Comorbid Conditions in Persons Exposed to Ionizing Radiation and in Veterans of Local Wars

Objectives: The objective of this study is to conduct an analysis of the prevalence rate and characteristics of comorbid conditions among patients who have been exposed to ionizing radiation and who have been a part of the Afghan war.

Methods: Analysis of the frequency, spectrum of morbidity, comorbidity in patients in the long-term period (30-35 years) after ionizing radiation (IR) at the Semipalatinsk Nuclear Test Site, at the Chornobyl Nuclear Power Plant and participants of the Afghan war. A cohort prospective and retrospective research on 675 patients was carried out. All patients underwent a comprehensive examination:

Results: Numerical data were processed by the methods of variation statistics in the “STATISTICA 6” program and are presented as mean (M)±, standard deviation (SD), median (ME) and quartile spread (25% and 75%). The statistical significance of differences between groups was determined using Student's t-test, Pearson $X^2$ criteria. The p<0.05 level was taken as statistically significant.

A high incidence of cardiovascular diseases (CVD) was found (hypertension (HT) – 55%, cardiac ischemia (CI) – 32.9%), exceeding the population level in this age group.

Conclusions: The total impact of causal occupational, environmental, and ultra-high stress factors in the combat zone in participants of the Afghan war, along with common conventional ones, contributes to the formation of a specific comorbidity structure, which requires a rational approach in detection of early predictors of cardiovascular events, central nervous system disorders, pathognomonic clinical symptoms in this cohort of patients and choosing appropriate methods and ways to conduct treatment and prevention measures.

Key words: low radiation doses, participants of the Afghan war, comorbidity, coronary heart disease, vessels, cerebrovascular accidents

1. INTRODUCTION

To date, the problem of the influence of occupational and environmental factors on the development of comorbidity remains understudied. The increase in multiple diseases with age, the concept of comorbidity, is widely discussed in the literature and is mainly associated with the demographic situation in many countries. This problem affects more cardiology patients due to the high prevalence of cardiovascular diseases and their pathophysiological association with damage to various organs [1]. At present, the relevance of this problem is represented by an increase in the number of comorbidity patients, on the one hand, and by an increase in the overall comorbidity index in an individual patient, on the other. Ultimately, the presence of comorbidities and high cardiovascular risk hinders rehabilitation to the required extent, is associated with polypharmacy, increased length of hospital stay, incidence of complications, disability and mortality [2].

The field of comorbid conditions has been extensively researched. However, every medical and research domain will always have gaps that need more investigation, and the realm of comorbidities is no exception. While numerous studies have explored the individual health impacts of ionizing radiation exposure and participation in military conflicts, there is a notable dearth of comprehensive research into the combined or cumulative effects of these occupational and environmental factors on comorbidity. Current literature often delves separately into health outcomes of radiation exposure and those of war veterans. The intersection where both factors converge, potentially compounding health risks, remains underexplored.

The increase in comorbidity with age, which primarily reflects involutional processes in the body, is the subject of many studies and publications [2]. Among the factors influencing comorbidity, most often, in addition to age factors – involutional ones, the following are indicated: genetic, social, infectious, iatrogenic, etc. However, the problem of comorbidity in persons exposed to IR, participants of the Afghan war and participants in other local military conflicts (Hungary, Czechoslovakia) has been little studied so far. This problem is of particular relevance now when the
participants in military conflicts, the liquidators of the Chornobyl accident, the Army servicemen who were directed at the Semipalatinsk nuclear test site (STS), as well as those who lived in nearby territories during nuclear tests, are included in the older age category. Consequently, involutional processes, in addition to factors associated with special conditions in this cohort of patients, are naturally reflected in systemic disorders of the body. 37 years have passed since the Chornobyl accident, 34 years after the Afghan events and 32 years after the closure of the Semipalatinsk test site. Most of the clinical studies on the health status of participants in these tragic events were published in the short term – in the first decades [3-6].

But there are less studies of this problem in the remote period directly from exposed individuals. At present, the main work is devoted to studying the consequences of ionizing radiation in subsequent descendants affected by the STS and the Chornobyl nuclear power plant [6, 7]. In the Central Clinical Hospital for Veterans of the Patriotic War in Astana, veterans of the Great Patriotic War, participants in the war in Afghanistan, liquidators of the Chornobyl accident, persons exposed to ionized radiation at the Semipalatinsk nuclear test site undergo inpatient treatment and rehabilitation. The purpose of research – analysis of the incidence rate and characteristics of comorbid conditions in patients exposed to ionizing radiation, participants of the Afghan war. Research tasks: conduct a comprehensive examination of patients upon admission to the hospital; analysis of morbidity and characteristics of comorbid conditions in patients; to identify early predictors of cardiovascular system disorders.

Understanding the role of occupational and environmental factors in comorbidity formation can pave the way for better preventive measures, early diagnosis, and holistic treatment strategies. Given the immense implications for public health, it's vital that this area receives more attention and resources in both research and policy domains.

2. METHODS

A cohort prospective and retrospective research was conducted among hospital patients who were on inpatient treatment in the period of 2017-2019. The research included 675 patients. All patients underwent a comprehensive examination upon admission to the hospital:

- Cardiovascular methods: ECG (electrocardiography), daily MT ECG, EchoCG, ABPM (Ambulatory Blood Pressure Monitoring), Ultrasound of brachiocephalic vessels and arteries of the lower extremities, Ultrasound of the abdominal cavity and small pelvis, peak flowmetry, according to indications: Fibrogastroendoscopy, computed tomography, magnetic resonance imaging, electroencephalography. Invasive methods (according to indications): CAG (Coronary Angiogram), electrophysiological study of the heart; load tests – BEM and 6 minutes of walking.
- Biochemical laboratory methods: levels of bilirubin, aspartate transaminase (AST), alanine transaminase (ALT), gamma-glutamyl transpeptidase (GGTP), alkaline phosphatase, creatinine, glomerular filtration rate, urea, hormones – TSH, free T4, antibody titer to thyroglobulin (ATG), glucose; Glycemic profile, glycated hemoglobin, lipid profile (total cholesterol, LDL-C, HDL-C, thyroglobulin), coagulogram (INR, PT, APTT), etc.
- The psycho-emotional state was assessed: the frequency, nature and severity of psycho-emotional disorders (tests – Mini-Mult, V. P. Zaitsev)
- Conventional RFs were analyzed: smoking, alcohol intake, increased BMI, obesity, impaired glucose tolerance (IGT), hypercholesterolemia (HCH), low physical activity (LPA), hyperuricemia. The BMI level of 30.0 kg/m² was taken as an indicator of obesity.

All research was conducted with the consent of the patients and approved by the local ethical committee. Exclusion criteria were: acute coronary syndrome, malignant neoplasms, mental illness/disorders. Digital data were processed using methods of variation statistics in the “STATISTICA 6” program and presented as an average value (M)±, standard deviation (SD), median (Me), and quartile spread (25% and 75%). The significance of differences between groups was determined using Student's t-test, Pearson's X² criteria. The p<0.05 level was taken as statistically significant.
For a more detailed analysis of the incidence and clinical characteristics, all of the patients were divided into 3 groups. Group I included 152 patients who received ionizing radiation (IR) while serving at the Semipalatinsk test site and persons who lived in the nearby areas of the Semipalatinsk test site during nuclear tests. All men, middle age 61.8±8.04 years (25% – 56; 75% – 68). Group II included 246 patients – liquidators of the consequences of the Chornobyl accident (LCA) – all men, middle age – 58.3±7.56 years (25% – 52; 75% – 63). The III groups of patients consisted of 277 people – participants of the Afghan war (PAW), all men, middle age – 53.9±4.91 years (25% – 50; 75% – 56).

The investigations were carried out following the rules of the Declaration of Helsinki of 1975, revised in 2013. All participants have been informed if the anonymity is assured, why the research is being conducted, how their data will be used and if there are any risks associated. All participants agreed to participate in the research.

3. RESULTS

Analysis of the entire cohort of patients hospitalized in the therapy department during the research period showed that cardiovascular diseases prevailed in the structure of morbidity: arterial hypertension (HT) in 375 (55.6%) patients and coronary artery disease in 223 (33.0%) patients in the form of angina II-III FC, myocardial infarction, ischemic cardiomyopathy. In second place was cerebrovascular pathology – in 461 patients (68.3%), complicated by stroke in 11.1% of cases and manifested by dyscirculatory encephalopathy (DEP) of II degree in 73.7%, and III degree – in 26.3% of patients. The rather high prevalence of endocrine pathology in the form of a violation of fat and carbohydrate metabolism draws attention. Obesity, predominantly visceral, occurred in 467 (69.2%) cases, of which I degree in 61.8%, II degree – in 7.4%. Associated with this, diabetes mellitus is quite common: type 2 diabetes was observed in 149 (22.1%), type 1 diabetes – in 26 (3.9%) of the patients, in more than half of the patients (56%) had IGT. Next are diseases of the musculoskeletal system, in particular, osteochondrosis of the spine in 43.2%, deforming osteoarthritis (DO) in 33.2% of patients, diseases of the gastrointestinal tract, predominantly non-alcoholic fatty liver disease (in 32.8%) and chronic pancreatitis (in 28.3%).

In a comparative analysis, it was found that the spectrum of incidence in the studied groups differs significantly. Among patients exposed to radiation at the Semipalatinsk test site (group I) and at the Chornobyl nuclear power plant (group II), there was an initially high frequency of hypertension in advanced stages – 2-3 degrees (in 67.8% and 55.5% of cases), coronary artery disease (in 40.8% and 33.3%). The research has also established a high prevalence of type 2 diabetes mellitus (23.7% and 18.3%). This factor is associated with a high incidence of obesity. Because of the obesity of I-II degree suffered 71.1% of patients in group I and 68.7% – in group II. In general, the metabolic syndrome, including visceral obesity, hypercholesterolemia, type 2 diabetes/IGT, HT, in some patient’s hyperuricemia, occurred in 21.1% in group I and in 18.3% of cases in group II.

Particular attention is drawn to the frequency of thyroid pathology in this category of patients: in 21.7% and 22.3% of cases, more often in the form of nodular goiter (66.7%, 56.3%), diffuse nodular goiter was less common (8.6%, 5.45%), cystic formations were in 24.7% and 38.3% of cases. The data of these researches indicate a high frequency of peripheral vascular lesions: in 41.4% and 36.6% of patients during the examination, atherosclerosis of the brachiocephalic arteries, abdominal aorta, vessels of the lower extremities were detected, in a number of patients (in 5.3% and 4.5%) clinical symptoms of Raynaud’s syndrome were detected.

In contrast to this cohort, in patients of group III – participants of local war, multifocal atherosclerosis (25.6%) with damage to the brachiocephalic vessels, arteries of the lower extremities were relatively less common, and thyroid pathology was much less common (14.1%) in the form of cystic-nodular formations mainly with euthyroidism. As mentioned above, in individuals exposed to ionizing radiation, a high frequency of HT was established. Along with this, this research showed a high incidence of complications (19.1%), in the form of acute cerebrovascular accident (ACA), especially in the group of liquidators of the Chornobyl accident (23.2%). As main interest there is the fact that a number of patients developed strokes without HT. From the above, it follows that in this


category of patients who underwent of IR, the clinical picture was dominated by signs of cerebrovascular pathology in the form of dyscirculatory encephalopathy (DEP) of the II degree, in some of them – of the III-degree, psycho-emotional disorders with asthenic-neurotic syndrome: rapid fatigue, weakness, sleep disorders.

Thus, in the studied cohort of patients who underwent of IR, vascular pathology with clinical manifestations of hypertension, cerebrovascular diseases, and peripheral vascular lesions prevailed in the structure of morbidity. Although among patients of group III – participants of the Afghan war, the most common diseases were also cardiovascular diseases: hypertension (in 55.9%), coronary artery disease (30.7%), exceeding the level of population indicators, but in the clinical picture of patients, signs of cerebrovascular pathology predominated as a result of injuries and contusions received during military operations and manifested as signs of DEP of II-III degree, in some patients with severe neurological symptoms up to convulsive syndrome (in 7.2%), dizziness, persistent headaches, noise in the head; psycho-emotional disorders: anxiety-depressive and neurasthenic syndromes, in some cases psychopathic, aggressive manifestations. Regarding the frequency of the most common conventional risk factors: smoking, obesity, IGT, HCH, low physical activity, hyperuricemia in all three study groups was quite high, without significant differences. Obesity (71.1%, 68.7%, 65.0%), smoking (67.8%, 63.0%, 60.6%), IGT (65.1%, 58.1%, 52.3%), HCH (28.9%, 25.1%, 31.7%). It is obvious that the state of the cardiovascular, nervous system in the liquidators of the Chornobyl accident, in people who were at the nuclear test site, in war veterans, was determined not only by the absolute values of ionizing radiation, injuries, concussions, extreme ultra-high stress situations in the war zone, but and age, constitutional features, lifestyle, the presence of common risk factors.

By taking into account many multisystemic lesions in the research cohort, authors analyzed comorbidity in the most common cardiovascular pathology. 357 patients with ischemic heart disease, angina pectoris II-III FC and myocardial infarction (19.9%) were studied in three compared groups (Table 1). In group I of patients with coronary artery disease who received IR at the Semipalatinsk test site, the most common were hypertension (89.9%) and cerebrovascular pathology in the form of DEP II-III degrees (87.2%).

**Table 1.** The structure of comorbidity in patients with coronary heart disease

<table>
<thead>
<tr>
<th>Comorbid pathology</th>
<th>Exposed to ionizing radiation at the Semipalatinsk test site</th>
<th>Liquidators of the consequences of the Chornobyl accident</th>
<th>Total, n=357</th>
<th>Assessing differences</th>
</tr>
</thead>
<tbody>
<tr>
<td>I group, n=109</td>
<td>n</td>
<td>%</td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>Arterial hypertension</td>
<td>98</td>
<td>89.9%</td>
<td>109</td>
<td>93.2%</td>
</tr>
<tr>
<td>Cerebrovascular disease</td>
<td>95</td>
<td>87.2%</td>
<td>98</td>
<td>83.8%</td>
</tr>
<tr>
<td>Dyscicular encephalopathy II level</td>
<td>93</td>
<td>85.3%</td>
<td>96</td>
<td>82.1%</td>
</tr>
<tr>
<td>Dyscicular encephalopathy III level</td>
<td>2</td>
<td>1.8%</td>
<td>2</td>
<td>1.7%</td>
</tr>
<tr>
<td>Defect of the perif. vessels</td>
<td>51</td>
<td>46.8%</td>
<td>53</td>
<td>45.3%</td>
</tr>
<tr>
<td>Obesity</td>
<td>83</td>
<td>76.1%</td>
<td>83</td>
<td>70.9%</td>
</tr>
<tr>
<td>Type 2 diabetes mellitus</td>
<td>29</td>
<td>26.6%</td>
<td>30</td>
<td>25.6%</td>
</tr>
<tr>
<td>Acute disorders of cerebral circulation</td>
<td>14</td>
<td>12.8%</td>
<td>20</td>
<td>17.1%</td>
</tr>
</tbody>
</table>
This is followed by metabolic disorders: obesity, predominantly visceral (76.1%) and type 2 diabetes (26.6%), lesions of the musculoskeletal system – (36.7%). Attention is drawn to the high frequency of peripheral vascular lesions – in 46.8% of cases and thyroidopathy (24.8%), in a quarter of them with an increase in thyroglobulin antibody titer (an autoantibody that targets thyroglobulin). In group II – in the liquidators of the consequences of the Chornobyl accident, coronary artery disease was also most often associated with hypertension (93.2%) and CVD in the form of DEP (83.8%), peripheral vascular lesions (45.3%), and thyroid disorders (30.8%). Moreover, one third of them (30.5%) had an increased titer of thyroglobulin antibodies. Further, according to the frequency of syntropy in this group of patients with coronary artery disease, follows next: osteoarthritis (OA) (28.2%), type 2 diabetes (25.6%).

An analysis of clinical observations showed that within the framework of comorbidity in patients with coronary artery disease – war veterans (group III), a special place is occupied by CVD. In this cohort, they occurred in 100% of cases – all patients were diagnosed with DEP II-III degree (Table 1). The peculiarity of comorbidity in war veterans was not only in the high frequency of CNS damage, as a result of injuries, concussions, but also on the severity of the cerebrovascular syndrome (a term for conditions that affect blood flow to the brain): DEP III degree was observed in 21.4%, neuropsychiatric disorders in 27.5%. HT in this group took the second position (82.4%). OA (35.8%) ranked third in frequency; type 2 diabetes was observed in 18.3% of patients. Attention is drawn to the high prevalence of obesity in all three groups of patients: 76.1%, 70.9%, 69.5%. In war veterans with coronary artery disease, the incidence of thyroid disease was 12.2%, peripheral vascular lesions – 23.7%, which is significantly lower than in groups of patients exposed to radiation. Authors analyzed the degree of comorbidity in the studied groups (Figure 1).

In group I – in victims at the Semipalatinsk test site, most often (in 31.7%) comorbidity consisted of 4 diseases, then it goes in descending order: 5 diseases in 26%, 6 in 18.7%, 7 diseases and more had 12.2% of patients. Among the liquidators, syntropy most often consisted of 5 diseases (in 33.8%), 27.3% of them had 6 pathologies each, and 20.7% of patients had 7 or more diseases.
Figure 1. The frequency of comorbidity in patients with coronary artery disease in the groups of EIR STS, LC CNPP and PAW

Note: EIR STS – exposed to ionizing radiation at the Semipalatinsk test site; LC CNPP – liquidators of the consequences of the accident at the Chernobyl nuclear power plant; PAW – participants of the Afghan war.

Among war veterans, comorbidity was also most often (in 36.0%) represented by 5 diseases, then in 10.5% – by 6 pathologies, and in 8.4% of cases, 7-9 diseases were observed simultaneously in one patient. In general, the total comorbidity in groups was: 4.57; 4.61; 4.74.

4. DISCUSSION

Exposure to ionizing radiation and participation in local wars can significantly affect one's health, both physically and mentally. When these factors are combined or when individuals are exposed to both, the complexity of potential health problems rises. The study of comorbid conditions in such individuals is vital to address their unique healthcare needs. The results of a cohort study performed on the general population of patients observed at Veterans' Hospitals indicate that the overall incidence structure is consistent with the indices for this entire age group. [2]. At the same time, the authors' research also identified certain differences. Thus, the incidence of cardiovascular disease: HT – 55.6%, CI – 32.9%, relatively higher than the general population: HT – 39-42%, CI – 10-20% [5, 8]. Many clinical studies show an increased risk of developing cardiovascular diseases, such as hypertension and coronary heart disease, in people exposed to radiation [8-12].

The next feature – the second position in terms of prevalence in authors’ studies is occupied by cerebrovascular diseases in the form of DEP (68.3%), often complicated by stroke (11.1%) without HT. Further, the sequence of the incidence of diseases generally corresponds to the population average. The obtained data became the basis for a more detailed study of the incidence structure in this cohort, taking into account causal factors. Comparative analysis showed significant differences in the structure of comorbidity in the studied groups. So, in patients with coronary artery disease, exposed to radiation at the Semipalatinsk nuclear test site and the Chernobyl nuclear power plant, HT is most common in the long-term period, as in the general population [5, 8]. However, further the structure of comorbidity differs significantly. Cerebrovascular pathology in the form of DEP II – III degree comes to the background. In addition, these patients had a relatively high incidence of peripheral vascular lesions with multifocal atherosclerosis (46.8%, 45.3%) and thyroid pathology (24.8%, 30.8%), mainly with hypofunction and increased titer carriage antibodies to thyroglobulin.
Moreover, among the liquidators of the Chornobyl accident, thyroid disorders occupy the fourth position. The high frequency of thyroid lesions in individuals exposed to low doses of radiation has been established by numerous studies [3, 4].

Damage to the endothelium of small vessels with subsequent development of stromal fibrosis and a decrease in thyroid function is considered to be the main mechanism for the formation of postradiation hypothyroidism [13, 14]. In almost half of the two groups studied (46.8%, 45.3%), IHD was combined with multifocal atherosclerosis. The atherogenic effect of exposure to low doses of radiation is confirmed in many studies [15]. Thus, a common feature for patients exposed to ionizing radiation, and at the same time, a defining feature of comorbidity for this category of patients, is the high frequency of association of coronary artery disease with hypertension, CVD, peripheral vascular and thyroid lesions, in contrast to the general population indicators. Thus, in a large-scale population-based study of comorbid pathology with cardiovascular diseases in the United States, it was shown that diabetes mellitus (about 40%), arthritis (40.6–45.6%), anemia (38.7–51.2%) were most often observed and almost every fourth patient had chronic kidney disease, cataracts, chronic obstructive pulmonary disease, depression [3]. In numerous works [16], the general population level of the incidence of obesity and diabetes in patients with coronary artery disease is in the range of 28–44%. However, the frequency of association of obesity and coronary artery disease in authors’ observations is much higher (76.1%, 70.9%, 69.5%). At the same time, disorders of fat metabolism with the level of obesity of I-II degree were most often manifested in groups of people exposed to radiation. The fact of lipid metabolism disorders, the development of obesity under the influence of low doses of radiation was reflected in the studies of other authors.

The results of numerous clinical and experimental studies [15–17] indicate a generalized lesion of the vessels of the microcirculatory bed in persons exposed to ionizing radiation. Similar pathomorphological changes in the vessels in the form of vasculitis, microvascular disorders have been found by other researchers, which plays an important role in atherogenesis. According to many authors, under the influence of multiple small doses of radiation, genome instability develops – a genetic effect caused by free radical mechanisms with activation of chain reactions of lipid peroxidation and increased production of reactive oxygen species, a decrease in the regulatory function of endothelial nitric oxide synthetase [7, 18]. The results of authors’ studies – the systemic nature of the lesion with the formation of a complex specific comorbidity structure in patients in the long-term period after exposure to ionizing radiation, as well as the analysis of clinical observations and experimental data [19], confirm the hypothesis of the biological effect of low doses of radiation on tissues with slow cellular renewal, which are considered not responsible for the immediate outcome of irradiation. These include, first, endothelial cells – the main structural and functional element of the microcirculatory bed. Endothelial dysfunction causes the development of hypertension and contributes to the progression of atherosclerosis. Japanese researchers have published data on the high prevalence of arterial hypertension and dyslipidemia in residents of evacuated areas after the Fukushima accident [7].

In domestic studies of the consequences of the actions of the Semipalatinsk landfill, a high prevalence of arterial hypertension, coronary heart disease, dyslipidemia was also established. And B. Grosche et al. [19] pointed to the prevalence of mortality from diseases of the circulatory system among those exposed to radiation at the Semipalatinsk test site. This opinion is also confirmed in authors’ studies, which have established a high frequency of vascular lesions in this cohort in the long-term periods after ionizing radiation: arterial hypertension, cerebrovascular diseases, complicated by stroke, multifocal atherosclerosis. There is very little clinical data in the domestic and foreign literature on the study of cerebrovascular pathology among those exposed to radiation [20, 21], although, as authors’ studies have shown, cerebrovascular lesions occupy leading positions not only in frequency, but also in the clinical characteristics of patients. Z. Ungvari et al. [22] established microvascular endothelial lesions of the brain. Most studies are devoted to the study of neuropsychiatric status, autonomic dysfunctions [23].

Probably, the fact of the high frequency and severity of cerebrovascular diseases in the authors' studies is due to the fact of studying this contingent of patients in the long-term period (25-30 years)
after radioactive exposure, when pathophysiological processes, violations of regulatory systems led to a new clinical situation - somatic pathology, and their specific combination. To date, the problem of clinical research among participants of the Afghan war has been practically insufficiently studied both in domestic, Russian and foreign literature. Although, according to this research, this contingent of patients, often with severe combined pathology, deserves close attention, in-depth study of the clinical status, development of algorithms of management and selection of methods of treatment and rehabilitation measures. At the same time, in this category of patients, as in the general population, there is a high frequency of constitutional and metabolic risk factors. Traumatic stress increases the risk of developing cardiovascular comorbidities [24].

In general, the pathogenetic relationship of many associated diseases in the long-term period after IR still needs to be studied in depth. Most of the published works are devoted to research in the short term, including the compatibility of various pathologies. So, according to Ya. V. Porovsky et al. during the examination of the liquidators of the consequences of accidents at the Chornobyl Nuclear Power Plant in 10-14 years, from 5 to 13 diseases (on average 8.3) were registered in one liquidator, which is comparatively higher than authors’ results in terms of the frequency of syntropia [25]. However, authors must take into account the fact that this study in the long term (after 34 years) included liquidators, with the exception of those who dropped out due to death, i.e. patients initially with a more favorable prognosis. The results of authors’ studies indicate the systemic nature of vascular disorders in the long-term period after ionizing radiation, but with a predominant lesion of the cerebral vessels, the central nervous system as a whole, in some cases with the development of strokes without arterial hypertension (17.1%). This point of view is shared by other researchers [26, 27].

Authors have considered various comorbidity indices proposed by the authors, for the prediction of mortality, severity of the disease and disability, the main purpose of which is to assess economic costs. However, the structure of the association of pathologies in patients has a specific feature and is not included in the framework of the proposed indices. With this in mind, it seems that there is a need to develop an adequate diagnostic standard, other markers of severity assessment and prognosis for this category of patients [28, 29].

In conclusion, understanding the comorbid conditions in persons exposed to ionizing radiation and veterans of local wars is crucial. Their unique experiences and exposures necessitate specialized healthcare strategies and a deeper understanding of potential health challenges. The insights derived from such studies can significantly inform healthcare policies and interventions tailored to their needs.

Any study or research endeavor comes with its own set of limitations. Understanding these limitations is crucial for interpreting the findings and recommendations appropriately. There is a problem of recall bias. Especially in retrospective studies, participants might not remember past events or exposures accurately. If participants or subjects aren't chosen randomly, there may be inherent differences in the groups being compared, leading to skewed results. The study recruited patients who passed a preliminary examination and were further selected according to certain characteristics. While recognizing the limitations of a study might seem like it weakens the research, it's quite the opposite. Acknowledging and understanding these constraints provides context, ensuring that findings are interpreted correctly and with the appropriate caution. It also offers guidance for future research, indicating where further studies or different methodologies might provide clearer insights.

The results of this research have established that in the cohort of patients exposed to causal specific factors – ionizing radiation, stressful situations of military hostilities, the structure of morbidity in the long-term period as a whole differs significantly from the general population indicators. Although cardiovascular diseases (arterial hypertension, coronary heart disease) also come to the fore, but then cerebrovascular diseases prevail, often in severe form (Dyscirculatory encephalopathy II-III degrees) with frequent complications, such as strokes [30-32]. The peculiarity of this cohort is the relatively high frequency of peripheral vascular lesions, multifocal atherosclerosis and thyroid pathology. The revealed significant differences in the structure of comorbidity in the subgroups of patients with coronary heart disease indicate the causal influence of professional, man-
made, environmental, stress factors – under the influence of radiation in the long term, comorbidity with a predominance of generalized vascular lesions (multifocal atherosclerosis, strokes, cerebrovascular disease) is formed in patients, which brings patients with cardiovascular diseases of this cohort into the category of high and very high cardiovascular risk. The impact of ultra-high stressful situations, injuries, contusions in war veterans in the structure of comorbidity, central nervous system lesions come to the fore, ahead of cardiovascular diseases: Dyscirculatory encephalopathy II–III degrees, often strokes, neuropsychiatric disorders [33].

Along with this, this cohort of patients also has common behavioral, constitutional and metabolic factors, the summation of which with specific ones has a significant impact on the formation of their comorbidity. Summarizing the presented results of this research and the opinion of many authors, it can be stated that understanding the essence of the influence of professional, environmental factors, primarily related to ionizing radiation, as well as ultra-high stress situations in war zones, with the formation of a specific comorbidity structure, requires a rational approach in identifying early predictors of disorders from the cardiovascular system, central nervous system, pathognomonic clinical symptoms in this cohort of patients can help clinicians in developing adequate methods and ways to conduct therapeutic – preventive measures.

The distinctive morbidity patterns arising from exposure to ionizing radiation and stressful wartime situations present unique challenges to patient management and broader healthcare strategies. Understanding these implications is essential to providing optimal care to affected individuals and ensuring that healthcare systems are adequately equipped to address their needs. It worth to consider a holistic approach where patients can access oncologists, endocrinologists, cardiologists, and mental health professionals all within the same care center. Also, due to increased cancer risks, regular screenings (like thyroid ultrasounds or mammograms) are essential to detect malignancies early [34, 35]. Addressing the implications of these specific morbidity patterns requires a multi-dimensional, patient-centric approach. It's not just about treating diseases but also about providing comprehensive care that addresses physical, emotional, and social challenges, ultimately aiming to improve the quality of life and longevity of affected individuals.

The preliminary results presented in this paper of the study of the features of the comorbid state in patients in the long-term period after ionizing radiation and war veterans serve as the basis for further, more detailed study of the problem of comorbidity in this cohort. Authors consider it appropriate to devote a separate study to an in-depth study of the effect of comorbidity on cardiovascular risk of cardiovascular diseases, the prognosis of patients. The phenomenon of comorbid conditions presents multifaceted challenges and opportunities for research. A multidisciplinary approach, integrating insights from medicine, sociology, economics, and technology, is vital to comprehensively address and manage the complexities of comorbidity.

Reference


