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MODERN APPROACHES TO COMPLETE PHYSICAL EXAMINATION AND TREATMENT OF PATIENTS WITH POSTOPERATIVE VENTRAL HERNIAS

Timeliness of the postoperative ventral hernia (PVH) issue is determined by both prevalence of this disease and poor results of surgical treatment. According to the data of Ukrainian and foreign literature 6-35% of patients have PVHs after laparotomy performed on the subject of various abdominal diseases (2). Mortality at operations on large and giant PVHs reaches 12-21% (4).

Nowadays PVH issue is considered as a complicated pluricausal condition characterized by local abdominal wall defect and determined by severe disorders concerning functions of many internal organs (4).

Patients with PVHs mainly get surgical interventions of two types: reparative that deals with complete adaptation of musculo-aponeurotic structures of abdominal wall to abdominal functional recovery; corrective that deals with preservation of fixed diastasis in musculo-aponeurotic layers. The patient’s recovery and quality of his or her life also depends on the surgeon’s choice of the most rational plastics type.

Under the conditions of modern surgery the extent of preoperative examination of the patients with PVHs, including physical examination of the patient, X-ray contrast testing of gastrointestinal tract and ultrasound scan, has certain disadvantages. Subjectivity, absence of concrete markers that are subject to further analysis, poor anatomico-functional state visualization of abdominal wall lead to data distortion in course of information communication from diagnostic part to the surgeon.

Object

of this research is the diagnostic quality improvement and the results of surgical treatment of PVHs by designing algorithm of the complex study of patients at preoperative stage.

Materials and techniques.

Treatment results of 135 patients who were operated at the Surgery of Kharkov Municipal Clinical Hospital №17 during 2008-2012 were studied.

All examined patients were divided into two groups.  
The main group consists of 85 patients operated on the subject of medial hernias. The patients’ age varied from 20 to 75 years. There were 50 women (58.8%) and...
Table 1 The content of pollutants in the air of Dnepropetrovsk (2006-2010 years)

<table>
<thead>
<tr>
<th>Metals</th>
<th>Indicators the average daily concentration</th>
<th>share of MPC</th>
<th>% of samples exceeding the MPC</th>
<th>the maximum single concentration</th>
<th>share of MPC</th>
<th>% of samples exceeding the MPC</th>
</tr>
</thead>
<tbody>
<tr>
<td>dust</td>
<td>0.25±0.003</td>
<td>1.7</td>
<td>98.3</td>
<td>2.0</td>
<td>4.0</td>
<td>90.0</td>
</tr>
<tr>
<td>SO₂</td>
<td>0.0059±0.0006</td>
<td>0.12</td>
<td>0</td>
<td>0.55</td>
<td>1.1</td>
<td>1.7</td>
</tr>
<tr>
<td>CO</td>
<td>2.24±0.018</td>
<td>0.75</td>
<td>33</td>
<td>30.0</td>
<td>6.0</td>
<td>91.7</td>
</tr>
<tr>
<td>NO₂</td>
<td>0.08±0.001</td>
<td>2.0</td>
<td>100</td>
<td>0.17</td>
<td>2.0</td>
<td>91.7</td>
</tr>
<tr>
<td>H₂S</td>
<td>0.0026±0.00007</td>
<td>0.33</td>
<td>33</td>
<td>0.082</td>
<td>10.3</td>
<td>100</td>
</tr>
<tr>
<td>phenol</td>
<td>0.0027±0.00004</td>
<td>0.9</td>
<td>23.3</td>
<td>0.034</td>
<td>3.4</td>
<td>75.0</td>
</tr>
<tr>
<td>NH₃</td>
<td>0.039±0.0004</td>
<td>0.98</td>
<td>25.0</td>
<td>0.34</td>
<td>1.7</td>
<td>11.7</td>
</tr>
<tr>
<td>formaldehyde</td>
<td>0.009±0.00002</td>
<td>3.0</td>
<td>93.3</td>
<td>0.098</td>
<td>2.8</td>
<td>28.3</td>
</tr>
<tr>
<td>benzopyrene</td>
<td>1.3±0.18</td>
<td>1.3</td>
<td>55.0</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Comparison of data regarding the number of samples exceeding the MPC by basic and specific pollutants revealed an interesting feature about the content of carbon monoxide and hydrogen sulfide in the air. The average annual daily concentration of these pollutants meet hygiene requirements, while their maximum single concentration almost in all investigated samples exceeds MPC. This fact perhaps testifies to the shortcomings of regulation of their content in the air and requires revision of existing standards for the harmonization of existing standards of the average daily and the maximum single concentration.

Summary results of studies of heavy metals content in the air of residential zone over the period of 2006-2010, are presented in Table 2. These results indicate that the superficial layer of residential area of Dnepropetrovsk is determined by such metals as lead, cadmium, iron, manganese, copper, nickel, chromium and zinc. Their concentrations over the period of observation from 0.005 mcg/m³ for chromium, to 0.087 mcg/m³ for copper and on average do not exceed the respective MPC. However, content of most heavy metals with the exception of manganese and chromium in the air of Dnepropetrovsk is 2.4-30.0 times higher than background levels for uncontaminated areas confirming their technogenic origin [12].

Table 2 Average annual concentration of heavy metals in the air of Dnepropetrovsk (2006-2010 years), M±m

<table>
<thead>
<tr>
<th>Metals</th>
<th>actual content</th>
<th>background concentrations</th>
<th>MPC, Russia**</th>
<th>MPC, WHO**</th>
</tr>
</thead>
<tbody>
<tr>
<td>lead</td>
<td>0.028±0.0037</td>
<td>0.3</td>
<td>0.008-0.05</td>
<td>0.3</td>
</tr>
<tr>
<td>cadmium</td>
<td>0.006±0.0013</td>
<td>0.3</td>
<td>0.0002</td>
<td>0.2</td>
</tr>
<tr>
<td>manganese</td>
<td>0.053±0.007</td>
<td>1.0</td>
<td>0.013</td>
<td>1.0</td>
</tr>
<tr>
<td>chromium</td>
<td>0.005±0.0012</td>
<td>1.5</td>
<td>0.006</td>
<td>1.0</td>
</tr>
<tr>
<td>nickel</td>
<td>0.012±0.0036</td>
<td>1.0</td>
<td>0.005</td>
<td>0.2</td>
</tr>
<tr>
<td>copper</td>
<td>0.094±0.018</td>
<td>2.0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>zinc</td>
<td>0.073±0.013</td>
<td>50.0</td>
<td>0.023</td>
<td>-</td>
</tr>
<tr>
<td>iron</td>
<td>0.072±0.012</td>
<td>4.0</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>


In anamnesis 15 patients (17.6%) were observed to have hernias less than three years; 35 patients (41.2%) had from three-year to ten-year hernias and 35 (41.2%) – more than ten-year hernias.

Most repeated causes for herniation were operations on the subject of gallstone disease – 25 cases (29.4%), and gynaecologic operations – 20 cases (23.5%). 10 patients’ (11.8%) hernias appeared after operations on the subject of umbilical hernia; 10 (11.8%) – after relaparotomy on the subject of peritonitis; 10 (11.8%) – after operations on the subject of adhesives obstruction, and 10 more (11.8%) – after surgical interventions on the subject of large intestine oncopathology.

On the basis of hernial orifice size PVHs were divided into small – from 5 to 10 cm, large – from 10 to 15 cm, and giant – more than 15 cm. 10 patients (11.8%) had small hernias, 26 patients (30.5%) had medial hernias, 36 patients (42.4%) had large hernias and 13 patients (15.3%) had giant hernias.

Control set consisted of 50 patients with different pathology of abdominal cavity organs who didn’t go through laparotomy. They were to be operated on the subject of the major disease. The patients’ age varied from 21 to 75 years. 18 patients (36%) were younger than 50, 32 patients (64%) were from 51 to 75 years old. There were 35 women (70%) and 15 men (30%).

The main pathologies on the subject of which the operation was based were the following: gallstone disease and its complications of 16 patients (32%); stomach and duodenium diseases of 7 patients (14%); liver diseases of 10 patients (20%); pancreas diseases of 5 patients (10%) and intestines diseases of 12 patients (24%).

Main and control sets were matched on the basis of sex, age, severity of pathologic process and other clinical parameters.

Preoperational checkup consisted of objective patient examination techniques, laboratory tests, monitoring of cardiovascular system, spirometry and X-ray research.

During preoperative period 50 patients of the control set and 85 patients with PVHs went through ultrasound scan on Philips HD II apparatus with the help of linear, surface and sector probes with scan rate 3.5 – 7.5 mHz. Duplex scanning programs, color flow imaging of abdominal rectus muscle and energy mapping were used.

Study of Doppler topography aa. epigastri ca superior et inferior was performed in abdominal rectus muscle to determine the view of vascular arrangement, paths of vessels, and preventive care to avoid vascular injuries during plastics. View of vascular arrangement was marked on the skin and taken into consideration when performing the operation.
To evaluate the index of peripheral resistance, the resistibility index (RI) and linear blood flow rate (LBFR) were determined.

The anterior abdominal wall and abdominal cavity organs state was examined to detect comorbidity. The following parameters of the hernia were studied: localization, size of hernial sac and its content, size of hernial orifices and their quantity, and also degenerative changes of abdominal wall musculo-aponeurotic structures.

Computer tomography was performed on Toshiba Acvium 16 multispiral apparatus. The area of examination was limited to cupula of diaphragm and bones of pube symphysis. Parameters of the examination are the following: interval between slices – 8 mm, section thickness – 10 mm.

In the control set of patients elements of abdominal wall were examined to detect age degenerative changes and abdominal cavity organs – on the subject of the major disease and revealing corresponding pathology.

Study concerning the abdominal wall state of patients with postoperative ventral hernias (PVHs) was conducted, it covered atrophy, adipose degeneration, and cicatricial deformity of the elements of musculo-aponeurotic layers; the following parameters of hernias were examined: localization, size of hernial sac and its content, size of hernial orifices and their size. Besides, state of abdominal cavity organs, retroperitoneal space and small pelvis were studied to reveal comorbidity.

Received data were analyzed with the help of the package of statistical analysis Statistica 6.1.

**Results and discussion.** In course of abdominal wall ultrasound scan 50 patients were diagnosed with expansion of subcutaneous fat with different degree of manifestation: in 15 cases (30%) its state was normal (not bigger than 2 cm), in 13 cases (26%) – moderate (from 2 to 4 cm) and in 22 cases (44%) – expressed (more than 4 cm). In course of palpation no defects in musculo-aponeurotic layer were found.

Ultrasound scan data showed that as the patients’ age level grows degenerative changes affect those who didn’t experience surgical interventions on abdominal wall at 50 and later that was observed in 30 cases (60%). 15 patients at the age starting from 60 were diagnosed with adipose degeneration (30%). 17 patients (34%) younger than 50 didn’t experience any changes in abdominal rectus muscle.

Normal muscular tissue looked hypoechogenic with well-defined hyperechogenic «starry sky» type in the transverse plane of the scanning representing connective in layers of perimysium. Thickness of rectus muscles was not less than 10 mm.

Ultrasound scan showed that atrophic changes were expressed in volume depletion of muscular tissue, thinning of muscles under examination for less than 10 mm. No expressed changes of muscular tissue of the patients belonging to the control set were revealed.

Ultrasound scan data are consistent with CT data. Degenerative changes of abdominal wall were not revealed in cases of patients under 50. Women have degenerative changes after 50, and men – after 60.

Based on the results of previous studies [1, 8, 11] it was found that in the city of Dnepropetrovsk there was formed a complicated industrial complex, which in conditions of irrational infrastructure and growing powerful urbanization of the city forms a high level of pollution. It should be emphasized that diffuse location in the city of residential zone of industrial facilities, irrational location of the motorway network and complicated relief within the sanitary protection zones create unfavorable conditions for dispersion of atmospheric contaminants and as a consequence – the formation of high levels of contamination of superficial atmospheric layer.

The most active pollutants of the city atmosphere are the industrial enterprises of metallurgy, metalworking, chemical industry. Their total number is more than 200, they have 7.5 thousand stationary sources of air emissions, of them 6600 sources (89%) – organized. Motor transport makes a significant contribution into the total air pollution in cities – 40% of all emissions [11, 12].

The foregoing creates an extremely complicated ecological situation in the city, being confirmed by the results of the research. Thus in general for five years follow-up (Table 1) the average daily values of formaldehyde, nitrogen dioxide, dust and benzopyrene in the air were 0.009±0.00002 mg/m³, 0.08±0.001 mg/m³, 0.25±0.003 mg/m³ and 1.1±0.18•10⁶ mg/m³ respectively, exceeding the existing hygiene standards by 3.0, 2.0, 1.7 and 1.1 times; this puts the above-mentioned substances into the rank of major air pollutants in Dnepropetrovsk. At the same time the excess of the MPC for these pollutants was observed in 55.5-100% of the samples, which characterizes the level of air pollution by this indicator as very dangerous and unacceptable. The content of ammonia in an average over 5 years of observation, was 0.039±0.0004 mg/m³, which practically corresponds to the standard value. Nevertheless in 25% of samples ammonia content exceeded hygienic standards, which also characterized the state of air pollution by this compound as very dangerous. The remaining pollutants were determined at concentrations within 0.12-0.9 MPC, although excess hygienic standards was observed in 3.3-23.3% of samples. Only the content of sulfur dioxide and hydrogen sulfide in all studied samples did not exceed the established MPC.

Regarding the maximum single concentrations, their values for all studied pollutants constituted 0.03-10.3 MPC. The highest ratio of MPC exceeding for hydrogen sulfide – 0.082 mg/m³ (10.3 MPC), carbon monoxide – 30.0 mg/m³ (6.0 MPC), dust – 2.0 mg/m³ (4.0 MPC), phenol – 0.034 mg/m³ (3.4 MPC); this correlates with relevant percentage of the most significant non-standard samples – 75-100% and characterizes the degree of air pollution with pollutants as unacceptable and very dangerous. At the same time, despite the fact that the multiplicity of maximum permissible concentration of nitrogen dioxide occupies 5 rank place, the excess of hygienic standards was observed in 91.7% of samples. Only the content of sulfur dioxide practically corresponded to hygienical requirements over the whole period of observation.
Unfortunately, despite the active implementation of air rehabilitation programs, a number of environmental protection measures that contribute to reducing harmful emissions, economic issues, disconnected work of various departments, absence of state strategy of information and analytical providing of management decisions led to the deterioration of chemical monitoring component [2, 4]. In such conditions, only improving quantitative defining of substances in the air, calculation of their average daily and annual concentrations, creating of a single network of information exchange about pollution and the exposed population, definition of risk to public health will allow to improve ecological and hygienic monitoring of air quality as an important part of a complex of preventive measures to preserve population’s health [5, 6, 7, 8, 9].

II. Formulation of the problem.

The aim of research – complex ecological and hygienic evaluation of atmospheric air quality of Dnepropetrovsk – one of the most developed industrial city in Ukraine.

Materials and methods. Hygienic analysis of content of basic contaminants (dust, sulfur dioxide, nitrogen dioxide, carbon monoxide) and specific contaminants (hydrogen sulfide, phenol, ammonia, formaldehyde, benzoylpyrene, lead, cadmium, manganese, chromium, nickel, copper, zinc) by average daily and maximum single concentration in the air of residential zone of Dnepropetrovsk for the period of 2006-2010 years was done.

Evaluation of air pollution was carried out by values of actual pollutant content, ratio of exceeding the maximum permissible concentration (MPC), percentage of non-standard samples according to [10], and background levels for unpolluted areas.

In addition, the analysis of air pollution level by total air pollution index (API) was calculated by the formula [5, 10]:

\[
I = \sum_{i=1}^{n} \left( \frac{x_i}{MPL_i} \right) C_i, \quad (1)
\]

where \( I \) – index of air pollution by 5 priority pollutants, dimensionless value; \( x_i \) – average annual concentration of the corresponding substance; \( C_i \) – coefficient, which takes into account class of unsafety substance. Evaluation of results was conducted according to the existing classification [5].

Due to the simultaneous presence in the air of the following pollutants – sulfur dioxide, carbon monoxide, nitrogen dioxide and phenol, for which biological effect of summation is estimated [10], the coefficient of the combined action of these substances (C_{CA}) by the sum of their ratio MPC excess, which should not exceed 1, was calculated.

The results are processed by traditional methods of variation statistics using licenced statistical programs Statgraphics and Statistica 10.

Men aged 60-75 and women aged 50 and older were diagnosed with adipose degeneration of abdominal wall muscles. Altogether 30 patients (60%) aged 50 and older had muscle atrophy, and 15 patients (30%) older than 60 had adipose degeneration.

Normal muscular tissue that was registered in 9 cases (18%) in course of ultrasound scanning and in 24 cases (48%) in course of CT looked homogeneous with sharp and smooth contours and had total density of 50-60 HU and thickness not less than 10 mm.

Weak degree of degenerative changes of abdominal wall rectus muscles was revealed in 24 cases (48%) at ultrasound scan and in 21 cases (42%) at CT; it was expressed in thinning of rectus muscles in axial sections of less than 8-10 mm, with total density of 40-50 HU and had inhomogeneous structure at the cost of low-density single inclusions.

Moderately expressed degenerative changes of abdominal rectus muscles are characterized by thinning up to 6-8 mm, total density of 20-40 HU at the cost of intramuscular fat and a large amount of grumous saccules. As a rule, muscle contours are irregular and visible along the entire length. Similar changes were revealed in the control set in 16 cases (32%) at ultrasound scan and in 13 cases (26%) in CT.

Expressed changes that were registered in 2 cases (4%) at ultrasound scan and in 13 cases (26%) at CT were characterized by muscle thickness not less than 6 mm up to filamentary structure with thickness of 1-2 mm. Density of muscular tissue in the last category was diffusively reduced to less than 20 HU and was inhomogeneous due to a small amount of small areas of preserved muscular tissue. Muscular fiber contours of are irregular. This distinction in received data of ultrasound scan and CT is explained by limited sensation of ultrasound scan method. In this way the regularity concerning age level increase and degenerative changes aggravation of abdominal wall elements in cases of patients who didn’t go through laparotomy was revealed.

Topography Doppler ultrasound scan of epigastric vessels belonging to anterior abdominal wall did not show significant abnormalities.

According to our observations the diameter of epigastric vessels of abdominal rectus muscle did not vary regardless of the patients’ age. Average diameter a. epigastrica superior was 1.71 ± 0.11 mm; v. epigastrica superior 1.9 ± 0.21 mm; a. epigastrica inferior 2.6 ± 0.13 mm, v. epigastrica inferior 3.6 ± 0.21 mm.

Blood velocity in epigastric vessels of patients with expressed degenerative changes of abdominal rectus muscles is positively lower than those of patients without degenerative changes or with moderate ones (p < 0.05), i.e. there is a direct connection between the degree of atrophy of musculo-aponeurotic structures and blood velocity.

Average value of LBFR in epigastric arteries of abdominal rectus muscle of patients with normal muscular tissue was 10.3 m/s in systole and 3.2 m/s in diastole. Reduction of speed was registered in 13 cases (26%) of patients with expressed abdominal wall elements degenerative changes. Patients with obesity, diabetes mellitus and aged patients had more expressed Doppler abnormalities (7.9 m/s in systole and 2.6 m/s in diastole).
Average value of RI in arteries of patients who did not have degenerative changes or who had a minor degree of degenerative changes of abdominal rectus muscles was $0.62 \pm 0.016$ m/s. RI of patients who had expressed degenerative changes increased to more than $0.7$ m/s and reached $0.72 \pm 0.028$ m/s.

In this way, the degree of arterial blood flow depression directly depends on the degree of degenerative changes in musculo-aponeurotic structures of anterior abdominal wall.

Comparing degenerative changes in anterior abdominal wall musculo-aponeurotic layers of patients with hernias we revealed more expressed degenerative changes. It was discovered that changes expressiveness depends on size of a hernia and duration of having it. Patients who had hernias for less than 3 years had weak degrees of degenerative changes in 4 cases (8%), moderate – in 2 (4 %), and there were not registered any expressed changes.

Patients with disease duration from 3 to 10 years had weak degree of degenerative changes in 8 cases (16 %), moderate – in 4 (8%), and expressed – in 2 (4%).

The degenerative changes degree of patients who had hernias for more than 10 years reached 12%, 10% and 8% correspondingly.

It is necessary to observe that in the group of patients with small hernias degenerative changes were not registered, in the group of patients with medial hernias degenerative changes were revealed in 2 cases (4%).

Patients with large hernias had degenerative changes in 10 cases (20%) and with giant – in 7 (8.2%, that is 8.2% of the general group and 46.7% of the group with this pathology).

The bigger the hernia is the more expressed are degenerative changes.

Blood velocity in epigastric vessels of patients with large and giant PVHs is positively lower ($p < 0.05$). Values of LBFR of patients with large and giant PVHs changed to the deterioration of arterial blood flow – 6.4 m/s in systole and 2.1 m/s in diastole. Average value of RI in this category increased to more than 0.7 m/s, and reached $0.75 \pm 0.028$ m/s.

In this way, deterioration degree of arterial blood flow has a direct connection with duration of having a hernia, size of hernial sac and hernial orifices, i.e. with the degree of degenerative changes in anterior abdominal wall musculo-aponeurotic structures.

According to the data of clinical examination, 7 patients (8.2%) were assigned to the group of patients with small hernias. 21 (24.7%) – to the group of patients with medial hernias, 30 (35.3%) – to the group of patients with large hernias, 27 (31.7%) – to the group of patients with giant hernias.

Studying sizes of hernial orifices through ultrasound scan showed that in 47 cases (55.3%) hernial orifices were not bigger than 10 cm. According to the ultrasound scan data hernial orifices of 13 patients (15.3%) with large and giant PVHs were not bigger than 15 cm.

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**CONTAMINATION OF INDUSTRIAL CITY ATMOSPHERIC AIR AS AN ACTUAL ECOLOGICAL AND HYGIENIC PROBLEM**

**Abstract.** The article presents the results of a complex ecological and hygienic evaluation of atmospheric air quality of one of the most industrialized Ukrainian cities – Dnepropetrovsk. It is revealed, that dust, nitrogen dioxide, hydrogen sulfide, carbon monoxide, formaldehyde, phenol, ammonia and phenol are the main air pollutants of the city by the multiplicity of the hygienic standards (1.1-10.3 MPC). In accordance with an air pollution index the level of Dnepropetrovsk air pollution is characterized as high (API=11.02). Such situation, together with the identified pronounced processes of biological summation of pollutants negative influence (CCA=3.77) may cause the increased risk of ecologically dependent diseases.

**Key words:** air pollution, negative influence, air quality, excess, hygienic standards.

I. Introduction.

Today atmospheric air is undergoing intensive technogenic pollution, which takes a global character almost in all countries of Europe, including our country [1]. Social and ecological situation, that has evolved in Ukraine in the recent years has led to deterioration of population’s health and demographic situation in general. It should be emphasized that a complicated, unfavorable and in some regions even acute ecological situation has formed in Ukraine. Only 15.3% of the population live in conditions of a low level of contamination, 52.8% – of moderate, 24.3% – of high and 7.6% – of a very high level of contamination [2].

Air pollution – a priority risk factor for health, because aerogenic way of harmful factors intake traditionally belongs to the most dangerous for humans [3, 4]. Usually the negative impact of xenobiotics on the human organism is complex, through all life-supporting environments, but most of all it is caused by aerogenic component. Such a situation is associated with a wide spectrum of pollutants in the atmospheric air and possibility of their high entering into organism due to a large volume of air consumption, their direct access into the blood, human is inability to individually control air quality. These circumstances give importance and informativity of studing of air pollutants impact on human health and substantiate it as a classic hygienic approach in evidence-based preventive medicine [5, 6, 7].

**Conclusions.**

CT data show that sizes of hernial orifices were smaller than 5 cm in 15 cases (30%), smaller than 10 cm – in 16 (32%), from 10 to 15 cm – in 11 (22%), and more than 15 cm – in 8 (16%). In this way, we revealed inconformity of clinical examination data with ultrasound scan and CT data. The latest techniques of research provide with a possibility to estimate the size of hernial sac more accurately. Besides, absence of regularity between the size of hernial orifices and the size of hernial sac was revealed.

**List of references**


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**Table 5 The scheme of the adolescent boys' biological age express assessment recommended for use in the process of physical education**

<table>
<thead>
<tr>
<th>Length of the body</th>
<th>Level of hair distribution in the axillary crease</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low, low than average (from $T - 0.68 \sigma$ and less)</td>
<td>R</td>
</tr>
<tr>
<td>Average ($T + 0.67 \sigma$)</td>
<td>C</td>
</tr>
<tr>
<td>Higher than average, high ($T + 0.68 \sigma$ and more)</td>
<td>C</td>
</tr>
</tbody>
</table>

3. Conclusions

1. Among the studied nine methods of the adolescent boys' biological age evaluation there is none that would be interrelated to all the others.
2. The evaluation of the adolescent boys' biological age can be verifiably (with the probability of 90.2%) performed based on the set of three indicators. They are the physical development level, the index of the growth' and development heterochrony and the degree of the secondary sexual characters' evidence. Their contributions to the biological level' assessment amount to, respectively, 58.5%, 18.9% and 12.8%.
3. An improved method of the adolescent boys' biological age evaluation is proposed that is recommended for use in scientific studies, as well as the corresponding method of an express assessment – for use in the physical education practice.

The further studies are directed at assessing the physical capabilities of the adolescent boys of different biological ages and at the development of the differentiated health-improving' and developmental physical training lessons for the general education school' students.

**Bibliography**