (CJ II-III) was in 10, respiratory distress was syndrome (RDS) without infection was in 6 infants, aspiration syndrome was in 6, general edema syndrome was in 9 preterm infants and in 7 full-term newborns, hemorrhagic syndrome (HS) was in 13, congenital malformation (CM) was in 7, intrauterine growth retardation (IGR) was in 9 infants.

The concentration of chemical elements in the breast milk which newborns with perinatal and neonatal disorders were feed, it was compared with indicators of the norm. The normal indices (the norm) have been determined by us during the examination of healthy women who gave birth to healthy newborns [9].

#### 3. Results

The results of our research revealed the relationship between the content of various chemicals, including heavy metals in the breast milk and the presence of diseases in newborns.

The results of the study are shown in Table 1: there is an increased concentration of chemical elements in the women's breast milk of women if there is presence of disease in newborns of these women.

Table 1. The increase of chemical elements' concentration in the women's breast milk with the presence of the diseases in their babies.

Diseases in newborns	The increase of chemical elements' concentration in the breast milk (in percent to the maximum value of the normal)	The appearance of the rare metals in the breast milk
Mild inflammatory infection	Pb by 13%, Ba and Ti by 21%-24%, Fe by 7%-28%, B by 100%-203%	No
Tracheobronchi-tis	Sn and Si by 7%, Bi and Al by 10%-16%, Ti and Zn by 21%-177%, Ba by 21%-198%, B by 51%-203%, Pb by 131%-366%, Sr by 28%-580%	As, Mo, Cd, In, Sb
Pneumonia	Sr, Cr, Si by 8% -13%, B and Ni by 9%-23%, Sn by 12%-29%, Al by 14%-32%, Au by 11-75%, Zn by 28%-83%, Ti by 11%-94%, Ba by 16%-171%, Pb by 36%-434%	As, Mo, Cd, In, Sb, Ag
The conjugational jaundice of I degree	Cr by 17%, Sn by 43%, Ni and Ti by 57%-58%, Bi by 68%, Ba by 8%-82%, Pb by 122%-192%, B by 332%	Cd
The conjugational	Cr and Bi by 11%-13%, Al by 14%-25%, Cu by 29%, Mn and Fe by 41%, Ti by 23%- 42%, Zn by 31%-68%, Ba by 40%-71%, Sr by 13%-87%, B by 22%-105%, Ni by 12%-	Cd
Jaundice of II, III degree	107%, Pb by 18%-310% Mn by 8%, Cr by 11%-17%, Cu by 29%, Al by 14%-32%, Si by 35%, Sn by 12%-42%,	
Hemorrhagic syndrome	Zn by 14%-68%, Ti by 17%-76%, B by 9%-105%, Ni by 12%-107%, Ba by 8%-171%, Pb by 20%-248%	Cd
Congenital malformation	Ti, Sn, Sr by 11%-25%, Ni by 34%, Al by 18%-38%, Bi by 39%, Ba by 38%-44%, Si by	Cd

Annotation. The detection of the elements in the milk and the increase of their concentration were not observed in all milk samples, but only in 7% - 75% of women. 100% concentration of only titanium was increased during an aspiration syndrome in full-term newborns.

There was increased concentration from one to nine chemical elements in breast milk in 50 mothers of infants among 57 in comparison with women's breast milk of healthy infants. The excess concentration in reference to the upper limit of normal is fluctuated from 7% to 580%. However, this increase ranged from 35% to 300% in most samples of breast milk (75% of women). The largest increase in the concentration of chemical elements in the milk was in women whose infants are diagnosed with tracheobronchitis, pneumonia, hemorrhagic syndrome, and / or congenital malformations (increase up to 248 - 580%).

We found these high concentrations of chemical elements in breast milk which newborns with various diseases were obtained: Pb - 0,321-1,511 mg/kg, Cr - 1,074-2,207 mg/kg, Cu - 1,216 mg/kg, Al - 16,81- 21,73 mg/kg, Mn - 0,0994-0,31 mg/kg, Sr - 0,432-2,489 mg/kg, Ti - 0,669-1,67 mg/kg, Si - 4,32-6,5 mg/kg, Ba -2,803-7,808 mg/kg, Zn - 8,7432,49 mg/kg, Sn - 2,68-3,575 mg/kg, Ni - 0,169 mg/kg, B - 3,03-12,01 mg/kg, Au - 0,122-0,149 mg/kg.

In breast milk of some mothers were also found Bi in concentration 0,161-0,255 mg/kg; As - 0,323-2,13 mg/kg; Mo - 0,235-1,25 mg/kg; Cd - 0,011-0,407 mg/kg; In - 0,212-0,439 mg/kg; Sb - 0,14-0,291 mg/kg; Co - 0,01-0,02 mg/kg, Ag - 0,02 -0,04 mg/kg.

The content of chemical elements under study is not over the limit in 7 women. The perinatal diseases of light degree were diagnosed in newborn infants of these mothers: general edema syndrome - in 2 infants; RDS, infections without complications, in 2; conjugated jaundice of I degree - in 2; conjunctivitis - in 1 infant.

Table 2 shows the results of the study on the frequency of occurrence of the chemical elements' high content in the breast milk with different pathologies in infants.

Table 2. The frequency of the increased content of chemical elements in the women's breast milk with the presence of the different diseases in their babies.

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Elements	The frequency of the increased content of chemical elements in the breast milk with newborns' different pathology in % of the number of babies who are diagnosed with relevant disease
Pb	HS 69%, edematous syndrome of prematurity 75%, RDS 67%, aspiration syndrome 33%, IGR 63%, CJ I, II 40%, CM 71%, MII 33%, tracheobronchitis 38%, pneumonia 54%
Cr	HS 15%, edema syndrome of preterm infants 13%, RDS 17%, CJ II, III 17%, CM 14%, pneumonia 11%
Cu	HS 8%, CJ II, III – 10%
Al	HS 31%, edema syndrome of preterm infants 75%, edema syndrome of full-term infants 33%, RDS 50%, CJ II, III 50%, CM 29%, tracheobronchitis 25%, pneumonia 17%
Mn	HS 8%, edema syndrome of preterm infants 25%, edema syndrome of full-term infants 33%, RDS 17%, CJ II, III 10%, CM 43%, tracheobronchitis 13%, IGR 13%, aspirated syndrome 17%
Sr	Edema syndrome of preterm infants 33%, RDS 17%, CJ II, III - 20%, CM 29%
Ti	HS 45%, edema syndrome of preterm infants 25%, IGR 38%, CJ I, II 33%, CM 29%, MII 33%, tracheobronchitis 50%, pneumonia 54%, aspirated syndrome 100%
Si	HS 8%, edema syndrome of preterm infants 25%, RDS 33%, CM 14%, tracheobronchitis 13%, pneumonia 8%
Ba	HS 38%, edema syndrome of preterm infants 25%, edema syndrome of full-term infants 67%, RDS 17%, aspirated syndrome 67%, IGR 13%, CJ II, III 33%, CM 43%, MII 33%, tracheobronchitis 38%, pneumonia 31%
Zn	HS 31%, edema syndrome of preterm infants 25%, edema syndrome of full-term infants 33%, RDS 17%, CJ II, III 20%, CM 58%, tracheobronchitis 13%, pneumonia 31%
Sn	HS 15%, edema syndrome of preterm infants 13%, RDS 17%, CJ I 17%, CM 14%, tracheobronchitis 13%, pneumonia 11%, IGR 13%
Ni	HS 23%, edema syndrome of preterm infants 25%, 17%, IGR 25%, CJ I, II 30%, CM 14%, pneumonia 8%
Bi	Edema syndrome of preterm infants 38%, RDS P 33%, CJ II 20%, CM 14%, tracheobronchitis 13%
В	HS 31%, RDS 17%, CJ 1, 2 –20%, CM 14%, MII 33%, tracheobronchitis 38%, pneumonia 11%
Au	Pneumonia 31%

Annotation. Abbreviation of the diseases: HS – hemorrhagic syndrome, CM – congenital malformation; RDS – respiratory distress syndrome; IGR – intrauterine growth retardation; MII – mild inflammatory infection; CJ I, II, III – conjugated jaundice I, II, III degree.

It was determined that in the mothers' breast milk of infants who had infectious and inflammatory diseases of varying severity, the level of the following chemical elements often was increased: lead, titanium, barium, boron (in the 11 -100% of milk samples). If infants had pneumonia then every third sample of milk had high concentration of zinc. The increase of elements such as strontium, chromium, silicon, aluminum, manganese, tin, bismuth and nickel, observed only in a few cases in the breast milk in infants' infectious and inflammatory diseases.

Often (33% - 67% of cases) there were increased concentration of lead, strontium, aluminum and bismuth in the breast milk of mothers of preterm infants with RDS. If aspiration syndrome in full-term infants in the milk of all mothers had elevated levels of titanium, 67% of milk samples had higher concentrations of barium, and in every third sample - lead.

There often found a high concentration of lead, barium, titanium, aluminum, and nickel (30 - 50% of cases) in the breast milk of mothers of infants with conjugation jaundice.

Infants with congenital malformations fed with their mother's milk, which often had increased level of lead (71% of the samples) and manganese (43% of samples). Increasing the concentration of other elements in the CD was found in a few cases.

The high level of lead (63% of milk samples), titanium (38% of milk samples) and nickel (25% of milk samples) were in the mothers' breast milk of infants with intrauterine growth retardation. The increase of other elements such as chromium, barium, zinc, boron, manganese, tin, bismuth met rarely (in 12% - 13% of mothers).

Often there was a high concentration of lead (69% of samples), titanium (45%), barium (40%), zinc, aluminum, and boron (31%), nickel (23%) in the mothers' breast milk of infants who developed a hemorrhagic syndrome. High level of chromium is registered in 15% of milk samples.

In terms of rare metals in the mothers' breast milk of sick infants, the cadmium was appeared. There were detected an arsenic, molybdenum, indium, antimony, silver in case of infectious and inflammatory diseases in addition to cadmium

It should be emphasized that it was rarely visible a direct correlation between the severity of the infants' disease from high concentrations of elements which entering the body of an infant with his mother's milk. This correlation was observed after receiving the lead and aluminum with mothers' milk into the premature babies' body and development (among the last) infectious and inflammatory diseases, hemorrhagic and edema syndrome. Furthermore, the concentration increase of lead or nickel in the milk, the degree of conjugated jaundice increases among infants. With the increase of the lead concentration in milk, it was noted the growth of the degree of intrauterine malnutrition in infants with morphological and functional immaturity.

However, for the majority of the studied elements are unable to identify the links between their level in the milk and the frequency and severity of diseases. Obviously, the development of the disease and its severity are more dependent on the individual threshold of sensitivity to xenobiotics and the duration of their exposure.

### 4. Discussion

As the study showed, a high content of heavy metals in the breast milk in women of babies who had a wide range of diseases. Apparently, it is bound with the fact that the damaging effect of these chemical elements is directed at the general biochemical system of the human.

It is known that heavy metals have strong cumulative properties, high biological activity towards sulfhydryl, thiol, carboxyl and other active groups of proteins and amino acids. A solid complex formation of metal with the protein can induce an allergic reaction and inactivate certain enzymes, which leads to the breakage of biochemical chain and formation of pathological condition [1, 4, 5].

Taking into account the ability of heavy metals to the transplacental transition and its high sensitivity of the human body in the early stages of ontogeny, it becomes clear that newborns and infants are in the group of a high-risk for the development of pathological conditions dependent on the microelements.

Breast milk is a special object for detection of heavy metals and other toxic chemicals. On the one hand, the content of foreign substances reflects the level of toxic load on the mother's body also during pregnancy. An increased level of heavy metals in breast milk may be use as an indicator of such a load [6, 10]. Chronic admission of heavy metals into a mother's body can negatively affect the health of both: the fetus and newborn baby. That links with the low efficiency of the placental barrier and the absence of specific protective mechanisms [5, 6, 10]. The present study also showed that the high content of heavy metals in breast milk was accompanied by the development of pathological conditions in newborn infants who consumed the milk.

On the other hand, the admission of heavy metals into the body of newborns and infants with mother's breast milk strengthens the toxic effect that began during the fetal life. In our study, probably the following facts are pointing out at it. Thus, the development of "ventilator - associated pneumonia" occurred in babies with RDS or aspiration syndrome, as well as morphological and functional immaturity of the fetus. Certainly the important fact in the pneumonia' development had a hardware artificial ventilation of lungs. However, respiratory failure from the birth of newborns could be formed due to an intrauterine chronic toxic effect of heavy metals. As the study had shown, the breast milk is an indicator of toxigenic load on the woman and the fetus, therefore, the high concentrations of heavy metals were found in the breast milk. It was accompanied by the development of RDS, aspiration syndrome and morphological and functional immaturity.

The second factor is related to the fact that the increased concentration of toxic metals was detected in the milk of

women whose babies was born with numerous birth defects. In such cases there is a high possibility of the damaging effect of heavy metals on the fetus.

An important question is the possibility of babies' breastfeeding when the high concentrations of heavy metals are detected in the breast milk. In resolution of this issue an individual approach is required. The calculations of the oral toxic load on the babies' body during breastfeeding have shown the maximum toxic load is accounted for the infants up to 6 months. Subsequently there is a relative toxic agents' reduction (per 1 kg of body mass) due to increase of baby's body weight and reduction of the milk' weight in his diet [6]. Moreover, it must be kept in mind that the estimated toxic load of heavy metal can be different from the actual toxic load. The actual toxic load of heavy metal depends on many factors: the condition of the gastrointestinal tract, substances' resorption in the gut, the activity of body's detoxification systems, individual sensitivity to toxicant, and other reasons. It is also necessary to bear in mind that the breast milk contains a large amount of proteins and antioxidants [11, 12, 13]. These substances have detoxifying effect against heavy metals. In this context, we have tried to maintain breastfeeding in our patients. In this context, we tried to maintain breastfeeding in our patients.

The research' continuation of the mechanisms of heavy metals' chronic toxic effect, their distribution and accumulation in the mother's body and the newborn will help to develop new methods of protection from these toxins. Particularly, the use of natural chelates and antioxidants may be effective and safe.

## 5. Findings

1. Most of newborns (88%) who live in the industrial area, were fed with the breast milk, which had the high content of the chemical elements from 1 to 9 (mainly heavy metals). 2. The newborns with different pathologies were fed with the breast milk, the concentration of heavy metals in this breast milk could exceed the upper limit of normal on 7 - 580%; 3. The frequency of individual chemical elements' detection in the increased concentration was from 8 to 100% in newborns with different pathologies. The high concentration of Ti (in 25-100% of infants), Pb (33-75%), Al (17-75%), Ba (17-67%) was met with the highest frequency. 4. The high concentrations of Pb, Al, Ti and Ba were found in the breast milk of newborn babies with many diseases (from 8 to 10 nosological units).

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