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Multivariate Analysis of Echocardiographic Pattern of Treatment of Viral and Bacterial Pneumonia

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Abstract

A multivariate analysis of indicators in five-, nine-, and three-dimensional phase space of parameters of echocardiographic pattern of treatment in patients from primary and control group with viral and bacterial pneumonia during treatment was conducted. In patients with viral and bacterial pneumonia, primary ($n = 20$) and control ($n = 20$) groups severe course of the disease accompanied with the first, the second day of the formation of acute respiratory distress syndrome, subtotal lobar pneumonia, expressed intoxication syndrome, toxic nephritis, hepatitis, encephalopathy, and other complications. The most pronounced therapeutic effect was registered in patients receiving optimal treatment program (including inhalation with surfactant, dornase, mechanical ventilation for sparing technique, high doses of corticosteroids). During treatment options of echocardiographic pattern, quasi-attractors (rX , Vx) decreased to a greater extent in patients of the main group, indicating the stabilization of the functional state of an organism.

Keywords

Multivariate analysis; Total asymmetry volume – rX ; Total volume – Vx ; Viral and bacterial pneumonia; Acute respiratory distress syndrome; Surfactant; Mechanical ventilation for sparing technique

Introduction

Despite the considerable progress in diagnosis and treatment of pneumonia, mortality in this disease is increasing [1]. Relative mortality rate of viral-bacterial pneumonia during the epidemic of influenza A H1N1 (2010-2011) is particularly high, due to the complications such as acute respiratory distress syndrome (ARDS), multiple organ failure on a background of heavy flow pneumonia [2].

At the same time, in spite of that the mortality in ARDS remains high, methods of intensive care for this complication in patients with pneumonia heavy flow are under development. All modern methods of treatment of patients with ARDS are the only elements of maintenance therapy [3-5].

Materials and Methods

Under the supervision patients were from the main group ($n = 20$) and control group ($n = 20$) aged 18-58 yrs with viral and bacterial heavy flow pneumonia (total on the one side and on the other segmental were observed, respectively, at 5 and 6 patients); subtotal on the one side and on the other segmental in 6 and 6 patients; lobar duplex at 9 and 9 patients. Among 12 patients of the main group and 15 from control group (23.9%) had ARDS. Pneumonia (pneumococcal, respectively, in 5 and 4 patients, and due to *Staphylococcus aureus*, respectively, in 14 and 16 patients with ARDS) were found on the 1-3 days hospitalization (timely). All patients had (with identification of the antigen) ribonucleic acid (RNA) in nazofaringial swabs or aspirates by polymerase chain reaction (PCR). All patients subsequently underwent thorough clinical, biochemical, immunological, instrumental examination (including multislice computed tomography).

From the first days of the disease, all patients received various combinations of antibiotics (ceftriaxone, linezolid, tigecycline, meropenem), the main group of patients received antiviral drugs – imidazoliletanamid pentandiov acid (Ingavirin) (90 mg – 1 times per day) or oseltamivir (Tamiflu) (75 mg twice a day – 2); patients in the

control group – umifenovir (arbidol). In addition, patients received conventional intensive care, including mechanical ventilation (MV) in the power saving mode (S.N. Avdeev, 2007). In contrast to control groups patients from the main group received the inhalation with surfactant emulsion 12 ml per kg, dornase alfa (25 mg, 2 times a day), almitrin (scheme). In this, patients from the main group received prednisolone in a higher dose for 3 days (15 mg/kg) and also (alpha – tocopherol and ascorbic acid).

In scientific work, along with a physical examination, the following methods were used:

X-ray: digital fluoroscopy, digital radiography, multislice computed tomography. Ultrasound examinations of intracardiac hemodynamics.

The following indicators were calculated: end-systolic left ventricular size (ESS LV); end-diastolic dimension of the left ventricle (EDS CRA); the diameter of the right ventricle (DRV); the thickness of the anterior wall of the right ventricle (TAWRV); the size of the left atrium (LA RP); the thickness of the posterior wall of the left ventricle (TZSLZH); interventricular septum thickness (IVST, seen), stroke volume of the left ventricle (SVLV, ml); LV ejection fraction (LVEF%); ejection fraction of the right ventricle (FIRV%).

The dynamics of echocardiography were studied.

Systematization of the material and presented results of calculations were performed using spreadsheet software Microsoft EXCEL, statistical calculations were performed using the package Microsoft Statistica for Windows 2000, "Biostat". The significance of differences was assessed

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using a paired Student *t*-test with parametric data distribution. Analysis of correlation relationships between variables was performed in parametric data distribution method of linear Pearson correlation analysis. For the assessment the dynamics of parameters on the background of the treatment paired Wilcoxon method analysis were used.

In this study, new approaches chaos theory and synergetics (TCS) were also used, which are based on the analysis of the parameters of attractors VSOCH changing under the influence of ecofactors. Last (VSOCH) is based on a comparison of the parameters of the various clusters representing biological dynamic systems. These methods are relied on the identification of attractors VSOCH in phase volume for one cluster and for another. For more information about the method TCS, see works of Eskova and Burykina [6-9]. Processing of data on the behavior of attractors VSOCH in *m*-dimensional space for the patients of viral and bacterial pneumonia was made using the author's program Eskova: "Identification of the parameters of the state vector attractors behavior of biological systems in the *m*-dimensional phase space".

Coordinates VSOCH before and after the treatment of viral bacterial pneumonia with severe course of ARDS were calculated. All these parameters were calculated by computer, all intervals are determined by changes XI 5th or 4th coordinates, RX indicators asymmetry in each coordinate, and all in general, as well as the total volume (V), parallelepiped (General V VALUE), limiting attractor and calculated. Tables representing XI and asymmetry parameters for each coordinate X and volume of the parallelepiped were found. We studied the effect of the symptoms on the value of the distance Z between the centers of attractors.

Results and Discussion

The studies found that since the early days of the disease, there was a decrease in oxygenation (ratio of PaO₂/FiO₂ less than 200 mm Hg) so on the 1-2 days of illness patients had the prevalence of pneumonia and ARDS.

Symptoms: headache, pharyngitis, rhinitis, tracheitis, conjunctivitis in the main group were cropped to 1.5-3 days earlier than in those from the control group. It was found that in patients of the main group normalization of body temperature were observed at 5 days, the arterial blood oxygen saturation – 6 days, respiratory rate – 6 days, heart rate – on 5 days, the systolic blood pressure – by days 5, in blood leukocyte – 14 days, stab – 10 days, the lymphocytes – 14 days, CRP – 11 days, fibrinogen – on 6 days, erythrocyte sedimentation rate (ESR) – 30 days, whereas the patients from the control group normalization of these parameters were observed at: 18, 8, 11, 9, 9, 18, 15, 17, 15, 10, 50 days, i.e., significantly in the later periods. However, complicated cumulative index (in points) in patients of the main group in the initial state (2-3 days after disease), after 12 days, after 6 weeks was: 55.0, 9.1, 4.3; whereas in the patients from the control group, it was significantly greater, respectively: 72.2; 48.0; 20.4. It should be noted that the disappearance of infiltrative changes in the lungs of patients from the main group was after 18-49 days of treatment, while in the patients from the control group – after 36-68 days of comprehensive treatment.

The study found that in the initial state in individuals from the first and second group parameters of end-diastolic left ventricular size (were, respectively: 5.08 ± 0.04 and 5.1 ± 0.036) did not differ from

those in healthy and end-diastolic size of the right ventricle (4.16 ± 0.05 and 4.23 ± 0.05) were significantly greater ($p < 0.001$) than in healthy.

Parameters of the systolic pulmonary artery pressure (in mm Hg) significantly (52.4 ± 1.7 and 50.1 ± 1.8) exceeded those (23.1 ± 0.5) are healthy. Symptoms of right heart overload accompanied by a significant increase (as individual from main and the control group) of indicators of the anterior wall thickness of the right ventricle (in cm), respectively, to (0.61 ± 0.04 to 0.49 ± 0.042).

Along with it, in the initial state, a decrease of right ventricular ejection fraction (%) was found, respectively, to (47.7 ± 1.5 and 46.8 ± 1.6 and left ventricular ejection fraction (respectively up to 47.4 ± 1.3 and 50.8 ± 2.1).

In this case, the right ventricular diastolic function (according to E/BPH) was (0.76 ± 0.35) and left E/LVA ventricle was (0.74 ± 0.03), lower ($p < 0.001$).

During treatment, the systolic function of the left and right ventricles (according to the end-diastolic left-ventricular size (KDRLZH), right ventricle (KDRPZH), left ventricular ejection fraction (LVEF), right ventricular ejection phase (FIPZH), index thicker anterior wall of the right ventricle (ITPPZH), systolic pulmonary artery pressure (MPAP), as well as diastolic function (E/LVA; E/BPH) in patients from the first group returned to normal, and in patients from the control group was carrying a tendency to normalization.

In multivariate analysis in eight-dimensional phase space echocardiographic parameters in patients from the main group during the treatment parameters of quasi-attractors much greater extent than in those in the control group decreased: asymmetry index decreased from 7.2346 rX to 2.2727 at 27.9 times, and the total volume Vx decreased from 9753.7440 to 16.2402 in 600 times that indicated the expression of the efficiency of treatment, stabilization of the FSO, the restoration of compensatory abilities excreted primarily in patients of the main group, in contrast to those in the control group of patients.

Thus, an improved method of treating patients with severe viral and bacterial pneumonia with ARDS includes inhalation of surfactant, gentle ventilation, and provides the most pronounced positive effect, which was reflected in a significant decrease in patients of the main group of asymmetry index rX, characterizing the measure of chaotic of the system, a significant reduction Vx (total volume, indicating that the expression of the efficiency of the method proposed of the intensive care, while stochastic statistics methods indicated a significant improvement in characterizing the diastolic and systolic function of the heart.

It should be noted that bioinformatic analysis of echocardiographic parameters better reflects the qualitative changes of the cardiovascular system during treatment.

Conclusion

The most pronounced positive effect was observed in the main group.

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