ENGLISH VERSION: ASSOCIATION BETWEEN RESPIRATORY DYSFUNCTION AND ATMOSPHERE POLLUTION IN CHRONIC RHEUMATIC HEART DISEASE*

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The prevalence of chronic rheumatic heart disease (CRHD) depends on ecology of environment. The aim of our research is to estimate clinic pathologic roles of aeropollutants in case of respiratory dysfunction of such patients. Material and methods. There were 474 patients with CRHD under observation (33% men and 67% women) at the age from 16 to 66 years old. We estimated the impact of discharge to the atmosphere of xenobiotics, the concentration of ammonia in the air, benzpyrene, dioxides C, N, S, oxide C, hydrogen sulphide and phenol, and also the integral atmosphere pollution with pollutants (IQA) on the parameters of ventilation, moisture separating, diffusion, and surfactant producing lung function. Results. Patients with CRHD living in the cities breathe in the air with benzpyrene concentration which is 3.6 times higher than in the country side. The concentration of dioxides C, N, S, is 2.3, 2.1 and 2.0 times higher respectively. The concentration of hydrogen sulphide is higher by 83%, oxide C by 59% and phenol by 50%. IQA defines the integral parameters of breathing capacity, bronchial permeability and surfactant functions of lungs in accordance with the assessment of physicochemical characteristics of condensate of expiratory air. The condition of alveolar-capillary membrane is defined by the content of ammonia in the atmosphere, dioxide C and phenol, and expiratory moisture separating depends on the level of benzpyrene and hydrogen sulphide. The content of dioxide C and IQA are the prognostic indicators in relation with respiratory abnormalities. Conclusion: atmosphere pollution of patients' living zones with xenobiotics affects the respiratory dysfunction in case of CRHD.

Key words: rheumatism, heart, defects, lungs, atmosphere.

Introduction

Chronic rheumatic heart disease (CRHD), like any other cardiac pathology, is accompanied by certain changes of the respiratory system [1, 12]. Close relationship of the respiratory and circulatory organs leads to mutual reinforcement of hypoxemia process in the pathogenic constructions and intrapulmonary hemodynamic changes [2, 7]. Respiratory dysfunction by CRHD is of great importance in genesis of cardiac arrhythmias [5].

The number of patients with CRHD becomes more dependent on environmental factors [6]. Atmospheric gas pollution and dust pollutants pollution significantly increase prevalence of the disease [4, 8, 10]. While many issues remain poorly studied, it was found that the number of patients with CRHD is much higher in urban areas than in rural areas [9, 11], and an unfavorable environment of respiratory air causes enhancement of pulmonary hypertension in patients with heart disease [3].

The aim of the work was to evaluate the clinical and pathogenic role of air pollutants by respiratory dysfunction in patients with CRHD.

Material and methods

474 patients with CRHD aged from 16 to 66 (average 38.9 ± 0.42 years) were examined. Among these patients were 155 (33%) men and 319 (67%) women. Every second observed patient had acute rheumatic fever in the childhood. The duration of identified heart disease averaged at 17.2 ± 0.52 years. Mitral insufficiency (MI) is diagnosed in 99% of patients, mitral stenosis (MS) – in 52%, aortic regurgitation (AR) – in 70%, aortic stenosis (AS) – in 17%, tricuspid insufficiency (TI) – in 12%. The average number of organic heart defects per patient was 2.5 ± 0.04. Frequency of combinations of certain heart diseases was as follows: isolated AR AR + TI and MI + TI occurred in 1% of cases, MI + AR + AS + TI and MI + MS + TI - 2%, AR + TI + MI - in 3%, MI + MS + AR + TI - 5%, MI + AR + AS - 13%, isolated MI and MI + MS - 14%, MI + AR - 16%, MI + MS + AR - 24%. At the previous stages, surgical correction of heart defects was performed for 42% of the number of patients with CRHD, including mitral valve prosthesis – in 20% of cases, aortic – in 23%, mitral commissurotomy – in 57%. The 1st functional class of heart failure (FCHF) was found in 21% of cases CRHD, 2nd - in 37%, the third – in 31%.

The patients underwent electrocardiography (devices "MIDAK-EK1T", Ukraine; "Bioset-8000", Germany), echocardiography ("Acuson-Aspen-Siemens", Germany; "Envisor C-Philips", the Netherlands; "HD-11-XE-Philips", the Netherlands;"SSA-270A-Toshiba", Japan), and Holter monitoring ("Kardiotekhnika-04-08", Russia), spirography ("Master-Scope-Jaeger", Germany), bodypneumography ("Master-Screen-Body-Jaeger", Germany). Condensation of moisture in exhaled air was collected within 20 minutes in the morning using glass receivers immersed in melting ice. The surface tension (ST), relaxation (SR) and viscoelasticity (VE) expirates have been evaluated using computer tensiorheometer "ADSA-Toronto" (Germany-Canada). In general, the rate of respiratory moisture production (RMP), systolic and diastolic blood pressure (SP, DP) in pulmonary artery, the ratio of SP to the mean systemic arterial pressure (MP/AP), pulmonary vascular resistance (PR) and its correlation with peripheral vascular resistance (PR/ PR), the cavity size of the right ventricle (CRV), anterior wall size in diastole (AWD) and end-diastolic diameter (EDD), inspiratory reserve (IR) and exhalation reserve (ER), lung capacity (LC), forced expiratory volume (FEV), diffusing lung capacity (DLC) were measured. As a control, we examined 25 practically healthy persons (9 men and 16 women at the age from 17 to 60 years). Any changes of respiratory parameters were found in all patients, surfactantgenous lung function disorder – in 96% of them, moisture production function – in 88%, ventilating function – in 75%, diffusion – in 38%. Integral severity of respiratory dysfunction (IWL) was calculated by the formula: $IWL = (\Sigma N : n) \times 10$, where ΣN – number of changed signs by a patient, n - total number of the studied signs.

Hygienic estimation of anthropogenic air pollution was carried out on the basis of determination of xenobiotics in

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34 regions of Donetsk region before temporary occupation of the territory. Before military activities, data were obtained as a result of laboratory tests of sanitary stations, regional offices of the State Committee on, Hydrometeorology, Environmental Control and Environmental Safety. We estimated air emissions level in atmosphere and accumulation of industrial waste in it per year based on a person and territory square, concentrations of ammonia, 3,4-benzopyrene, dioxides C, N, and S, oxides, hydrogen sulfide and phenol, their maximum allowed concentrations as well as an integral index of unfavorable environmental impact by pollutants on the atmosphere (IQA).

The statistical analysis of obtained research results was carried out by computer variational, non-parametric, correlation, regression, one-way (ANOVA) and multiway (ANOVA/MANOVA) analysis of variance (the program "Microsoft Excel" and "Statistica-Stat-Soft", USA). We evaluated average values (M), their standard errors, standard deviations (SD), correlation coefficients (r), criteria of dispersion (D), multiple regression, Student, Wilcoxon Rao and reliability of statistics ratios (p).

Results and Discussion

The pollutants emissions level into atmosphere of patients residence cities was by 10.5 times higher than in rural areas, and waste accumulation of industry, transport, energy and agroindustrial complex – by 9.7 times. Only ammonia content in the air inhaled by patients with CRHD in cities and villages differed a little, while benzopyrene concentration in atmosphere of cities was by 3.6 times as much, dioxide C by 2.3 times, carbon dioxide N by 2.1 times, dioxide S by 2.0 times, hydrogen sulfide – by 83%, oxides C by 59%, phenol by 50%.

Parameter changes (> M + SD healthy) PR were found in 100% of patients with CRHD, SP in 90%, CRV in 81%, DP in 49%, EDD in 14%, VE and AWD in 2% based on reduction of indicators SR in 99%, RMP in 90%, IR in 87%, ST in 87%, ER in 80%, FEV in 42%, LC in 34%, DLC in 26% of patients. According to the multivariate analysis of variance Wilcoxon-Rao, the integral state of respiratory functions by CRHD is significantly influenced by patients' place of residence (city, village), IQA values, concentrations of ammonia, benzopyrene, carbon dioxide, C, N, S and hydrogen sulfide in atmospheric, as evidenced by ANOVA/MANOVA.

Urban and rural regions of patients' residence have dispersion effect on IR, DLC, RMP, ST, SR and VE. We can see from the Table 1 that IQA level affects the parameters of PR, EDD, ST and SR, and with IQA values there are direct correlations of the parameters of MP, DLC and AWD, invert with LC and ST. Taking into account performance of variance and correlation analysis, it was found that IQA level > 2 o.e. (> M + SD regions of residence of patients) is a negative forecast in regard to increasing size of the right ventricle and surfactantgenous lung function disorders by CRHD.

Table 1.
Relationship of parameters of respiratory function with IQA parameters by CRHD

Respiratory indices	Relationship character			
	IQA impact		Correlation with IQA	
	D	p D	r	p r
SP	0.98	0.516	+0.228	<0.001
DP	1.31	0.216	+0.020	0.741
PR	1.64	<0.001	+0.004	0.954
CRV	0.77	0.570	+0.003	0.956
EDD	2.10	0.005	+0.166	0.007
AWD	1.34	0.148	+0.188	0.002
IR	2.01	0.111	-0.093	0.113
ER	0.08	0.774	-0.059	0.340
LC	1.40	0.243	-0.165	0.008
FEV	0.75	0.558	-0.059	0.340
DLC	0.36	0.996	+0.060	0.325
RMP	1.21	0.262	-0.095	0.121
ST	2.12	0.001	-0.223	<0.001
SR	2.86	<0.001	-0.019	0.764
VE	1.61	0.053	-0.064	0.297

IWL values are significantly affected by the IQA parameters, emissions level of xenobiotics into atmosphere and accumulation degree of industrial, energy, transport and agriculture waste in air. It should be noted that with emissions value of xenobiotics significant direct correlative relationship takes place.

The condition of respiratory dysfunction by CRHD is closely related to the concentration of dioxide C, oxide and hydrogen sulfide in the atmosphere and there is a direct relation with content of dioxide C (Table. 2). In our opinion, dioxide C indicators in air more than 6 mg/m3 (> M + SD regions of residence of patients) are forecast negative criteria as to severity of respiratory disorders by patients CRHD.

Table 2.
Relationship of the parameter IWL with concentrations of certain xenobiotics in the atmosphere

Xenobiotics	Relationship character			
	Impact on IWL		Correlation with IWL	
	D	p D	r	p r
Ammonia	0.63	0.677	+0.010	0.831
Benzpyrene	1.61	0.155	+0.023	+0.624
Dioxide C	4.22	0.001	+0.127	0.006
Dioxide N	2.20	0.053	+0.022	0.635
Dioxide S	1.56	0.172	+0.031	0.498
Oxide C	2.74	0.019	+0.046	0.313
Hydrogen sulfide	2.33	0.042	+0.036	0.430
Phenol	0.55	0.740	+0.015	0.741

Multiple regression analysis showed a significant negative relation with IQA changes of respiratory capacity and patency of bronchi, RMP and surfactantgenous lung function, but not with integral hemodynamic parameters of pulmonary circulation and DLC. In cases of violation the condition of alveolar capillary membrane these patients lived in regions with significantly elevated levels of ammonia in the atmosphere by 38%, carbon dioxide C by 32%, phenol by 13%, and patients with a change of moisture production lived in areas with increased concentrations of benzopyrene by 21 % and hydrogen sulfide by 23%.

Summary:

1. The patients with CRHD living in cities breathe air with concentrations of benzopyrene exceeding those in rural areas by 3.6 times, dioxide C, N and S by 2.3, 2.1 and 2.0 times respectively, hydrogen sulfide by 83% and oxide C by 59%, phenol by 50%.

2. Air pollution through xenobiotics of residence areas of patients influences respiratory dysfunction by CRHD.

3. IQA defines integral parameters of respiratory capacity, patency of bronchi, surfactantgenous lung function according the evaluation of physical and chemical properties of an exhaled air condensate, the state of alveolar-capillary membrane is determined by the content of ammonia, carbon dioxide C and phenol in the atmosphere, and expiratory moisture production depends on the level of hydrogen sulfide and benzopyrene.

4. IQA level is a predictor in relation to increased size of the right heart ventricle and surfactantgenous lung function disorder, dioxide C in atmosphere – in relation to severity of respiratory disorders in patients with CRHD.

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