INTRODUCTION

The work of locomotive drivers is very difficult, intense and responsible. Action of harmful production factors on workers of locomotive crews has adverse impact on their health [1-5]. These factors leads to permanent stress and forced working position at the workplace, that characterized by excessive bending in the cervical spine. Nutrition of workers has irregular, unbalanced, irrational character, due to the shift work and the lack of normal conditions for nutrition in the cab of driver [6-8]. Workers of locomotive crews have most sedentary working posture and that is why they have pure physical activity. Also vibration, noise, electromagnetic radiation, unfavorable microclimate conditions, the effect of infrared radiation, neuro-emotional overload in driver's cabs act on health of workers [9, 10]. Consequently, there is a high prevalence of somatic and occupational pathology among locomotive drivers, including vibration disease, neuro-sensory hearing loss, diseases of the cardiovascular system, digestive system, musculoskeletal system, visual organs and dust diseases of lungs [11-13]. A lots of production harmful factors leads to metabolic disorders and spreading of atherosclerotic changes and endothelium dysfunction in cerebral vessels [14]. Its manifested by increasing of the thickness of the carotid intima-media complex, the presence of atherosclerotic plaques, and decreased blood flow in the brain vessels Development of pathological depends on length of service of locomotive drivers [15-18].

Given that the pathogenesis of cardiovascular disease plays an important role in metabolic disorders, special attention should paid to the metabolic and disorders that occur among workers of locomotive crews [19, 20]. Metabolic changes include hyperlipidemia, hyperglycemia and consequently the development of a number of pathological changes in the body, spreading of atherosclerotic changes in vessels of the circulatory system [21-24]. This article discusses of pathological changes that occur in intra and extra cranial vessels depending on their length of service [25]. The high information content and authenticity of extra- and intracranial Doppler examination provides an estimate hemodynamic significance of pathogenic factors of violation of circulation, degree of morphological changes, as well as a range of functional ability of arterial and venous circulation, when encephalopathy of various origins [26]. One of main reason of hemodynamic changes in cerebral vessels [10].
vessels in workers of locomotive crews is prolonged flexion and extension in the cervical area during the work of machinists [27-29]. It leads to compression in the cervical spine and stenosis in the important arteries of the neck and head.

In this article, the main goal is the study of brain and neck vessels using intra- and extra cranial Doppler examination, the identification and quantification of the degree of stenosis, atherosclerotic changes in workers of locomotive crews with complaints of transient ischemic attacks, and patients who have not clinical manifestations [30]. The main diagnostic unit during Doppler examination is Doppler spectrum. It can diagnosed pathological processes that lead to the development of local and systemic disorders of blood flow with corresponding Doppler equivalents [31, 32]. Given that a number of pathologic vascular processes accompanied by the development of similar hemodynamic violations received during examination Doppler indices, suggest the presence of patients with certain hemodynamic syndrome but not a specific disease [33]. Besides possible evaluation and dynamic monitoring of induced functional changes in blood flow and peripheral cerebral vasospasm, endothelium dysfunction and atherosclerotic changes of cranial and peripheral indicators reactivity [34].

The issue of early diagnosis and prevention of vascular diseases of the brain in working locomotive drivers are relevant for medicine rail transport because ischemic and atherosclerotic changes of vessels are established risk factors for brain strokes, vascular encephalopathy and sudden death [34].

**MATERIALS AND METHODS**

The study involved examination of the main group that includes 249 males, aged 21 to 60 years who work as machinists and their assistants with an average age of 40.33 years. Among the workers in this category are 52.61% of smokers with 10 years or more. As a randomized by its basic parameters (sex and age) of the control group were employed 93 engineers (age from 40 to 60 years). This category of persons not exposed to harmful production factors. According to the work experience of the surveyed workers divided into 8 groups:

1. 1-5 years of work experience, 49 persons (19.7%);
2. 6-10 years of work experience, 24 persons (9.6%);
3. 11-15 years of work experience, 15 people (6.0%);
4. 16-20 years of work experience, 25 persons (10.0%);
5. 21-25 years of work experience, 44 persons (17.7%);
6. 26-30 years of work experience, 36 people (14.5%);
7. 31-35 years of work experience, 29 persons (11.6%);
8. 36-40 years of work experience, 27 persons (10.9%).

Doppler ultrasound of the neck and brain (left and right sides) performed on a Vivid-7 machine manufactured by General Electric. From the Doppler ultrasound of the vessels of the brain and neck studied linear blood flow velocity (linear blood flow rate, linear maximum blood flow velocity), resistant index, the spread of reduced vascular elasticity, violation of venous circulation, reduced blood flow in the bloodstream. Excel applied software and specialized software STATGRAPHICS Plus v. 2.1. Study does not contradict the principles of the Declaration of Helsinki (2013), the European Convention on Human Rights and Biomedicine.

**THE AIM**

The aim was to investigate the pathological changes in intra- and extra cranial blood vessels in workers of locomotive crews depending on their length of service.

**RESULTS AND DISCUSSION**

In the course of the research calculated the average values and its errors of Doppler indicators of left and right...
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The data presented in Table 1, 2, 3. Received results that indicate the average values and their errors of indicators of Doppler examination of intra- and extra-cranial vessels. The linear velocity of blood flow (average), the linear velocity of blood flow (maximum), resistance index of all examined workers of locomotive crews are reduced compared with control group, indicating that the action of harmful factors on workers leads to atherosclerotic changes and cerebrovascular pathology.

Next we have studied all the indicators of Doppler examination of neck vessels and brain in workers of locomotive crews depending on their length of service. Received results of examination presented in Table 4 and Table 5.
Based on the received results can to argue that the speed of blood flow in the neck vessels and brain in workers of locomotive crews with increasing length of service and age naturally reduced. Indicators of linear velocity of blood flow especially reduced. It is become pathological in workers, who have worked 20 years or more. These facts also confirm the presence of atherosclerotic changes in intracranial vessels in these groups of workers and the growing tendency to develop atherosclerosis with increasing length of service and age of employees. The lowest index of resistance observed in workers of locomotive crews with work experience of 21-35 years, confirming previous statements on the progressive development of vascular changes in drivers of locomotive and their assistants. Workers of locomotive crews with work experience up to 20 years have resistance index is somewhat higher, which is significantly associated with increased vascular tone of the young age. Workers of locomotive crews with work experience from 35 to 40 years have resistance index also high. In this case, change significantly associated with sclerotic changes in intra and extra cranial vessels.

We have found that spreading of pathological changes in neck and cerebral vessels among the workers of locomotive crews depend on their length of service. Results of examination showed that with increasing of length of work of locomotive drivers (according to the increasing of their age). We can see reduced elasticity of blood vessels (77.6% of the patients), increased violation of venous circulation (86.4% of the patients), reduced blood flow in the basilar artery (64%), and reduced blood flow in the right and left vertebral arteries (65.6% and 65.5% respectively), which is directly related with length of work of workers of locomotive crews. Probably is the result of negative production factors on employees (Table 6, 7).

In addition, we have found that the thickness of the carotid intima-media complex has a direct correlation with length of service of locomotive drivers. In general, 70, 68 % of drivers have overweight in the intima-media complex. The most significant thickening of the intima-media complex is observed in machinists with more than 15 years of length of work (1,19±0,3; 1,20±0,3) in average (Table 8).

### Table 6. The spread of pathological changes of cerebral in workers of locomotive crews depending on their length of service (n = 249)

<table>
<thead>
<tr>
<th>Length of work</th>
<th>Reduced elasticity of blood vessels</th>
<th>Decreased blood flow in a.vert.</th>
<th>Decreased blood flow in a.basil.</th>
<th>Violation of venous circulation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>right</td>
<td>left</td>
<td></td>
</tr>
<tr>
<td>1-5 (n=49)</td>
<td>27,77 %</td>
<td>23,52 %</td>
<td>23,52 %</td>
<td>50 %</td>
</tr>
<tr>
<td>6-10 (n=24)</td>
<td>37,5 %</td>
<td>37,5 %</td>
<td>37,5 %</td>
<td>62,5 %</td>
</tr>
<tr>
<td>11-15 (n=15)</td>
<td>50 %</td>
<td>40 %</td>
<td>40 %</td>
<td>90 %</td>
</tr>
<tr>
<td>16-20 (n=25)</td>
<td>68,42 %</td>
<td>60 %</td>
<td>60 %</td>
<td>94,73 %</td>
</tr>
<tr>
<td>21-25 (n=44)</td>
<td>100 %</td>
<td>100 %</td>
<td>100 %</td>
<td>100 %</td>
</tr>
<tr>
<td>26-30 (n=36)</td>
<td>100 %</td>
<td>100 %</td>
<td>100 %</td>
<td>100 %</td>
</tr>
<tr>
<td>31-35 (n=29)</td>
<td>100 %</td>
<td>100 %</td>
<td>100 %</td>
<td>100 %</td>
</tr>
<tr>
<td>36-40 (n=27)</td>
<td>100 %</td>
<td>100 %</td>
<td>100 %</td>
<td>100 %</td>
</tr>
</tbody>
</table>

### Table 7. The spread of pathological changes of cerebral vessels in workers of locomotive crews (n=249)

<table>
<thead>
<tr>
<th>N</th>
<th>Reduced elasticity of blood vessels</th>
<th>Decreased blood flow in a.vert.</th>
<th>Decreased blood flow in a.basil.</th>
<th>Violation of venous circulation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>right</td>
<td>left</td>
<td></td>
</tr>
<tr>
<td>249</td>
<td>77,6 %</td>
<td>65,6 %</td>
<td>65,5 %</td>
<td>64 %</td>
</tr>
</tbody>
</table>

### Table 8. Dynamics of thickening of the intima-media complex (TIMC) in machinists, depending on work experience (n=249)

<table>
<thead>
<tr>
<th>Length of work</th>
<th>TIMC of a.carotis sin</th>
<th>TIMC of a.carotis dex</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-5 (n=49)</td>
<td>0,75±0,2</td>
<td>0,74±0,2</td>
</tr>
<tr>
<td>6-10 (n=24)</td>
<td>0,89±0,3</td>
<td>0,90±0,3</td>
</tr>
<tr>
<td>11-15 (n=15)</td>
<td>0, 97±0,2</td>
<td>0, 98±0,2</td>
</tr>
<tr>
<td>16-20 (n=25)</td>
<td>1,19±0,3</td>
<td>1,20±0,3</td>
</tr>
<tr>
<td>21-25 (n=44)</td>
<td>1,22±0,2</td>
<td>1,23±0,2</td>
</tr>
<tr>
<td>26-30 (n=36)</td>
<td>1,24± 0,2</td>
<td>1,25± 0,2</td>
</tr>
<tr>
<td>31-35 (n=29)</td>
<td>1,24±0,3</td>
<td>1,24±0,3</td>
</tr>
<tr>
<td>36-40 (n=27)</td>
<td>1,26±0,3</td>
<td>1,28±0,3</td>
</tr>
</tbody>
</table>
CONCLUSIONS

1. Considering received results of examination, we found that speed of blood flow in intra- and extra cranial vessels reduced with increase the length of service of workers of locomotive crews.

2. The lowest index of resistance observed in workers of locomotive crews with work experience of 21–35 years. Workers of locomotive crews with work experience up to 20 years of resistance; index of resistance is somewhat higher, which is a result of the increase in vascular tone in young people. In workers of locomotive crews with experience of 30 to 40 years resistance index also increased, due to atherosclerotic changes of vessels.

3. During the studies found that with increasing of experience of work in workers of locomotive crews is reduced elasticity of intra- and extra cranial vessels (in 77.6% of examined). It increased violation of venous circulation (86.4%), reduced blood flow in the basilar artery (64% of examined), and reduced blood flow in right and left vertebral arteries (65.6% and 65.5% respectively). It related to experience of work of the workers of locomotive crews. It is the result of impact of harmful production factors on employees.

4. In general, 70, 68 % of drivers have overweight in the intima-media complex. The most significant thickening of the intima-media complex is observed in machinists with more than 15 years of length of work (1,19±0,3; 1,20±0,3) in average.

REFERENCES


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Conflict of interest:
The Authors declare no conflict of interest.

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