Diagnosis of pulmonary hypertension and pulmonary heart at Berylliosis and plutonium pneumosclerosis (Clinical-functional investigation)

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Abstract: The subject of the research was 54 workers with Beryllium and Plutonium incorporation from 33 to 60 old, all of them had 41 - Berylliosis and 13 - Plutonium pneumosclerosis. Patients were investigated with ECG, pulmonary, kinetocardiography, echocardiography. Hypertension in the pulmonary artery developed due to a combination of anatomical and functional disturbances and also with increasing of a stroke and minutely volumes at a definite stage of the disease with Beryllium and Plutonium pneumosclerosis. Two type of hypertension were discovered with pulmonary reography in the Beryllium and the Plutonium pneumosclerosis patients: hypervolume and hypertension type. Hypervolume type of pulmonary circulation (31.7 % and 53.8 %) consist ed of a high amplitude systolic wave. It was revealed in patients at the early stage of disease, when the pulmonary vessels stretching and right ventricle function kept still at a good condition. Hypertensive type of pulmonary circulation (68.3 % and 46.2 %) had a low amplitude systolic wave. The low amplitude systolic wave caused by increasing resistance of the pulmonary vessels, decreasing in the flow of blood in arterial system and the injection fraction and a low circulatory volume.

Material and methods

54 patients in the age of 33-60 years, from them 41 - patients berylliosis, 13 - patients with a plutonium pneumosclerosis are investigated. Depending on weight of a clinical picture and a degree of radiological changes in lung patients berylliosis are divided into 3 groups: I group - 15 patients at whom came to light berylliosis I stages, II - 17 sick berylliosis II stages and III - 9 sick berylliosis III stages. IV group was made by patients with a plutonium pneumosclerosis, at which the clinical picture and a degree of radiological changes in lung corresponded to I (7 patients) and II (6 patients) to stages of disease. The control group of healthy people in quantity 53 person in the age of 20-54 years is investigated also.

Registered volumetric and differential reogram lung J.T.Pushkarja by a technique. Reograms lung, KCG movings and yugularis phlebograme registered on 6-channel electro-phonocardiography "Cardiorex-6" firms "Siemens" synchronously with the electrocardiogram (ECG), phonocardiogram and with piezogram artery carotid. Systolic in pulmonary arteries estimated pressure on the basis of definition of duration of a phase of an isometric relaxation right ventricle: on phlebograme on an interval from pulmonary a component of II tone phonocardiogram up to top V (d) waves phlebograme and on an interval h-i on kinetocardiograme (KCG) and ultrasonic with use nomograms L. Berstin.

Results
As a result of the indirect estimation of pressure lead carried out by us in pulmonary arteries on kinetocardiogram right ventricle and on jugularis phlebogram and nomogram L. Berstin the high pulmonary hypertensia is on the average found out in patients berylliosis 1 - 101 mm mercury, 2 - 106 mm. mercury, 3 stages - 112 mm. mercury and at patients with a plutonium pneumosclerosis - 86 mm. mercury. At a part of patients berylliosis 1 stages (6 %) and plutonium pneumosclerosis 1 stages (42,8 %) the moderate hypertensia was observed (up to 75 mm. mercury). At other patients - a high hypertensia. The hypertensia in pulmonary arteries at patients berylliosis and is caused by a plutonium pneumosclerosis, basically, a combination of anatomic and functional changes in vascular system lung, and also at the certain stage of disease - the increased shock and minute volume of heart. The received data completely will be coordinated to results of an estimation pulmonary blood circulations by a method reography lung. At reography lung at patients berylliosis and a plutonium pneumosclerosis it is revealed two types pulmonary hypertensia: hypervolume and hypertonic type. Hypervolume the type pulmonary blood circulations was observed at 31,7 % sick berylliosis all stages (at 33,3 %, 41,2 %, 11,1 % of patients, according to stages of disease), hypertonic type - at 68,3 % of patients (at 66,6 %, 58,8 % and 88,9 % of patients on stages). At patients with a plutonium pneumosclerosis hypervolume the type pulmonary blood circulations was observed at 53,8 % sick (57,1 % at 1-st and 50 % - at 2-nd stage), hypertonic type at 46,2 % sick (42,8 % and 50,0 % of patients, according to stages). Hypervolume the type pulmonary blood circulations was characterized by high amplitude systolic waves/fig. 1/. Katacrotic a knee, incisure and dicrotic a wave settled down highly, have been badly differentiated and are not visible almost on a curve. A venous wave of the big amplitude with the flat, slowed down descent release. High systolic the wave is caused by the increased shock volume right ventricle which hyperfunction develops in reply to increase of resistance of a vascular channel lung and hypoxemy. Intensity of a volumetric blood-groove for 1 minute at these patients also high. It is necessary to note, that at patients with a plutonium pneumosclerosis with hypervolume type pulmonary blood circulations, the amplitude systolic waves was higher, than at patients berylliosis with hypervolume type pulmonary blood circulations. Taking into account, that pressure in pulmonary artery at the first was lower, than at the second, apparently, resistance of a vascular channel lung and hypoxemy at the patients with a plutonium pneumosclerosis having hypervolume type pulmonary of blood circulation, have been less expressed, than at patients berylliosis. Hypervolume type pulmonary blood circulations which was characterized by decrease\textit{ reduction} in amplitude systolic waves, a high arrangement katacrotic a knee, incisure, dicrotic waves and a huge venous wave with the slowed down flat descent\textit{ release} and additional venous waves/fig. 2/. At these patients in connection with progressing of the basic disease resistance of a vascular channel lung sharply increases, pressure in pulmonary arteries raises, accrues hypoxemy and right ventricle any more in a condition to increase shock and minute volume. In these conditions mainly isometric type of hyperfunction right ventricle is formed. Pulmonary insufficiency is aggravated, thus, with connection of heart insufficiency. The important factor influencing quantity\textit{ amount} of blood in lung, is the parity\textit{ ratio} debits right and left ventricles. The assumption, that in many cases quantity\textit{ amount} of blood, throw out ventricles hearts, unequally is put forward. Filling pulmonary vessels increases, when left ventricle throws out less blood, than acts in a small circle from right ventricle. At a return parity\textit{ ratio} when activity right ventricle is reduced, the surplus of blood available in pulmonary vessels, flows to the left heart, thus, prevalence debit right ventricle promotes increase pulmonary volume of blood, and prevalence debit left ventricle conducts to his\textit{ its} reduction\cite{5, 6}. The high venous wave on reogram lung, testifying about difficulty of outflow of blood on veins lung, is caused by decrease\textit{ reduction} contractility functions of the left departments of heart and increase of pressure in the left auricle. Estimating contractility right ventricle according to phase and peak parameters kinetocardiogramme, it is possible to note ability, that the phase of a voltage is lengthened at all patients berylliosis and a plutonium pneumosclerosis due to both periods of its\textit{ her} components, but mainly due to the period of isometric reduction that can serve as the instruction\textit{ indication} on increase of pressure in a small circle. After treatment duration of this phase remains lengthened in comparison with healthy. The phase of exile has been on the average short at patients berylliosis in comparison with healthy and shortening stages of disease accrued in parallel. Were accordingly reduced intersystolic a parameter and factor Blumbergera so at patients берилиозом III stages it was observed sharp shortening the period of exile (0,22 second),
decrease (reduction) intersystolic a parameter (82%) and factor Blumbergera (1.8) and after treatment at these patients it was not observed positive dynamics (changes). Duration of the period of exile at patients with a plutonium pneumosclerosis on the average also has been short in comparison with healthy and after treatment small positive dynamics (changes) was observed. The period of exile analyzed in view of duration of an cardiac cycle. Shortening it (him) before treatment or lengthening after treatment was observed basically due to a phase of slow exile while the phase of fast exile remained without essential changes. Shortening the period of exile right ventricle in relation to due sizes it is revealed at 73.2% of patients berylliosis and at 38.5% of patients with a plutonium pneumosclerosis. The analysis of duration of phases of a systole right ventricle has revealed 3 phase syndromes (on V.L.Karpmana's classification). Most the syndrome hypodinamyc (at 60.0% of patients berylliosis I stages, at 70.5% - II stages and at 100% - III stages was frequently observed; at 57.1% of patients with plutonium pneumosclerosis I and at 16.6% of patients of II stage), the syndrome raised (increased) diastolic pressure (at 20% of patients berylliosis I stages, at 11.7% of patients - II stages much less often came to light; at 14.3% of patients with plutonium pneumosclerosis I of a stage). The third syndrome - a syndrome of the mixed loading in volume and pressure met at patients berylliosis I stages in 20% of cases and a little bit less often at patients of II stage (17.6%), and at patients with plutonium pneumosclerosis I of a stage in 28.6% and in 83.3% at II stage). It is necessary to note, that the syndrome of the mixed loading in volume and pressure was observed at patients with hypervolume type pulmonary blood circulations, and a phase syndrome hypodynamic - at patients with hypertonic type pulmonary blood circulations. At patients with hypervolume type pulmonary blood circulations on KCG the deep negative wave was observed during a systole, and at patients with a plutonium pneumosclerosis with hypervolume type pulmonary blood circulations she (it) was deeper, than at patients berylliosis. Middle-systolic cogs at these patients were still rather low and narrow.

In process of progressing pathological process in lung, increases in resistance of a vascular channel, increase of pressure in system of a small circle and increase hypoxemy there was a reduction of depth of a negative wave on KCG, the height and duration pathological positive middle-systolic waves which started to borrow (occupy) 50% of a systole, and then and all systole as a paradoxical pulsation increased. These positive pathological middle-systolic cogs testify to increase in a hypertrophy right ventricle down to a stagnant overload of it (him). A stagnant overload right ventricle at patients with plutonium pneumosclerosis I and II stage it was not observed. The increase in a systole of the right auricle and factor of auricles at patients berylliosis and was observed by a plutonium pneumosclerosis in parallel a stage of disease, and after treatment parameters have remained without essential positive dynamics (changes). Before treatment it was observed also shortening the period of filling and increase in a corner of filling with appreciable positive dynamics (changes) of these parameters after treatment, and at patients with a plutonium pneumosclerosis the corner of filling was sharper, than at patients berylliosis. It is established [14], that occurrence high and wide atrium cogs on KCG grows out the increased quantity (amount) of residual blood in ventricle, increases certainly - diastolic pressure and stretchings of thin walls ear auricles and, that these changes grow out insufficiency of heart and appear at those without dependence from the reasons causing her (it).

The question on a condition left ventricle deserves special attention at berylliosis and a plutonium pneumosclerosis. The hypertrophy left ventricle at lung patients is well-known and described in the literature as consequence (investigation) of the secondary changes connected to amplification (strengthening) of breath, increase in minute volume of heart, hypoxemy hypoxya myocardium and combination reactions to a hypertrophy of the right department of heart [3, 4, 17]. At the phase analysis of a systole left ventricle at patients with III stage pulmonary hearts lengthening the period of a voltage and shortening the period of exile came to light. Pathological changes left ventricle can find an explanation in formation (education) and inclusion intersystem bronchopulmonary, and also arteriovenous shunts [8.] the opportunity of mechanical narrowing of a cavity left ventricle is not excluded in connection with dilatation in the left party (side) interventricular partitions. At an estimation contractility functions of a systole left ventricle at patients berylliosis and a plutonium pneumosclerosis can be noted, that lengthening a phase of a voltage at all patients was on the average observed in comparison with healthy due to both periods of its (her) components, but lengthening was less long, than a
phase of a voltage right ventricle. The period of exile left ventricle analyzed in view of duration of a cardiac cycle and on the average it\{he\} has been short at all patients basically due to a phase of slow exile, and shortening weights of disease accrued in parallel. It is necessary to note, that at patients berylliosis the period of exile left ventricle on the average was more long than the right disease at all stages, and at patients with a plutonium pneumosclerosis duration of the period of exile left ventricle was shorter than right. Укорочение на период с независимого пространства в 63,4 \% of patients berylliosis and at 30,8 \% of patients with a plutonium pneumosclerosis. The analysis of duration of phases of a systole left желудочка has come to light three phase syndromes: a syndrome hypodynamic - at 66,6 \% of patients berylliosis I stages, at 58,8 \% of patients of II stage and at 66,6 \% of patients of III stage; at 28,6 \% of patients with plutonium pneumosclerosis I and at 33,3 \% of patients of II stage, a syndrome raised\{increased\} diastolic pressure - at 20 \% of patients berylliosis I, at 17,6 \% of patients II and at 22,2 \% of patients of III stage; at 14,3 \% of patients with plutonium pneumosclerosis I and at 16,7 \% of patients of II stage. The third syndrome - a syndrome of the mixed loading in volume and pressure met more often at patients berylliosis II stages (23,5 \%), less often at patients I (13,3 \%) and III stage (11,1 \%), and at patients plutonium pneumosclerosis in 42,8 \% of cases at I stages, in 66,7 \% - at II stage. Depth negative systolic waves has accordingly decreased. It is necessary to note, that the paradoxical pulsation during a systole left ventricle was observed at a part of patients berylliosis II and at the majority of patients berylliosis III stages, but was absent at patients plutonium pneumosclerosis. Thus at patients berylliosis and a plutonium pneumosclerosis the hypertrophy left ventricle was observed, but the stagnant overload left ventricle took place only at a part of patients berylliosis II and at the majority of patients of III stage, and were not observed at patients with a plutonium pneumosclerosis. Atrium cogs, as a rule, were higher on KCG left ventricle in comparison with right except for patients berylliosis than III stage. It is marked [16], that, probably, in connection with features of a structure thick-walled left ventricle (smaller ability to a stretching) even the small increase diastolic volume conducts to the big increase intraventricule pressure, and from here to stagnation in lung and to occurrence high atrium cogs. It is necessary to note, that at a stagnant overload right ventricle the paradoxical pulsation appears on KCG right ventricle, and on KCG left ventricle during a systole the negative wave continues to come to light. At a stagnant overload of both ventricles the paradoxical pulsation is observed on KCG left and right ventricles. A number\{line\} of authors [10] emphasize, that is far from being always presence of a pathological pulsation on KCG is an attribute aneurysms of heart. Occurrence positive widened cogs can be caused by presence of a hypertrophy ventricle or “dynamic aneurism”, or a sharp stagnant overload ventricle at cardiac insufficiency without dependence from the reason caused her{it}. Thus, at an early stage of disease in reply to increase of resistance of a vascular channel, increase of pressure in a small circle and hypoxemy hearts answers hyperfunction right and left ventricles which is accompanied by increase in shock and minute volume of a volumetric blood-groove for one minute, that causes increase of inflow to an arterial channel lung and formation hypervolume type pulmonary blood circulations, and increase in inflow to an arterial channel of a liver which is reflected on reogram a liver as high systolic waves. The phase syndrome of the mixed loading in volume and pressure is observed. Mainly isometric type of hyperfunction right ventricle is formed. At progressing berylliosis and a plutonium pneumosclerosis, connection broncho-bronchoalveolitis, interstitial pneumonias, emphysema lung, extensive pleura-diaphragmatic adhesions, the expressed decrease\{reduction\} in parameters pulmonary volumes and ventilation, amplification\{strengthening\} of work of breath there is an increase of resistance of a vascular channel lung, increase of pressure in pulmonary arteries up to a high hypertensia, increase hypoxemy, hypoxemyc hypoxy a myocardium and deep hypoxy fabrics. In this connection contractility function of heart is considerably reduced, formed a phase syndrome hypodynamic. Decrease\{reduction\} contractility right ventricle results functions in reduction of inflow of blood in an arterial channel lung, that on reogram lung is shown by low amplitude systolic waves. Alongside with it outflow of blood on veins of a liver is broken, venous stagnation which on reograms a liver is shown as high, and at patients berylliosis III stages of a huge venous wave with the slowed down flat descent\{release\} before which in a systole there is a negative wave, synchronous with the X-collapse on phlebograme, testifying about outflow of blood from a liver develops during a systole ventricle. It is necessary to note, that the high venous wave appears enough early. So at patients berylliosis I stages she{it} was observed in 12 cases
from 15. At patients with plutonium pneumosclerosis I of a stage the venous wave on reograme a liver appears also early, but the amplitude of her\{it\} is lower than at patients berylliosis I than a stage. Decrease\{Reduction\} contractility functions left ventricle resulted in infringement of outflow of blood on veins lung and to occurrence of venous stagnation which caused on reograms lung high, and at patients berylliosis III stages a huge venous wave with the slowed down flat descent\{release\} and additional venous waves (fig. 3). Besides inflow of blood to an arterial channel of a liver that was shown on reograme a liver as low amplitude systolic waves decreased.

At the analysis of levels of venous pressure in rest we observed natural increase of venous pressure depending on stages berylliosis. Rather low average figures of initial venous pressure can be explained by significant individual distinctions of levels of venous pressure (from rather high up to the lowest) at all stages of disease. The venous hypertensia at patients can be caused by infringement contractility functions of mainly right departments of heart at the kept tone of veins, and a venous hypotension - significant decrease\{reduction\} in a tone of veins in case of the expressed activity of toxico-infectious process in lung and expressed hypoxemy and hypoxy fabrics in connection with respiratory insufficiency. By improvement of a tone of veins some increase of venous pressure at patients chronic pulmonary berylliosis II stages after treatment can be caused and this increase of venous pressure can be estimated as a positive effect.

According to an electrocardiogram attributes of a hypertrophy right ventricle at patients berylliosis were observed in 63,4 % of cases, and at patients berylliosis I stages - in 46,6 %, II stages - 70,5 % and at patients of III stage - 77,7 %, thus most frequently there was a S-type of an electrocardiogram (56,1 %) and index Sodi-Pallaris (36,6 %). At patients with a plutonium pneumosclerosis attributes of a hypertrophy right ventricle were observed in 38,4 % of cases as P-pulmonale, S-type an electrocardiogram and index Sodi-Pallaris, and at patients with plutonium pneumosclerosis I of a stage - in 28,6 %, II stages - in 50,0 % of cases. Attributes of a hypertrophy left ventricle were observed at patients berylliosis in 60,9 % of cases, and at patients berylliosis I stages - in 66,6 %, at patients of II stage - 52,9 % and at patients of III stage - in 66,6 %. At patients with a plutonium pneumosclerosis attributes of a hypertrophy left ventricle were observed a little bit more often than right (in 46,1 %).

On data phonocardiography at patients berylliosis the amplitude of the first tone has been reduced at 48,7 % of patients, and decrease\{reduction\} in amplitude I of tone accrued to III stage of disease. Amplification\{strengthening\} of II tone was observed at 43,9 % of patients berylliosis and most frequently (66,6 %) at patients of III stage. At patients with a plutonium pneumosclerosis decrease\{reduction\} in amplitude I of tone was marked in 38,4 % cases. Amplification\{strengthening\} of the second tone on pulmonary arteries came to light at 61,5 % of patients and corresponded\{met\} to weight of disease.

Thus, results of our researches and the literary data show, that clinico-electrophonocardiography attributes pulmonary hearts at berylliosis and a plutonium pneumosclerosis meet rather seldom and cannot be considered\{examined\} as early functional changes. In connection with development and progressing of pathological process in lung anatomic and functional changes in vessels of a small circle result to hypoxy and to increase in resistance to a blood-groove in lung much earlier, that is a principal cause pulmonary an arterial hypertensia and chronic pulmonary hearts. Pressure in pulmonary arteries at patients berylliosis and a plutonium pneumosclerosis raises early, go at patients berylliosis I stages and at patients with plutonium pneumosclerosis I of a stage the moderate and high hypertensia, and at patients berylliosis II and III stages and by a plutonium pneumosclerosis of II stage - a high hypertensia in pulmonary arteries is already observed. By comparison of parameters hemodynamic a small circle of patients berylliosis and a plutonium pneumosclerosis it is possible to note the following distinctions: at patients with a plutonium pneumosclerosis met is more often and was more expressed hypervolume type pulmonary blood circulations; pressure in pulmonary artery at these patients was on the average lower, outflow on veins lung and a liver has been less complicated.

**Conclusion**
Thus, at patients berylliosis and a plutonium pneumosclerosis the hypertensia is early formed pulmonary: moderate at the majority of patients I of a stage, high at II and III stages of disease. pulmonary the hypertensia is the basic pathogenetic factor in formation chronic pulmonary hearts.

At the initial stage of disease in reply to increase of resistance of a vascular channel lung and hypoxemy hyperfunction of a myocardium of mainly right departments with increase in shock and minute volumes of heart, volumetric pulmonary a blood-groove is formed. These changes were observed more often and were more expressed at patients with a plutonium pneumosclerosis. The phase syndrome of loading in volume and pressure prevailed.

In process of progressing pathological process (connection broncho-bronchoalveolitis, interstitial pneumonias, emphysema lung, extensive pleura-diaphragmatic adhesions, the expressed decrease\{reduction\} in parameters pulmonary volumes and ventilation), increases pulmonary the hypertensia, accrues hypoxemy. In result are reduced shock and minute volume of heart, decreases volumetric pulmonary a blood-groove. The phase syndrome hypodynamic is formed.

Parameter of insufficiency of a myocardium of the right and left heart is the high venous wave on reograme lung and a liver which amplitude naturally accrues according to stages of disease and reflects difficulty of venous outflow. In most cases occurrence of a high venous wave precedes clinical display of insufficiency of blood circulation.

At patients berylliosis and a plutonium pneumosclerosis were marked both high figures of venous pressure, and a venous hypotension that can speak various mutual relations and expressiveness of intimate insufficiency and a pathology of a tone of veins. Definition of venous pressure can serve as early trouble-shooting test of revealing of insufficiency of blood circulation at patients with a pneumosclerosis in preclinical the period.

The applied complex of functional methods of research hemodynamic a small circle (it is especial kinetocardiography and reography lung) allows to estimate the basic parameters of blood circulation in an early stage of a pulmonary-cardiac pathology, rationally and in due time to solve questions of therapy and employment of patients berylliosis and a plutonium pneumosclerosis, and also persons with suspicion on a pneumosclerosis.
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Fig. 1. Reogram lung patient Д., 50 years. Berylliosis II stage. Hypervolume type of a curve.

Fig. 2. Reogram lung patient М., 55 years. Berylliosis II stage. Hypertonic type of a curve.
Fig. 3. Reograme lung patient Д., 48 years. Berylliosis III stage. The curve of hypertonic type has the two-humped kind formed highly located katacrotic by a knee (Б) and a huge venous wave (В), the amplitude систолической waves (А) is considerably reduced. (RJ-1,8).