NORTH-WESTERN DISTRICT SCIENTIFIC AND CLINICAL CENTER
NAMED AFTER L.G. SOKOLOV FEDERAL MEDICAL AND BIOLOGICAL
AGENCY

On the rights of the manuscript

Pershina Elena Igorevna

ORGANIZATION OF A SYSTEM FOR PROVIDING MEDICAL CARE TO PERSONS WHO HAVE BEEN EXPOSED TO IONIZING RADIATION OF NUCLEAR TECHNOLOGIES

Scientific specialty 3.2.3. Public health, organization and sociology
of healthcare, medical and social expertise

DISSERTATION
for the degree of Candidate of Medical Sciences
Translation from Russian

Academic adviser:
Doctor of Medical Sciences, Professor
I. M. Akulin

St-Petersburg
2024

CONTENTS

INTRODUCTION 4
CHAPTER 1. FEATURES OF MORBIDITY OF PERSONS WHO HAVE BEEN EXPOSED TO IONIZING RADIATION OF NUCLEAR TECHNOLOGIES (LITERATURE REVIEW) 18
1.1. Data available in open sources on veterans of special risk units of the Russian Federation 18
1.2. Data on liquidators of the consequences of the Chernobyl accident living in Russia 27
1.3. Data on the liquidators of the consequences of the Chernobyl accident living in the territories of the former republics of the USSR 31
1.4. A promising direction for the development of scientific and clinical components of medical care for persons who have been exposed to ionizing radiation of nuclear technologies 41
CHAPTER 2. MATERIALS AND RESEARCH METHODS USED 44
2.1. Research methodology 44
2.2. Data processing methods 49
CHAPTER 3. COMPARATIVE ESTIMATES OF THE INCIDENCE OF PERSONS WHO HAVE BEEN EXPOSED TO IONIZING RADIATION OF NUCLEAR TECHNOLOGIES AND PERSONS WHO HAVE NOT EXPERIENCED SUCH EXPOSURE 56
3.1. Analysis of data on the primary and general morbidity of persons from the study group of veterans of special risk units who have been exposed to ionizing radiation of nuclear technologies 56
3.2. Analysis of data on the primary and general morbidity of persons from the control group of representatives of the attached contingent who have not been exposed to ionizing radiation of nuclear technologies 69

3.3. Comparison of accounting characteristics of the studied and control groups using statistical criteria 80
CHAPTER 4. WAYS AND METHODS OF ORGANIZING A SYSTEM OF MEDICAL CARE FOR PERSONS WHO HAVE BEEN EXPOSED TO IONIZING RADIATION OF NUCLEAR TECHNOLOGIES 86
4.1. Substantiation of the model of the medical care system and algorithms of its functioning 86
4.2. Features of the functioning of the auxiliary process of the model of the medical care system for the persons of the contingent in question 94
4.3. Analysis of the results of the application of a three-level medical care system 102
4.4. Analysis of the results of the use of statistical surveys and questionnaires to obtain assessments of the quality of medical care 105
CONCLUSION 129
INFERENCES 138
PRACTICAL RECOMMENDATIONS 142
PROSPECTS FOR FURTHER DEVELOPMENT OF THE TOPIC 144
LIST OF ABBREVIATIONS 146
LIST OF LITERATURE 147
APPENDIX A 162
APPENDIX B 165
APPENDIX C 171
APPENDIX D 174
APPENDIX E 175
APPENDIX F 176

INTRODUCTION

Relevance of the research topic

Ionizing radiation is a physical phenomenon that occurs during radioactive decay, nuclear transformations, and inhibition of charged particles in a substance. As a result of the interaction of such radiation with the material medium, ions of different signs are formed in it. The scale of ionization of a substance depends on the intensity of radiation.

Every inhabitant of the Earth is exposed to natural ionizing radiation, which is often called background radiation. To a certain extent, it has a negative effect on the human body, but the compensatory capabilities of the body neutralize this effect [68].

The consequences of more intense radiation to the human body are the rupture of molecular bonds, changes in the chemical structure of molecules, the formation of chemically active radicals with high toxicity, and a violation of the structure of the genetic apparatus of the cell. As a result, various mutagenic changes, malignant neoplasms, hereditary diseases, etc. occur [75].

For our country, this topic became relevant in the fifties of the twentieth century, during the beginning of the development of nuclear technologies, which were, first of all, necessary to achieve the required level of state defense capability.

The use of these technologies had a characteristic feature – the presence of a radiation exposure factor. The risk of receiving radioactive exposure was experienced by military personnel of special risk division (hereinafter referred to as SRU) who participated in nuclear weapon tests and exercises using such weapons, sailors who served on nuclear submarines, nuclear charge collectors (until December 31, 1961), participants in the processes of radioactive waste disposal and other military personnel.

However, due to the high scientific intensity of these technologies, for some of SRU civilian specialists who carried out their activities in the same conditions as military personnel were included in the composition [30, 41, 59, 73, 97, 104].

The number of civilian specialists who fell into the risk zone also increased due to the use of nuclear technologies for energy needs, when the first nuclear power plants (hereinafter referred to as NPP) appeared [34, 35, 61].

Before the radiation accident at the Chernobyl nuclear power plant (hereinafter referred to as the Chernobyl NPP), which occurred on April 26, 1986, all issues related to the activities of SRU were classified and not subject to discussion.

According to the National Radiation Epidemiological Register of Russian Federation (hereinafter - NRER) at the beginning of 2021, the register includes information on 810,758 people, of whom 750,629 belong to the Chernobyl contingent. 198690 people were among the liquidators of the consequences of the Chernobyl accident [4].

According to the NRER data at the end of August 2023, the total number of registered persons is 823,357 people. Of these, at the same time, 330,438 people are registered [56].

The liquidators of the consequences of the Chernobyl accident belong to the most affected category of Russian citizens. Data on the structure and features of the morbidity of liquidators need to be generalized and are the basis for improving the organization of the system of providing them with specialized medical care [77].

After the accident at the Chernobyl NPP, issues of providing social and medical assistance to victims of the impact of ionizing radiation of nuclear technologies (hereinafter referred to as IIRNT) began to be openly discussed [64].

By this time, the secrecy period for testing nuclear weapons in the USSR had expired. It turned out that there are quite a large number of people in our country who suffered from radiation exposure long before the Chernobyl disaster [55, 100]. (These are the military personnel and civilian specialists of SRU already mentioned by us)

In order to protect their interests with the new opportunities that opened up, veterans of SRU in 1990 at a special conference decided to create a Committee, which was subsequently awarded the status of a State public organization.

The first official document that initiated the resolution of issues of support for persons affected by radioactive radiation was the Law of the RSFSR No. 1244-1 of May

15, 1991 «On Social Protection of citizens exposed to radiation as a result of the Chernobyl disaster», which granted rights and benefits to persons who were directly involved in the elimination of the consequences of the Chernobyl accident, and citizens who lived in the territory affected by radiation exposure as a result of the accident [83]. However, the veterans of SRU were not mentioned in this law [67].

Soon, the Resolution of the Supreme Council of the Russian Federation No. 2123-1 of December 27, 1991 «On extending the Law of the RSFSR «On Social Protection of Citizens Exposed to Radiation as a result of the Chernobyl disaster» to citizens from special risk units» was issued, confirming the corresponding status of veterans of SRU [67, 82].

In accordance with the Decree of the Government of the Russian Federation No. 806 dated October 21, 1992, the Scientific and Medical Center of the Veterans of SRU Committee was established on the basis of the Krasin City Hospital No. 13 in St. Petersburg (hereinafter referred to as SMC CVSRU). In 2008, the SMC CVSRU of the Russian Federation became part of the Federal State Healthcare Institution (hereinafter referred to as FSHI) «MSH № 144» [64, 80, 81].

In 2016, as part of the reorganization of the structures of the Federal Medical and Biological Agency (hereinafter - FMBA), SMC CVSRU became part of the clinical hospital «L.G. Sokolov Design Bureau No. 122 of the FMBA of Russia», which is currently transformed into the «L.G. Sokolov Northwestern District Scientific and Clinical Center of the FMBA of Russia» (hereinafter – NWDSCC).

According to the Committee of Veterans of SRU of the Russian Federation, 3,500 veterans of SRU currently live in St. Petersburg and the Leningrad Region (hereinafter - SPb and LR).

Medical care for this category of citizens is provided within the framework of the compulsory health insurance program (hereinafter – CMI) [64].

Veterans of SRU need special medical supervision and control, since social guarantees for this category of citizens are proof of the value of the work they did for the benefit of the country's security.

To date, the topic of providing medical care to workers and employees associated with activities in the risk zone of IIRNT remains relevant not only for veterans of SRU and liquidators of the consequences of the Chernobyl accident, but also for those who currently perform their duties in the field of nuclear technology. These are current employees of modern of SRU, and representatives of the attached contingent (hereinafter referred to as the AC) of medical institutions, who are exposed of IIRNT by their type of activity, and employees of existing or under construction NPP, and citizens who happened to be near the site of a man–made accident [68].

Currently, other professions associated with the risk of IIRNT have been added: we are talking about the field of radiation medicine and diagnostic radiology, the use of which requires taking into account the radiation doses received during the treatment of oncological diseases, not only by patients, but also by medical personnel working in this field.

Here and further in this study, when we talk about ionizing radiation from nuclear technologies, we mean a type of radiation in which the radiation intensity exceeds the background value as a result of the use of nuclear technologies both in normal mode and in man-made accidents [68].

The degree of elaboration of the research topic

The assessment of the level of primary morbidity of veterans of SRU, performed by V.A. Oleshko, showed that during the observation period from 1994 to 2002, 6,163 cases of primary diseases were recorded [60]. (The dynamics and structure of primary morbidity are considered).

The works of N.V. Alishev and his co-authors describe the long-term effects of exposure to radiation and other extreme factors in veterans of SRU in the form of humoral and cellular autoimmune shifts. It was shown that immune disorders were the causes of premature aging, pathology of the cardiovascular system in veterans of SRU [26, 45].

According to A.V. Veselkova, when studying the state of the ENT organs in veterans of SRU, pronounced dystrophic changes in the mucous membrane of the upper respiratory tract with increased bacterial flora, persistent immunodeficiency conditions were revealed, and on the part of the hearing organ - early presbyacoustic changes that manifested 10 years earlier than in healthy people [67, 100].

The features of the dermatomycosis clinic in veterans of SRU were studied. According to A.A. Vashkevich, the main pathogens of mycoses of the skin and its appendages in veterans of SRU are Trichophyton rubrum (96.0%) and Candida spp (16.5%), forming associations in 5.5% of cases [98].

In the study by V.Y. Rybnikov and V.A. Oleshko, the issues of assessing the biological age of veterans of SRU are considered. The results obtained allowed us to note that their biological age exceeds the passport age by an average of 5.53 years. In addition, it was found that the distribution of veterans of SRU relative to the control age group of the population by functional classes was significantly different. In general, the data of the study by V.Y. Rybnikov and V.A. Oleshko testify to the premature aging of veterans of SRU, which is a reflection of their previous professional activities related to the effects of specific factors, chronic polypathology and psychosomatic disorders [84].

According to O.V. Dmitriev, cognitive impairment in veterans of SRU is represented by initial forms in the form of moderate cognitive impairment and mild dementia, mainly of vascular etiology. The prevalence and structure of cognitive impairment in elderly and senile veterans of SRU in comparison with the general population of people comparable in basic clinical and demographic indicators, compactly living in the same territory, have no significant differences. The author of the publication concludes that the indicators of cognitive function depend on age and are not associated with the influence of low-level radiation [19, 67].

The team of authors (S.S. Aleksanin, V.Y. Rybnikov, K.K. Rogalev, V.A. Tarita) considered the features of morbidity and the main classes of diseases in victims of the Chernobyl accident in the long-term period when providing specialized medical care in a 24-hour hospital in the period from 2016 to 2018 [90].

According to the results of the study, it was determined that the first position is occupied by diseases of the circulatory system (48%). Diseases of the digestive system are in the second position (13%), and diseases of the musculoskeletal system and connective tissue are in the third position (11%). The fourth and fifth positions are for diseases of the endocrine system (8%) and respiratory diseases (7%), respectively [90].

To date, many aspects of the effects of radiation in the long term remain poorly understood. According to A.M. Nikiforov (2004), special attention has recently been paid to the study of the long-term negative effects of radiation on the human cerebrovascular and cardiovascular system [43, 44, 62, 115].

However, to date, the issue of organizing a system of medical care for people who have experienced IIRNT in the past has not been considered, taking into account the clinical and socio-psychological components of the treatment process.

The purpose and research objectives

The purpose of the study: development of the organizational structure of the medical care system for persons who have been exposed to ionizing radiation of nuclear technologies.

Research objectives:

1) To determine the currently dominant diagnoses of morbidity of people who experienced IIRNT in the past (before 1990), according to the NWSCC.

2) To substantiate a model of the system of medical care for people who have experienced IIRNT, taking into account clinical and socio-psychological aspects.

3) Evaluate the implementation of the clinical aspects of medical care within the framework of the system model.

4) Evaluate the implementation of the socio-psychological aspects of medical care within the framework of the system model.

Scientific novelty

1) An assessment is given of the dynamics of the dominant diagnoses of diseases of persons who experienced IIRNT in the past (before 1990), while providing medical care to these persons currently in St. Petersburg.

2) The organizational structure of the model of the system of medical care for people who have experienced IIRNT has been determined, taking into account the clinical and socio-psychological aspects of medical care.

3) An assessment of the effectiveness of the use of a three-level medical care system within the organizational structure of the model of the system of medical care for persons who have experienced IIRNT has been carried out.

4) The need for the use of additional information, taking into account the socio-psychological aspects of providing medical care to persons who have experienced IIRNT, has been determined.

Theoretical and practical significance of the study

The theoretical significance of the study:

a) it shows the presence of continuity in the composition of the dominant diseases of people who have experienced IIRNT after an eighteen-year period;

b) statistically significant differences were obtained between the study and control groups in the frequency of registration of the following diagnoses of primary diseases:

1) I Diseases of the circulatory system $p < 0.01$ (0.000007);

2) G Diseases of the nervous system $p < 0.05$ (0.031);

3) M Diseases of the musculoskeletal system and connective tissue

$p < 0.01$ (0.004);

4) J Diseases of the respiratory system $p < 0.05$ (0.033).

The exact significance level of the calculated criterion is shown in parentheses.

The practical significance of the study:

a) the application of the considered model of the organization of the system of medical care for persons who have experienced IIRNT allows to improve the quality of medical care for patients and contributes to improving the quality of life of persons in this category [68];

b) an act was received on the implementation of the results of the study «Organization of a system of medical care for persons who have been exposed to ionizing radiation of nuclear technologies» (appendix B)

Research methodology and methods

The methodological basis of the research is the works of domestic and foreign scientists in the field of healthcare organization, regulatory legal acts of the Russian Federation. During the development and implementation of the research program, the methodology of a systematic approach to the development of a model of the system of medical care for people who have experienced IIRNT was used.

A continuous study was applied to a group of veterans of SRU who experienced IIRNT. This group had the status of a study group, and it consisted of 259 people. The selection of participants in the control group of AC representatives who did not experience IIRNT was carried out randomly until a sample size equal to the number of participants in the study group was reached. Random selection of candidates was used in the formation of the three surveyed groups. The group of interviewed veterans of SRU who experienced IIRNT included 103 people, in the group of surveyed AC representatives who experienced IIRNT there were 101 people, and in the group of surveyed AC representatives who did not experience IIRNT there were also 101 people.

When comparing the study and control groups according to the frequencies of registered primary diseases, the choice of criteria for checking the significance of differences in the diagnoses of the same name was determined by the nominal type of processed data «there is a disease – there is no disease». Pearson's criterion 2 met all the necessary conditions of application.

The software package «Microsoft Office 2019» (Excel program) was used as mathematical tools for processing statistical data.

Main scientific results

Significant scientific results were obtained during the research.

1) According to the results of a telephone survey conducted in 2020 of veterans of SRU who experienced IIRNT, together with K. G. Dobretsov and S. S. Moskaleva, a database was developed, filled in and officially registered:

Certificate of state registration of the database No. 2021621045 Russian Federation. Survey data for veterans of special risk units using the author's questionnaire : No. 2021620883 : application 04.05.2021 : publ. 21.05.2021 / E. I. Pershina, K. G. Dobretsov, S. S. Moskaleva ; applicant Federal state budgetary institution «Nnorth-Western district scientific and clinical center named after L.G. Sokolov of the Federal medical and biological agency» [79] (appendix D).

2) The journal «Bulletin of the Ivanovo Medical Academy» discusses the organization of medical care for veterans of SRU of the Russian Federation.

The reasons for special attention to this category of citizens, who were the first in the country to encounter nuclear technologies, including those that ensure the country's defense capability, are indicated. The dominant diagnoses of the morbidity of this contingent are considered. The disability of veterans of SRU has been studied. The history of education and development, as well as the tasks of the scientific and medical center of the Veterans of SRU Committee are described:

Pershina, E. I. Organization of medical care for veterans of special risk units of the Russian Federation / E. I. Pershina // Bulletin of the Ivanovo Medical Academy. – 2020. – vol. 25, No. 2. – pp. 18-22. [67].

3) In a study conducted in the journal «Kremlin Medicine. Clinical Bulletin» together with K. G. Dobretsov, the issues of assessing the quality of medical care provided to veterans of special risk units were considered. 103 veterans of special risk units living in St. Petersburg and the Leningrad region participated in the survey.

According to the survey, it was found that in most cases the causes of disability are diseases of the circulatory system (43.69%), malignant neoplasms (22.33%) and diseases of the nervous system (14.56%). The data obtained indicate that 53.47% of respondents are completely satisfied with the quality of medical care, and the overall satisfaction of the entire group, taking into account partial satisfaction contained in other assessments, reaches 71%. However, the overall dissatisfaction is almost a third (29%), which requires increased attention to the organization of medical care for veterans of special risk units. It is concluded that the greatest attention should be paid to the prevention of diseases that are leading in the formation of disability and to improving the content and quality of medical care:

Pershina, E. I. Assessment of the quality of medical care for veterans of special risk units / E. I. Pershina, K. G. Dobretsov // Kremlin medicine. Clinical Bulletin. – 2020. – No. 4. – pp. 52-58. – DOI 10.26269/8f94-3978 [64].

4) In the process of providing medical care to 259 veterans of SRU living in St. Petersburg and the Leningrad region, they were conducted by specialists of the NWSCC in the period from 2015 to 2019. Analysis of the results of the examination for primary morbidity showed that the first position of the list is occupied by diseases of the circulatory system, the second position is occupied by diseases of the digestive system, the third and fourth positions are divided by diseases of the musculoskeletal system and diseases of the nervous system. Comparing the results obtained in the NWSCC with the results given in the literature, we see that the list of diseases is 80% the same, and diseases of the respiratory system are replaced by malignant and benign neoplasms:

Pershina, E. I. Organization of medical care for veterans of special risk units / E. I. Pershina, S. S. Moskaleva // Jubilee international scientific and practical conference « FSBI SSC FMBC named after A.I.Burnazyan FMBA of Russia: 75 years on guard of human health» : Abstracts of the anniversary international scientific and practical conference, Moscow, November 16-17, 2021. – Moscow: State Scientific Center of the Russian Federation - A.I. Burnazyan Federal Medical Biophysical Center, 2021. – pp. 220-223 [66].

5) One of the most important achievements in diagnostic cardiology is selective coronary angiography (CAG), which is used to determine the degree and nature of coronary sclerosis, treatment tactics and prognosis assessment. The article presents an analysis of the results of examination and CAH in unselected patients with cardiovascular diseases (CVD) – workers of harmful and dangerous industries (the main group) in comparison with an unselected control group who had no contact with harmful industrial factors, who underwent examination and treatment at the L.G. Sokolov Federal State Medical University of the Russian Academy of Medical Sciences. A more preserved state of the coronary bed was revealed in patients of the main group in comparison with the control group. This material was presented with a group of co-authors at the XVIII All-Russian Congress:

Semigolovsky, N. Y. Comparative coronarographic screening of workers of harmful industries as an indicator of the effectiveness of diagnosis and treatment / N.Y. Semigolovsky, S.O. Mazurenko, E.V. Balukova, E.I. Pershina, E.M. Nikolskaya, T.T. Berdikulova // collection of mat. XVIII Vseros. Congress «Health is the basis of human potential: problems and ways to solve them» November 23-25, 2023, St. Petersburg, vol. 18, No. 1, pp.294–303 [12].

The main provisions submitted for protection

1) In order to determine the strategy and tactics of providing medical care to persons who have experienced IIRNT, it is necessary to establish the dominant diseases of this category of citizens.

2) The developed model of the medical care system contains all the necessary elements to address issues of clinical and socio-psychological areas of activity.

3) The results of the analysis of the application of a three-level system of medical care for veterans of special risk units and representatives of the attached contingent of the NWSCC allow us to recommend this method for all persons who have experienced IIRNT.

4) To improve the quality of medical care, it is necessary to apply methods of obtaining additional information containing assessments of the quality of medical care, data on the implementation of the recommendations of the HLS and other elements of the socio-psychological aspect.

Approbation of the research results

1) The act on the implementation of the results of the dissertation research «Organization of the system of medical care for persons who have been exposed to ionizing radiation of nuclear technologies» (appendix B).

2) The main provisions of the dissertation are presented in the form of reports at the following forums:

– Pershina, E. I. Organization of medical care for veterans of special risk units / E. I. Pershina, S. S. Moskaleva // Jubilee international scientific and practical conference « FSBI SSC FMBC named after A.I.Burnazyan FMBA of Russia: 75 years on guard of human health» : Abstracts of the anniversary international scientific and practical conference, Moscow, November 16-17, 2021. – Moscow: State Scientific Center of the Russian Federation - A.I. Burnazyan Federal Medical Biophysical Center, 2021. – pp. 220-223 [66];

– Pershina, E. I. The second scientific and practical conference «Primary health care: modern approaches and best practices» (St. Petersburg, October 6-7, 2022). The conference was held in a hybrid format (in person and on the website). The author of the study presented the report «The working longevity of the attached contingent in the conditions of a «closed cycle» of medical care of the NWDSCC FMBA of Russia»;

– Pershina, E. I. Therapeutic scientific and practical conference «Primary health care: modern approaches and best treatment practices» (Nizhny Novgorod, October 13, 2023). The author of the study presented a report: «A risk-based approach to the longevity of military-industrial complex employees»;

– Pershina, E. I. Therapeutic scientific and practical conference «Primary health care: modern approaches and best treatment practices» (Nizhny Novgorod, October 13,

2023). The author of the study presented a report: «Occupational morbidity of employees of the Northwestern Federal District».

Publications on the topic of the dissertation

Based on the research materials, 7 scientific papers have been published, including 2 articles in peer-reviewed journals included in the List of the Higher Attestation Commission of the Russian Federation and the certificate of registration of intellectual property.

The scope and structure of the dissertation

The volume of the dissertation is 161 pages without appendices (176 pages with appendices).

The dissertation consists of an introduction, 4 chapters, conclusions, conclusions, practical recommendations, a list of abbreviations, a list of references, and appendices.

The list of references includes 104 domestic and 25 foreign sources.

List of illustrations: 32 tables, 30 figures.

Personal contribution of the author

The author carried out a search and analytical review of sources of domestic and foreign literature on the studied problem, and compiled a research program. The author selected patients for a retrospective analysis of the study and control groups, extracted the necessary materials from the NWDSCC database, performed statistical data processing and analyzed the information received, and drew conclusions about the results of medical care. The author selected patients for a survey of a group of veterans of SRU and a survey of two groups of representatives of the AC NWDSCC, processed the data obtained to assess the quality of medical care and other assessments of the

respondents. The author has developed proposals for the organization of a system of medical care for people who have experienced IIRNT.

CHAPTER 1. FEATURES OF MORBIDITY OF PERSONS WHO HAVE BEEN EXPOSED TO IONIZING RADIATION OF NUCLEAR TECHNOLOGIES (LITERATURE REVIEW)

1.1. Data available in open sources on veterans of special risk units of the Russian Federation

1.1.1. The structure of the primary morbidity of veterans of SRU

Since the first experiments with the use of nuclear technologies, a sufficient number of studies have been conducted on the effects of radiation on the human body.

There are a number of publications in the medical literature devoted to the consideration of the peculiarities of the morbidity of veterans of SRU. [22, 40, 48, 70, 88, 99, 111].

The assessment of the level of primary morbidity of veterans of SRU, performed by V.A. Oleshko, showed that during the observation period from 1994 to 2002, 6,163 cases of primary diseases were recorded [60]. The dynamics of the primary morbidity of veterans of SRU in the period under review is shown in figure 1.

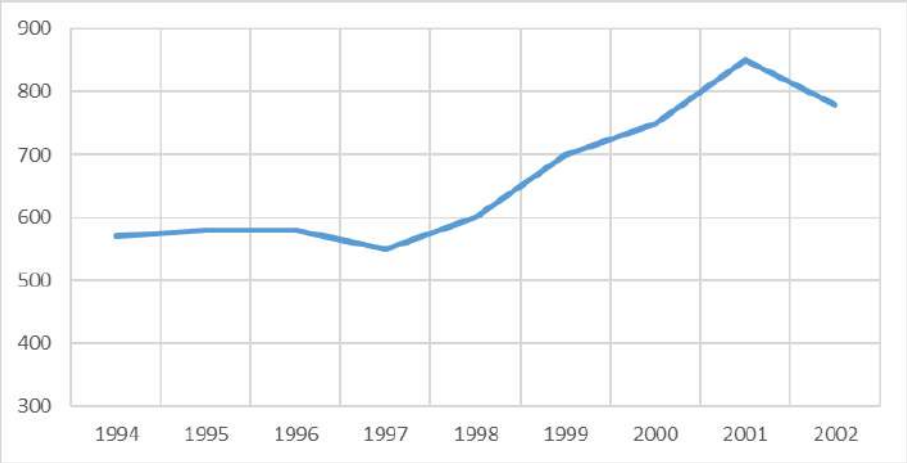


Figure 1 – Dynamics of primary morbidity of veterans of SRU in 1994 – 2002 (per 1000 people)

Note that in the period from 1997 to 2001, the increase in morbidity tended to be constant and significantly increased.

According to V.A. Oleshko (table 1), the structure of primary morbidity of veterans of SRU is dominated by diseases of the respiratory system, circulatory system and digestive organs [60].

Table 1 – Primary morbidity of veterans of SRU in 1994 – 2001 (per 1000 people)

Disease	Year of observation							
	1994	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
Nervous system	70,0	87,9	83,8	93,9	102,4	97,1	100,3	94,9
Circulatory system	92,1	121,8	144,3	162,0	181,0	204,3	219,4	226,6
Respiratory organs	106,3	129,9	158,7	171,6	193,0	216,4	186,3	214,3
Digestive organs	90,6	102,4	111,3	125,2	133,9	126,6	148,1	150,2
Musculoskeletal system	77,4	101,3	99,5	110,1	122,9	134,3	152,0	164,6

It should be noted that in the period 1994 – 1999 respiratory diseases prevailed, and from 2000 to 2001 diseases of the circulatory system began to dominate. Diseases of the digestive system occupied the third position of the list of diseases in 1994 – 1998, and from 1999 to 2001 diseases of the musculoskeletal system began to occupy it [67].

The tendency of diseases of the circulatory system to come to the fore, discovered when considering the primary morbidity of veterans of SRU, is also confirmed when considering the structure of chronic diseases [68].

The analysis of the structure of the main chronic diseases of veterans of SRU, conducted by V.A. Oleshko, showed [figure 2] that in this case, diseases of the circulatory system are leading (29%) [60].

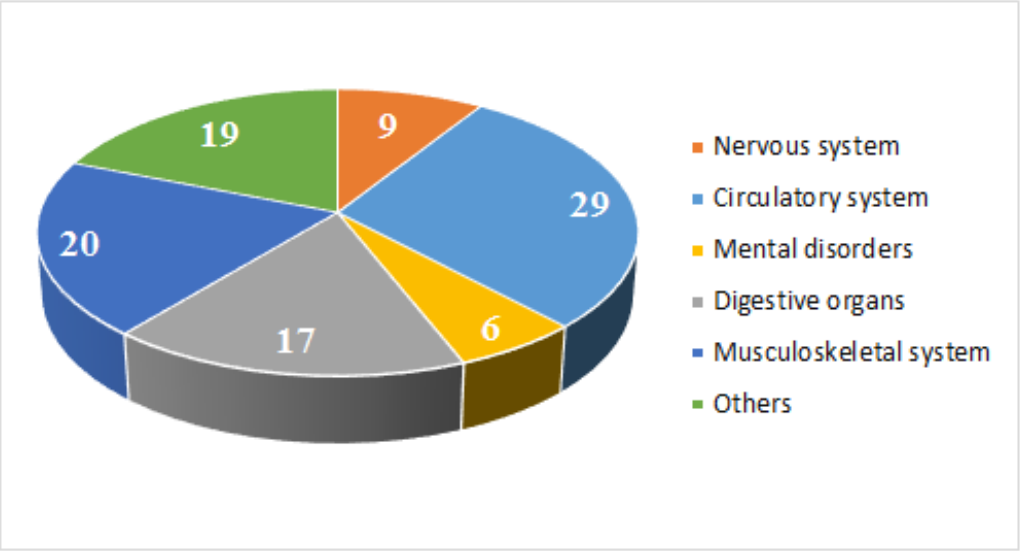


Figure 2 – Structure of chronic diseases of veterans of SRU (as a percentage)

According to V.A. Oleshko, they are followed by diseases of the musculoskeletal system (20%) and digestive organs (17%). Together, they account for 66% of the total number of chronic diseases.

Among the diseases of the circulatory system, hypertension accounts for 38.2%, coronary heart disease – 26.3%, cerebrovascular diseases – 24.1% [60].

Osteochondrosis and arthrosis prevailed among diseases of the musculoskeletal system (more often joints of the lower extremities) [60].

Almost all veterans of SRU of the Russian Federation suffer from osteochondrosis of the spine and polyarthritis. Gastritis and duodenitis (37.7%), peptic ulcer of the stomach and duodenum (22.5%), diseases of the gallbladder and biliary tract (25.2%) dominated among diseases of the digestive organs in veterans of SRU [67].

1.1.2. Long-term effects of radiation exposure

The medical literature describes the pathological changes occurring over time in individual body systems in relation to veterans of SRU.

It should be noted that for veterans of SRU, due to the secrecy of both the work carried out and the facts of the presence of emergency situations in the process of their implementation, until the end of 1992, when the Scientific and Medical Center of the

Committee of Veterans of SRU was established on the basis of the Krasin City Hospital No. 13 in St. Petersburg, no studies of their health were conducted. So there are questions here regarding the timeliness of veterans of SRU seeking medical help and the reliability of determining the primary incidence. For the same reason, for a significant part of veterans, it would be correct if the violation of their health status was additionally considered as a result of the long-term effects of radiation exposure.

The works of N.V. Alishev and his co-authors describe the long-term effects of exposure to radiation and other extreme factors in veterans of SRU in the form of humoral and cellular autoimmune shifts. It was shown that immune disorders were the causes of premature aging, pathology of the cardiovascular system in veterans of SRU [26, 45].

According to A.V. Veselkova, when studying the state of the ENT organs in veterans of SRU, pronounced dystrophic changes in the mucous membrane of the upper respiratory tract with increased bacterial flora, persistent immunodeficiency conditions were revealed, and on the part of the hearing organ – early presbyacoustic changes that manifested 10 years earlier than in healthy people [100].

The features of the dermatomycosis clinic in veterans of SRU were studied. According to A.A. Vashkevich, the main pathogens of mycoses of the skin and its appendages in veterans of SRU are Trichophyton rubrum (96.0%) and Candida spp (16.5%), forming associations in 5.5% of cases. The clinical picture of dermatomycosis in patients exposed to low doses of radiation is characterized by a widespread nature of the lesion involving the skin of the feet, hands, smooth skin, large folds and total damage to the nail plates. There is a combined lesion of the skin of the feet and hands according to the squamous-hyperkeratotic type and multiple total onychomycosis occurring according to the hypertrophic type. It has been shown that the effective treatment of dermatomycosis in veterans of SRU requires long-term use of systemic antimycotics in combination with the use of angioprotectors, multivitamin complexes, hepatoprotectors and adequate external therapy [98].

In the study by V.Y. Rybnikov and V.A. Oleshko, the issues of assessing the biological age of veterans of SRU are considered. The results obtained allowed us to

note that their biological age exceeds the passport age by an average of 5.53 years. In addition, it was found that the distribution of veterans of SRU relative to the control age group of the population by functional classes was significantly different [84].

In general, the research data of V.Y. Rybnikov and V.A. Oleshko indicate premature aging of veterans of SRU, which is a reflection of their previous professional activity associated with exposure to specific factors, chronic polypathology and psychosomatic disorders [84].

It follows from the above that the state of health of veterans of SRU in the long–term period of the study is characterized by an increase in general somatic and psychosomatic morbidity - diseases of the circulatory system, musculoskeletal system, digestive organs, nervous system and mental disorders. This pathology is characterized by polymorbidity, burdened by concomitant diseases and psychosomatic disorders [84].

According to O.V. Dmitriev, cognitive impairment in veterans of SRU is represented by initial forms in the form of moderate cognitive impairment and mild dementia, mainly of vascular etiology. The prevalence and structure of cognitive impairment in elderly and senile veterans of SRU in comparison with the general population of people comparable in basic clinical and demographic indicators, compactly living in the same territory, have no significant differences. The author of the publication concludes that the indicators of cognitive function depend on age and are not associated with the influence of low-level radiation [19].

1.1.3. The structure of disability of veterans of SRU

The work of V.A. Oleshko shows that according to the data of the medical and social expert commission of the Russian Federation, as of January 1, 1999, 9871 people (56%) out of 17,793 veterans of SRU had a disability group. According to the author's own data, as of January 1, 2006, more than 63% of the 25,800 veterans of SRU had a disability group [60].

The publication by V.Y. Rybnikov and V.A. Oleshko shows the structure of disability for various categories of citizens of the Russian Federation [84].

These data are shown in table 2.

Table 2 – Comparative data on the severity of disability of veterans of SRU, liquidators of the Chernobyl accident, residents of St. Petersburg and the population of the Russian Federation (before 1999, as a percentage)

Disability group	Veterans of SRU (1999)	Liquidators of the Chernobyl accident*	Residents of St. Petersburg, the entire population*	Of the Russian Federation as a whole, the entire population (1998)
1 group	12	2	6	12
2 group	72	43	84	66
3 group	16	55	10	22

Note. According to A.M. Nikiforov and co-authors [67]

It should be noted that when comparing the data of V.Y. Rybnikov and V.A. Oleshko [84], as well as the data of A.M. Nikiforov and co–authors [62], there is a shift in the number of citizens with disabilities towards a less severe form of disability - for persons from the liquidators of the Chernobyl accident relative to veterans of SRU.

The reasons for this may be that the composition of the liquidators of the consequences of the accident had its own characteristics. After all, due to the fact that the accident at the Chernobyl nuclear power plant was an extraordinary event, there were no special units for the elimination of its consequences, such as those. There is no exact information about the composition of the liquidator contingent, however, it was known from the media at that time that active military personnel and civilian specialists of working age participated in this operation. It follows from this that the liquidators were much younger than the veterans of SRU, which caused the difference in the disability structure of these population groups at the time of the study. It is possible that as the age of liquidators increases, the disability structure of this category of citizens will approach the disability structure of veterans of SRU.

The moment of the actual onset of disability of veterans of SRU is shifting towards a younger age and occurs at a higher rate. Perhaps this is due to the fact that there was no timely fixation of the fact of disability and timely initiation of preventive and therapeutic procedures.

According to V.Y. Rybnikov and V.A. Oleshko, the main causes of disability for veterans of SRU are diseases of the circulatory system, which account for 49%. Diseases of the nervous system and sensory organs occupy the second place (16%), followed by diseases of the digestive system (11%), mental disorders (9%) and diseases of the musculoskeletal system (8%). Neoplasms, as the cause of primary disability, occupy the sixth place (7 %) [67, 84].

These data largely overlap with the data on primary and chronic diseases given in paragraph 1.1.1. of this chapter, which makes it possible to consider the possibility of preventing and (or) providing a lighter course of disability for veterans of SRU through preventive preventive measures.

1.1.4. The main tasks of the scientific and medical center

The studies conducted in the country on the effects of IIRNT on veterans of SRU provided medical institutions with materials on the basis of which it became possible to provide this category of citizens with appropriate medical care. To increase the accessibility of the required medical care to veterans of SRU and, at the same time, to continue scientific work in this direction, a medical center was created that combines the properties of a medical and scientific institution.

The main objectives of the SMC are:

– study of the state of health and provision of medical care to persons who have experienced IIRNT and other pathogenic factors;

– study of the peculiarities of the course of diseases, and the development of new diagnostic and treatment methods that provide a differentiated approach to providing outpatient and inpatient care to veterans of SRU;

– improvement of methods of preventive care and medical rehabilitation aimed at a complete cure, as well as to alleviate the course of chronic diseases;

– informing veterans of SRU about social benefits and assistance in their registration [86].

1.1.5. The results of the survey of veterans of SRU in MSH No. 144

According to V.I. Puchkova and co-authors, in studies conducted at the SMC in the period from 2008 to 2016, when characterizing the incidence of diseases in veterans of SRU and control group individuals, diagnoses of the main and concomitant diseases were evaluated and accounted for according to their medical histories [33].

The authors of the publication considered the importance of immune mechanisms for the formation of pathological processes, including the immediate and long-term consequences of radiation exposure [26, 87, 105, 110, 112, 127, 128, 129].

It was analyzed according to the international classification of diseases

(ICD-10) incidence of the following diseases:

1. Infectious and parasitic diseases

2. Neoplasms

4. Diseases of the endocrine system

5. Mental and behavioral disorders

6. Diseases of the nervous system

7. Eye diseases

8. ENT diseases

9. Diseases of the circulatory system

10. Respiratory diseases

11. Diseases of the digestive system

13. Diseases of the musculoskeletal system

14. Diseases of the genitourinary system [63, 87].

The incidence rate was studied in groups of veterans of SRU who had been in radiation accidents on nuclear submarines, and in control groups of people of the same age, but not related to radiation [33].

The authors of the publication list the following environmental factors for submariners:

– long-term, up to 120 days, scuba diving;

– exposure to physical fields (magnetic, electromagnetic, electric):

– harmful chemical air pollution (up to 300 harmful impurities);

– radiation (gamma radiation, neutron radiation).

In accidents with nuclear submarines, people are exposed to combined external and internal radiation in combination with factors of a non–radiative nature - stress, toxic chemicals, hyperthermia and others [95].

The authors of the publication studied the consequences of radiation accidents on nuclear submarines in the long term (after 10, 20 and 30 years) after radiation exposure. The frequency of diseases was studied. The results of the analysis of the number of diseases according to 100 medical records of veterans of NPL were obtained and compared with the results of a control group of 23 people of the same age who were examined at the SMC, but were not associated with radiation exposure [33].

The results of the analysis of the number of diseases of the radiation accidents on nuclear submarines liquidators according to ICD-10 are shown in table 3.

Table 3 – Number of diseases of nuclear submarine accident liquidators according to ICD-10

Group	**The number of ICD-10 diseases per 100 nuclear submarine accident liquidators**									
	1	**2**	**4**	**5**	**6**	**7**	**8**	**11**	**13**	**14**
NPL veterans	62	19	25	13	57	35	9	94	92	96
Control	27	9	9	4	32	32	4	45	50	32
The validity of the	0,001	–	0,01	0,05	0,001	–	–	0,05	0,001	0,001

According to the authors of the publication, the differences in morbidity in the diagnoses of «Respiratory diseases» and «Diseases of the cardiovascular system» between representatives of the study and control groups were unreliable ($p>0.05$), and pathology of the respiratory and cardiovascular systems was often found not only in liquidators, but also in the control group of people, although not related to radiation, they were examined at the SMC [33].

According to the observations of the authors of the publication, from the materials obtained, it can be seen that a number of diseases were detected more often in submarine veterans of SRU compared with the control group. These differences were

especially pronounced and significant for endocrine, digestive, genitourinary, musculoskeletal and infectious diseases [33].

The authors of the publication draw attention to a more than three-fold predominance of the number of recorded diagnoses of «Mental disorders and behavioral disorders» in the study group when compared with the control group ($p<0.05$) and a predominance ($p<0.001$) of the number of diagnoses of «Nervous system disease», which may be due to an emergency stressful situation [33].

1.2. Data on liquidators of the consequences of the Chernobyl accident living in Russia

1.2.1. Materials of the 20-year dispensary observation

A group of Russian authors (T.M. Koroleva, V.N. Nuralov, I.E. Bronstein) analyzed the materials of a 20-year dispensary monitoring of the health of the liquidators of the Chernobyl accident. The comparison of primary morbidity in groups of liquidators with average radiation doses differing by an order of magnitude and the same age distribution was carried out [39].

According to the authors, the collection of information for the study was carried out in 2006 on the basis of the specialized city department of radiation occupational pathology of Hospital No. 20 in St. Petersburg. From the total database of 4,300 people, medical records of persons with officially registered doses of external radiation who have visited the dispensary for 20 years have been allocated. Two observation groups were formed by retrospectively examining the available material. The 1st group included persons with an external radiation dose of at least 200 mGr, and the second group included persons with an external radiation dose of no more than 50 mGr. Both age-matched groups were copy-pairs. The study of the health indicators of liquidators was carried out in the time interval from 1986 to 2005.

Each of the groups included 145 people. All persons in the first group were exposed to radiation in 1986-87 (87% of them in 1986). Of the second group, 70 % of individuals received a dose of radiation in 1988-89. The 20-year average primary

morbidity in group 1 was higher than in group 2 in all the considered classes of the international classification [39].

The results of the study on the types of diseases of liquidators are presented in table 4.

Table 4 – Comparative data on primary morbidity in groups of liquidators from 1986 to 2005

Software class ICD-10	**Type of disease**	**Group**	**N**	**%**	**Msr**	**P**
–	**All types of diseases**	1	1160	100	792,3	**0,001**
		2	998	100	688,7	
II	**Malignant neoplasms**	1	12	1	8,2	0,092
		2	5	1	3,4	
V	**Diseases of the nervous system**	1	150	13	102,5	**0,047**
		2	118	12	81,2	
IX	**Diseases of the circulatory system**	1	303	26	207,1	0,094
		2	265	27	183,9	
XI	**Diseases of the digestive system**	1	175	15	119,6	0,220
		2	153	15	105,3	
XII	**Diseases of the skin and subcutaneous tissue**	1	12	1	8,2	0,068
		2	4	1	2,7	
Software class ICD-10	**Type of disease**	Group	N	%	Msr	P
XIV	**Diseases of the genitourinary system**	1	50	4	34,2	**0,013**
		2	28	3	19,3	

Notes. 1. «N» is the number of cases of diagnosis; «%» is the percentage of diagnosis; «P» is the significance of differences according to the criterion «$\chi 2$» with the number of degrees of freedom df = 1; «Msr» is the average primary morbidity per 1000 people over 20 years of follow–up, in ppm; 2. Significant differences between groups are highlighted in bold

In both groups, the leading position in terms of the number of cases is occupied by diseases of the circulatory system, while the difference between the groups was not too large (statistically insignificant), which indicates a small dependence of this diagnosis on the received radiation dose.

The second position in terms of the number of cases turned out to be in diseases of the digestive system, and the differences between the groups are again statistically insignificant, and the dependence on the radiation dose is also small.

The third position in terms of the number of cases is fixed for diseases of the nervous system, for which there is also a statistical significance of differences between groups, which indicates an existing dependence on the radiation dose.

The fourth position in terms of the number of cases is allocated for diseases of the genitourinary system, which, although they do not exceed a five percent threshold, attract attention by the statistical significance of differences between groups depending on the radiation dose.

The remaining types of diseases do not exceed the one and a half percent threshold in number, and the difference in groups has no statistical significance [39].

1.2.2. Materials on treatment in a 24-hour hospital in the period from 2016 to 2018

Another team of authors (S.S. Aleksanin, V.Y. Rybnikov, K.K. Rogalev, V.A. Tarita) considered the features of morbidity and the main classes of diseases in victims of the Chernobyl accident in the long-term period when providing specialized medical care in a 24-hour hospital in the period from 2016 to 2018 [90].

They analyzed 4,195 medical records of liquidators of the consequences of the Chernobyl accident who underwent inpatient treatment in multidisciplinary clinics of the All-Russian Center for Emergency and Radiation Medicine named after A.M. Nikiforov of the Ministry of Emergency Situations of Russia (St. Petersburg), as part of the activities of the Union State in 2016-2018. The main groups of people exposed to radiation as a result of the Chernobyl disaster are participants in the liquidation of the consequences of the Chernobyl nuclear power plant and residents of radioactively contaminated territories [1, 2, 51].

According to the National Radiation and Epidemiological Register (Register), in 2015, 710.7 thousand people from among those exposed to radiation as a result of the Chernobyl disaster were registered in the Register, of whom 197.1 thousand liquidators

of the consequences of the Chernobyl accident, 7332 evacuees, 447 thousand who lived (lived) in the four most polluted areas were registered in primary accounting groups territories of the Russian Federation (Bryansk, Kaluga, Oryol and Tula regions) [51].

The medical features of this contingent are clinical polymorbidity with an increased risk and a higher level of general morbidity, as well as persistent social disadaptation due to psychological trauma due to the factor of long-term effects of radiation exposure [1, 3, 7, 28, 49, 76, 89].

The authors of the publication found that in the process of providing specialized, including high-tech, medical care to 4,195 victims of the Chernobyl accident, 85% of patients belonged to the category of liquidators. The remaining 15% belonged to the category of citizens living (who lived) in the radioactively contaminated territories of Russia. The age of the patients was 60 years or more, 87% were men. Of the patients belonging to the category of liquidators of the consequences of the Chernobyl accident, 70% had an established disability, mainly of the second group, which is largely close to similar data on the distribution of veterans of SRU by disability groups [89].

The volume of specialized medical care provided in the conditions of the round-the-clock hospital of the ARCERM by the main classes of diseases according to ICD-10 from 2016 to 2018 are presented in table 5.

Table 5 – The main diseases of victims of the Chernobyl accident in the period from 2016 to 2018 г.

Software class ICD-10	**Type of disease**	**Number by year**			**In 3 years**	
		2016	**2017**	**2018**	**Abs.**	**%**
II	Neoplasms (C00–D48)	27	27	27	81	3
III	Diseases of the blood, hematopoietic organs and individual disorders involving the immune mechanism (D50–D89)	2	3	7	12	1
IV	Diseases of the endocrine system, eating disorders and metabolic disorders (E00–E89)	76	63	73	212	8
VI	Diseases of the nervous system (G00–G98)	22	20	20	62	2
V	Diseases of the eye and its accessory apparatus (H00–H59)	20	10	38	68	3

Table continuation 5

IX	Diseases of the circulatory system (I00–I99)	538	289	450	1277	48
X	Diseases respiratory organs (J00–J98)	76	56	61	193	7
XI	Diseases of the digestive system (K00–K92)	156	108	108	372	13
XIII	Diseases of the musculoskeletal system and connective tissue (M00–M99)	133	67	102	302	11
XIV	Diseases of the genitourinary system (N00–N99)	11	3	12	26	1
XVII	Congenital anomalies [malformations], deformities and chromosomal abnormalities (Q00–Q99)	2	0	2	4	1
XIX	Injuries, poisoning and some other consequences of exposure to external causes (S00–T98)	7	3	9	19	1
XXI	Factors affecting the health of the population and appeals to medical organizations (Z00–Z99)	10	3	0	13	1
	Total:	**1717**	**1025**	**1453**	**4195**	**100,0**

Note. «Abs.» – absolute value; «%» – percentage value.

According to the results of the study, it was determined that the first position is occupied by diseases of the circulatory system (48%). Diseases of the digestive system are in the second position (13%), and diseases of the musculoskeletal system and connective tissue are in the third position (11%). The fourth and fifth positions are for diseases of the endocrine system (8%) and respiratory diseases (7%), respectively. The number of liquidators of the consequences of the Chernobyl accident with other diseases is three percent or less of the total number of treated [90].

1.3. Data on the liquidators of the consequences of the Chernobyl accident living in the territories of the former republics of the USSR

1.3.1. Data on Tajikistan

By now, the biological mechanisms of IIRNT on the human body in the near future after irradiation have been more or less well studied. However, many aspects of the effect of radiation in the long term remain poorly understood [6].

According to A.M. Nikiforov (2004), special attention has recently been paid to the study of the long-term negative effects of radiation on the human cerebrovascular and cardiovascular system [43, 44, 62, 115].

Considering the pathogenetic features of cardiovascular and cerebral pathology in long-term exposure to radiation, the authors' opinions are reduced to the leading role of chronic emotional stress. The cause of cerebrovascular disorders in liquidators are bioelectric signs of microstructural brain lesions characteristic of lesions of diencephalic structures (increased excitability of the higher parts of the autonomic nervous system), indirectly disrupting the regulation of the cardiovascular system [6, 50, 52, 69, 114, 125].

From the publications of P.N. Lyubchenko and co-authors (2004) and O.A. Kolenchukova and co-author (2006), the commonality of pathogenetic mechanisms in the formation of cerebrovascular and cardiovascular pathology is quite obvious, which cannot be considered in isolation from each other [38, 47]. The ambiguity of the results of previous studies in territories with different climatic and geographical conditions led to the need to study the pathogenetic features and risk factors for the development and progression of cardiovascular and cerebrovascular pathology in liquidators in the long-term period after the Chernobyl accident [6].

According to Z.D. Aliyeva (2013), a survey of 500 residents of Tajikistan who took part in the liquidation of the consequences of the Chernobyl accident at the age of 41 to 63 years was carried out [6].

Depending on the time elapsed after the accident, all the surveyed were divided into 2 groups: the first group – 300 people who worked early.

(1986 – 1987), and the second group – 200 people who worked late (1988 – 1990) (table 6).

Table 6 – Distribution of the surveyed by age

Age	1 group (1986-1987)		2 group (1988-1990)		Total	
	Abs.	%	Abs.	%	Abs.	%
41-49 years old	160	53	116	58	276	55
50-59 years old	104	35	67	34	171	34
60-63 years old	36	12	17	8	53	11

Note. «Abs.» – absolute value; «%» – percentage value

The majority of the surveyed were men aged from 41 to 49 years old: 160 people (53%) from the first group and 116 people (58%) from the second group. The total number of both groups is 276 people (55%). It is typical for this age category that at the time of the accident, the examined persons were between 18 and 20 years old (conscript soldiers) [6].

According to the available documentation, the liquidators of the first group received higher doses of radiation (table 7).

Table 7 – Distribution of the examined depending on the received radiation dose

Radiation dose	1 group (1986-1987)		2 group (1988-1990)		Total	
	Abs.	%	Abs.	%	Abs.	%
from 0.1 to 5.9 rem	129	43	112	56	241	48
from 6,0 to 10,9 rem	126	42	83	42	209	42
from 11 to 20,9 rem	37	12	2	1	39	8
from 21 to 40 rem	8	3	3	1	11	2

Note. «Abs.» – absolute value; «%» – percentage value

The analysis of the results of an in-depth medical examination showed the predominance of diseases of the neuropsychic sphere, which were registered in 325 (65%) liquidators. Next were diseases of the circulatory system, which were found in 268 (54%) of the examined [6].

Urinary tract diseases and endocrine pathology are quite common manifestations of health disorders of liquidators. The general structure of morbidity is shown in table 8.

Table 8 – Structure of the general morbidity of liquidators of the consequences of the Chernobyl accident

Morbidity	Abs.	%
1. Diseases of the neuropsychic sphere	325	23
2. Diseases of the circulatory system	268	19
3. Diseases of the endocrine system	170	12
4. Diseases of the urinary tract	161	11
5. Diseases of the gastrointestinal tract	130	9
6. Prostate diseases	88	7
7. Diseases of the liver and biliary tract	74	6
8. Diseases of the pancreas	61	4
9. Impotence	55	4
10. Diseases of the blood and hematopoietic system	48	3
11. Infertility	33	2

Note. «Abs.» – absolute value; «%» – percentage value; the total value of diagnoses in the column «Abs» exceeds the number of examined (500). An average of 2.8 diagnoses per person were determined. The structure was calculated based on the number of recorded diagnoses (1413)

The author of the publication concluded that age, the period of participation in rehabilitation work, and the dose of radiation received are important for an unfavorable prognosis of the formation of cardiovascular and cerebrovascular pathology [6].

An analysis of the morbidity structure of the liquidators of the consequences of the accident in the long-term period (25 years) showed that the priority is shifting towards diseases of the neuropsychiatric sphere (23%) and cardiovascular pathology (19 %) [6, 117, 118, 124].

A comparative analysis of the indicators of central hemodynamics in liquidators of the same age and the same period of work showed that in persons with the lowest received dose of radiation, an optimal level of blood supply is maintained in accordance with the energy needs of the body, and in persons who received a dose of radiation above 15 rem, intense work of the cardiovascular system is traced, and its compensatory capabilities may be disrupted [6].

The liquidators of the consequences of the Chernobyl accident, who worked in the early stages, recorded a high intensification of the processes of lipid peroxidation

against the background of insufficient activity of the antioxidant system (catalase activity). Such a state of the specified processes determines the destruction of cellular structures of organs and, in combination with other risk factors, contributes to the faster formation of cardiovascular pathology [6].

Electroencephalogram (EEG) analysis in the long-term period after the Chernobyl accident, liquidators revealed violations of the bioelectric activity of the brain, assessed (according to the classification of E.A. Zhirmunskaya) both significant (55.8%) and moderate (30.3%). An increase in the frequency of occurrence of type IV, a decrease in type I EEG and the appearance of type V EEG in liquidators compared with a group of practically healthy people is shown. The leading type of EEG changes is represented by disorganization of the dominant alpha activity. Spectral analysis of the liquidators' EEG showed a maximum increase in the power of bioelectric activity of the brain in the delta and theta frequency ranges in the temporal, frontal and central regions of the cerebral cortex [6].

The established changes in the systems of the processes of lipid peroxidation and bioelectric activity of the heart and brain indicate the need for preventive treatment of hemodynamic disorders and cerebrovascular pathology with the mandatory inclusion of antioxidants and immunocorrecting drugs in the complex [6].

1.3.2. Data on Armenia

Despite its remoteness from the site of the global Chernobyl disaster, Armenia also became involved in its sphere: in addition to radioecological problems, which were also significant, a large group of people (more than 3,000 people) formed in Armenia who were directly involved in the elimination of the consequences of the accident [72].

In this regard, the study of the health status of this cohort is of great scientific and practical interest, which is due not only to radiation and non-radiation exposure factors common to all countries involved in the accident, but also to a number of features specific to the inhabitants of Armenia (geographical location of the country, national peculiarities of mentality and gene pool factors, socio-economic conditions, psychoneurotic factors and so on) [72].

According to the authors of the publication, more than 2,500 liquidators of the consequences of the Chernobyl accident are under dynamic supervision. They are monitored according to a developed three-stage system, including dispensary, inpatient and rehabilitation stages. The age of the liquidators at the time of the accident was 20-55 years (12.6% of the subjects were aged 20-30 years, 31-40 years – 32.7%, 41-50 years – 38.5% and over 50 years – 16.2%). The main number of liquidators was in the accident zone in 1986 – 51.2%; and the rest – in 1987 (33.8%), in 1988 (14.3%) and in 1989 (0.7%). All liquidators were divided into three groups: the first consisted of persons with an external radiation dose (DVO) of up to 10 cGy, the second – (10-20) cGy and the third – more than 20 cGy [46].

The results of long-term studies have shown that pathological processes in liquidators, which were formed, as a rule, as a result of prolonged but low-intensity exposure to IIRNT, evolved further against the background of the pathogenic effect on the body of many non-radiation factors leading to the activation of its compensatory and adaptive mechanisms, which eventually led to the disappearance of symptoms characteristic of acute radiation exposure defeats [46].

According to the research results, it was found that the health indicators of liquidators deteriorated throughout the observed period, which generally corresponds to the existing literature data. Comparative analysis revealed that, on the one hand, there was a significant increase in pathological conditions atypical for radiation lesions and reflecting morphofunctional disorders of a polyethological nature in the protective and regulatory systems of the body, on the other hand, an increase in the number of diseases that can be considered radiation-related was revealed [46].

As the analysis of the dynamics of morbidity showed, the liquidators of Armenia had a gradual increase in diseases of the nervous and cardiovascular systems, gastrointestinal tract, respiratory organs and other systems (table 9). At the same time, 70% of the liquidators had the underlying disease for the first time after the work on the elimination of the accident. It is important to note that the average number of diagnoses per liquidator has increased from 1.5 over the past years in 1987 to (7 ... 8) – in recent years.

Table 9 – Dynamics of the morbidity of liquidators according to the data of dispensary observation (per 100 people)

Morbidity by organs and systems	Year of observation					
	1987	1990	1995	2000	2005	2010
Nervous system	32,0	60,4	78,0	94,6	68,0	69,2
Cardiovascular system	13,7	10,8	48,1	81,8	82,0	72,1
Respiratory organs	15,0	26,1	39,0	57,0	76,0	47,7
Digestive organs	16,3	30,8	27,4	59,4	55,0	40,1
Diseases of the musculoskeletal system	21,9	23,8	30,1	23,2	49,0	50,3
Genitourinary system	2,5	4,1	6,3	10,1	15,0	18,2
Neoplasms	0,1	0,2	1,3	2,5	3,0	3,4

Note. The figures correspond to the percentages of liquidators who have diseases of organs and systems shown in the table

From the data shown in table 9, it can be seen that diseases of the nervous system prevailed among liquidators until 2000, which, gradually increasing, amounted to more than 80% in the general structure of morbidity in (1987 – 2000). Apparently, these diseases, manifested in the first years after the accident, mainly in the form of functional nervous and neuropsychic disorders, later somatizing themselves as cardiocerebral pathologies, played an important role in the somatization of diseases of other organs and systems [23, 24, 31, 32].

It should be noted that in the period (2005 – 2010), diseases of the cardiovascular system took the first position, which corresponds to the data of V.A. Oleshko [64] given in Table 1 for the period (2000 – 2001).

In assessing the consequences of the accident, great importance is attached to the mortality of liquidators. This figure was in 2005. it amounted to 7.8% (172 people over all years). In the structure of causes of death, diseases of the cardiovascular system occupy the first place – 27.9%; followed by neoplasms, injuries (car accidents), diseases of the nervous system, respiratory organs, gastrointestinal tract, etc. Thus, among the causes of death, there is no pronounced connection with the work to eliminate the consequences of the accident and all cases are within the usual statistics for these

pathologies. There was no dependence of mortality on the year of work at the Chernobyl nuclear power plant [46].

The majority of liquidators with organic pathology (92%) revealed asthenic and depressive syndromes, manifested by pronounced weakness, drowsiness, mood instability, decreased mental performance, memory disorders, and decreased sexual activity.

Long-term monitoring of the Armenian contingent of liquidators revealed an increase in cardiovascular diseases among them – from 13.7% in 1987 to 82% in 2005. Moreover, as in the case of nervous disorders, there was a correlation between the year of stay of the liquidators in the accident zone, which indicates the dose dependence of diseases of the cardiovascular system [46].

Dynamic analysis of electrocardiogram changes revealed that in more than half of patients with pathology of the cardiovascular system, the sinus rhythm remained, which decreased dynamically, giving way to violations of automatism. In the initial period of the study, the patients had more pronounced parasympathetic effects, which in the long term turned into sympathetic ones. In the long-term period of the study, an increase in excitability was revealed, mainly due to ventricular extrasystoles, and a dynamic increase in more serious disorders of conduction function was noted.

A dynamic increase in hypertrophy of different parts of the heart was noted. Changes related to myocardial nutrition, mainly expressed in the initial period of the study in the form of hypoxia, decreased in dynamics due to decreased nutrition and impaired LV coronary circulation. The dynamics showed an increase in patients with scarring. All of the above changes indicate an increase in pathology and deeper changes in the cardiovascular system of the liquidators in the long-term period of the study, which are associated with both age-related changes and IIRNT [8, 57, 102].

Of course, bad habits are of great importance in the development of diseases of the cardiovascular system: smoking, alcohol consumption and others. The combination of several risk factors increases the likelihood of clinical manifestations of the disease or its complications. In this regard, it is advisable to allocate the total total risk of diseases of the circulatory system, in the development of which it is impossible to name

a single causal factor. It is impossible to deny the possibility of direct radiation damage to the vascular endothelium with the subsequent development of atherosclerosis and fibrosis in those exposed to radiation in the dose range that reached and exceeded the threshold level. However, in the range of low doses, a regular increase in the frequency of diseases of the circulatory system with an increase in dose has not been established. In these cases, they are most closely correlated with lifestyle and risk factors, which are aggravating factors. [10, 74, 91, 103].

Literary data indicate that among the diseases of the liquidators of the consequences of the Chernobyl accident, an important place is occupied by diseases of the respiratory system, which, according to official medical statistics, have reached one of the first places in morbidity. The pathology of the bronchopulmonary system includes primary and secondary organopathological changes in the lungs caused by radiation damage (radiation bronchitis and pneumonitis, incorporation of radionuclides with possible malignancy). It has been established that «Chernobyl dust» is a risk factor in the occurrence of chronic obstructive bronchitis, which, in combination with smoking, becomes an important risk factor for lung tumor diseases [46].

In the cohort of liquidators studied by the authors, in the last years of observation, respiratory pathology amounted to 76%, compared with 15% in 1987. The main nosological form is chronic obstructive bronchitis.

The authors' study of the dependence of respiratory morbidity on the year of stay in the Chernobyl zone revealed a direct relationship: 50% of liquidators with this diagnosis were in the zone in 1986; 33% – in 1987; and 17% – in 1988.

Long-term observations of the liquidators of the consequences of the accident revealed a significant contribution of the pathology of the digestive organs to the overall morbidity structure of this group. Most researchers believe that an increase in the frequency of diseases of the gastrointestinal tract is associated with risk factors, which include exposure to low doses of IIRNT, psychoemotional stress, changes in diet, work, rest, smoking, alcohol [46].

Based on complaints, several clinical syndromes have been identified:

– dyspeptic;

– painful;

– asthenoneurotic.

According to the structure, several groups of diseases of the digestive system are distinguished:

I – esophagitis, gastritis, duodenitis, pancreatitis;

II – peptic ulcer of the stomach and duodenum 12;

III – enteritis, enterocolitis, colitis, hemorrhoids;

IV – hepatitis, cholecystitis, biliary dyskinesis;

V – tumors of the gastrointestinal tract and hepatobiliary system.

As can be seen from the data shown in Table 9, over the years of observation, the liquidators showed an increase in diseases of the digestive system from 16.3 % up to 55%, the frequency of group I diseases increased 4.7 times, II – 2.2 times, IV – 7 times. There was no increase in cases of intestinal diseases, in general they accounted for 4.8% of diseases of the digestive system. The leading pathology in the class of diseases of the digestive system are chronic gastritis, gastroduodenitis, bulbitis, which were observed in 16% of the liquidators, followed by chronic hepatitis, which makes up 14%. Peptic ulcer of the stomach and duodenum occupies the third place (7.4%), chronic cholecystitis, pancreatitis account for 4% and 3%, respectively [46].

The authors of the study draw our attention to a number of changes characteristic of liquidators, which were found during the analysis of long-term laboratory data on various physiological and biochemical parameters. Thus, it turned out that the liquidators had cell-type immunodeficiency, an increase in the number, including Co-lymphocytes, a decrease in the phagocytic activity of peripheral blood neutrophils, complementary activity of blood serum and anti-infectious resistance, which manifested itself by pronounced dysbiotic phenomena in the composition of the skin, oral cavity and intestinal automicroflora and contributed to the development of diseases in the pathogenesis of which a significant immune mechanisms play a role [46].

1.4. A promising direction for the development of scientific and clinical components of medical care for persons who have been exposed to ionizing radiation of nuclear technologies

The use of biodosimetry to assess the degree of exposure to ionizing radiation from nuclear technologies on the human body should be considered as a promising direction.

According to V.Y. Nugis, A.Y. Bushmanov, E.E. Zapadinskaya and co-authors (2016), immediately after the Chernobyl accident, dose indication by chromosome aberrations (dicentrics) in peripheral blood lymphocyte cultures using the classical staining method was almost the only available source of information about doses received by affected persons, and in the work [71] The examination was mainly performed on patients who developed acute radiation sickness of varying severity [18].

Also, in a number of studies, cytogenetic analysis was used to determine lower doses of radiation damage in representatives of various groups of liquidators and residents of contaminated areas (adults and children) [13, 14, 15, 16, 20, 78, 93, 94, 101]. However, in the near future after this event, the study of chromosomal aberrations was performed only in a relatively small part of people who could have been exposed to radiation [18].

Subsequently, there was both a general need to assess the magnitude of the lesion of more significant contingents, and the need to indicate the very fact of radiation exposure and the dose received during the passage of interdepartmental expert councils to establish the causal relationship of diseases, disability and death of citizens exposed to radiation factors.

Since over time, the levels of unstable chromosome aberrations, which include dicentrics (the main indicator of radiation damage in the near future after exposure), tend to decrease their frequency, then for a more adequate assessment of the doses received in the long term or with chronic exposure (in contaminated areas), in

accordance with the methodological recommendations IAEA [108], various researchers have applied the FISH method of chromosome staining [85, 92, 96, 101].

The venous blood of persons allegedly exposed to radiation as a result of the Chernobyl disaster served as the material for cytogenetic studies. The surveyed group included liquidators of the consequences of this accident (41 people) and residents of contaminated areas (17 people). Blood sampling from various individuals was carried out in the general time interval from October 2014 to September 2015, i.e. approximately 28.4 – 29.4 years after the accident. Both FISH coloring of chromosomes and classical coloring of chromosome preparations were used for parallel comparison (in most individuals) [18].

The authors of the work provide estimates of the doses obtained based on the detected frequencies of FISH translocations. At the same time, they first established the statistical significance of the observed difference in the frequency of chromosome aberrations from their background values, and already in the case of a significant increase in the level of chromosome damage in the examined individual, they calculated the dose using the dose–effect calibration curve [9]. For this comparison, the χ^2 method with the Yates correction was used. At the same time, regardless of any number of analyzed cells, the presence of a single aberration, even belonging to the group of indicators of radiation exposure, cannot indicate overexposure and serve as a reason for quantifying the dose [17].

In general, the frequencies of FISH-registered translocations exceeded background levels in 15 (out of 58) people: in 12 (out of 41) liquidators and in 3 (out of 17) residents of contaminated territories. These data did not reveal a significant difference between the two groups in the number of individuals with a cytogenetically assessed dose ($p = 0.178$, Fisher's exact criterion). Doses for liquidators and residents ranged from 180 to 480 and from 200 to 240 mSv, respectively [17].

The authors of the publication made the following conclusions:

1) almost 30 years after the Chernobyl accident, it is possible to estimate the dose to the whole body in people involved in this situation using the FISH chromosome staining method;

2) in the same contingent, using the classical method of chromosome coloring, it was not possible to identify a significant difference in the frequency of chromosome aberrations from their background values;

3) the liquidators of the Chernobyl accident and residents of contaminated territories are characterized by the detection of single strongly aberrant cells in peripheral blood lymphocyte cultures, apparently associated with the action of non-emitting radionuclides, the dosimetric interpretation of which remains unclear [18].

In the work of V.Y. Nugis, A.Y. Bushmanov, M.G. Kozlova, O.A. Tikhonova [57], the above-mentioned study was further developed [18].

The authors indicated that the average retrospective assessment of the whole body radiation dose was performed only by the frequencies contained in the cells of single translocations [107, 122, 123]. The computerized Metafer 4 system (MetaSystems, Germany) was used to automatically search for metaphases and analyze them on the monitor [17].

The recalculation of the observed number of translocations for the entire genome was carried out using the methods presented in the works of domestic and foreign authors [85, 92, 94, 96, 101, 109, 113, 121, 126].

Another one was added to the conclusions made by the authors in a previous publication: the correlation between physical and biological dose estimates, although there is, is very weak. Therefore, according to the authors, the accuracy of Chernobyl documented physical dose estimates is questionable.

CHAPTER 2. MATERIALS AND RESEARCH METHODS USED

2.1. Research methodology

In accordance with the set goal and the tasks to be solved, the objects of research, units of observation, sources of information used and research methods are determined [5, 25, 29, 42, 54, 106, 116].

2.1.1. Description of the research stages

1) The first stage of the study is used to determine the currently dominant diagnoses of morbidity in people who have experienced IIRNT in the past.

To achieve the result, a retrospective review of the nomenclature of registered diagnoses of morbidity of persons from the studied group of veterans of SRU and the control group of AC representatives is used. At this stage, data selection, statistical data processing and analysis of the results of their processing are performed (Chapter 3 of this study). In the course of the study, information extracted from the clinical databases of the NWCC is used.

Subsection 3.1 examines the primary and general morbidity of individuals from the study group of veterans of SRU who have experienced IIRNT in the past. Depending on the subtasks being solved, two different time intervals are considered:

– (2015 – 2019) years (to compare data on the primary morbidity of the studied group of veterans of SRU with data on the primary morbidity of veterans of SRU from literary sources for the five years 1997 – 2001);

– (2017 – 2019) years (to compare data on the primary morbidity of the studied group of veterans of SRU with data on the general morbidity of the same group of veterans of SRU for the same period of time. Data on the primary and general morbidity of the studied group of veterans of SRU for the specified period of time will be used later – for comparison with similar data from the control group of AC representatives for the same period of time).

Subsection 3.2 analyzes the primary and general morbidity of individuals from the control group of AC representatives who have not experienced IIRNT.

The time interval (2017 – 2019) is considered to compare data on the primary morbidity of the control group of AC representatives with data on the primary morbidity of the studied group of veterans of SRU for the same period of time.

The same time interval (2017 – 2019) is used to compare data on the general morbidity of the control group of AC representatives with data on the general morbidity of the studied group of veterans of SRU for the same period of time.

In subsection 3.3, the main accounting characteristics of the studied group of veterans of SRU and the control group of AC representatives are compared using the statistical criterion χ^2.

2) At the second stage of the study, the substantiation of the model of the medical care system and the algorithms of its functioning is carried out (subsections 4.1, 4.2). A block diagram of the system with the level of detail required for the study is shown.

3) The third stage of the study is devoted to the assessment of the clinical aspects of the functioning of the model of the medical care system. Data selection, statistical data processing and analysis of the results of their processing are performed here (subsection 4.3). Information for evaluation is extracted from the clinical databases of the NWDSCC.

4) At the fourth stage of the study, an assessment of the socio-psychological aspects of the functioning of the model of the medical care system is carried out. The data is selected, the data is statistically processed and the results of their processing are analyzed (subsection 4.4). The information for the assessment was obtained from the data of surveys and questionnaires of patients in the considered cohort.

2.1.2. Drawing up a research plan

The research plan includes the following characteristics:

a) the object of research varies depending on the research task being performed. The dynamics of changes are discussed below;

b) the observation units are shown in table 10;

c) the place of study: St. Petersburg, Federal State Budgetary Institution «Northwestern District Scientific and Clinical Center named after L.G. Sokolov of the Federal Medical and Biological Agency of Russia»;

d) duration of the study: 4 years (from 2020 to 2023);

e) expected results of the study:

1) specific proposals have been drawn up for the organization of a system of medical care for persons who have experienced IIRNT;

2) it is shown that all elements of the system model are necessary for the proper level of organization of medical care for people who have experienced IIRNT.

Table 10 – Observation units

Type of research	Type of observation unit	Volume, number of people	Source of information
1) A clinical	Study group of veterans of SRU	259	Retrospective observation
2) A clinical	A control group of AC representatives who have not experienced IIRNT	259	Retrospective observation
3) Socio-psychological	The surveyed group of veterans of SRU who experienced IIRNT	103	Current observation, (telephone survey)
4) Socio-psychological	The surveyed group of AC representatives who have experienced IIRNT	101	Current observation, (the survey)
5) Socio-psychological	The surveyed group of AC representatives who have not experienced IIRNT	101	Current observation, (the survey)

Based on the existing purpose and objectives of the study, as well as taking into account the division into stages and the research plan, a research program has been developed, presented in table 11.

Table 11 – Research program

The task of the study	The object of the study	The unit of observation	The source of information	The research method
1) To determine the currently dominant diagnoses of morbidity of people who have experienced IIRNT in the past, according to the NWDSCC.	Current data on morbidity patterns	The studied group of veterans of SRU. The control group of representatives of the attached contingent of NWDSCC	Clinical databases of the NWDSCC.	Statistical, analytical.
2) To substantiate a model of the system of medical care for people who have experienced IIRNT, taking into account clinical and socio-psychological aspects.	A model of the system for providing medical care to people who have experienced IIRNT.	Elements of the model of the medical care system for people who have experienced IIRNT.	The results of this study.	Analytical, systematic approach
3) To evaluate the implementation of clinical aspects of medical care within the framework of the system model.	Clinical aspects of medical care.	The studied group of veterans of SRU. The control group of representatives of the attached contingent of NWDSCC	Clinical databases of the NWDSCC.	Statistical, analytical.
4) To evaluate the implementation of the socio-psychological aspects of medical care within the framework of the system model.	Socio-psychological aspects of medical care.	The interviewed group of veterans of SRU. Two surveyed groups of representatives of the attached contingent of NWDSCC.	Data from patient surveys and questionnaires.	Statistical, analytical, sociological, survey.

Notes. 1. IIRNT – exposure to ionizing radiation of nuclear technologies; 2. NWDSCC – Northwest District Scientific and Clinical Center named after L.G. Sokolov of the Federal Medical and Biological Agency of Russia; 3. SRU – Special risk units

2.2. Data processing methods

2.2.1. Calculation of the minimum allowable volumes of the studied samples

In the work of Koichubekov B.K. and co-authors (2014), formulas are given for calculating the minimum allowable sample size, which take into account the availability of data on the size of the general population [37].

For nominal and ordinal features, which are the shares of objects with a given feature, the following formula is used:

$$n = \frac{pqZ_{\alpha}^{2}N}{\Delta^{2}N + pqZ_{\alpha}^{2}} \quad (1),$$

where:

p – the variation of the sample or the proportion of positive responses to a research question based on;

q – the proportion of negative responses to the research question by gender, while $q = 1 - p$;

Z_{α} – the critical value of the standard normal distribution for a given level of significance α;

N – the volume of the general population;

Δ – sampling error [113, 117].

The value of p is selected empirically or, as an extreme case, the values of p = 0.5 and q = 0.5 are applied. In the latter case, the greatest possible variation is achieved. For example, if 90% of the variants on the attribute have a single value, and 10% have zero, then the variation is minimal, and the product of pq has the value: $0.9 \times 0.1 = 0.09$. If a single value was fixed in 50% of cases, then the product of pq will be: $0.5 \times 0.5 = 0.25$.

The significance level α is the probability of a first-kind error, in which we reject the null hypothesis when it actually occurs, that is, we find differences where there are none.

In this study, the significance level α is assumed to be 0.05, which corresponds to a 95% confidence interval.

Sampling error refers to an objectively occurring discrepancy between the characteristics of the sample and the general population. Just like the significance level, the sampling error is set by the researcher himself.

In this study, the value of the sampling error is selected taking into account the problem being solved.

To determine the statistical significance of differences in the frequency of diagnoses depending on the presence of a risk factor, the study and control groups were selected. The minimum allowable sample size, calculated using the formula (1) with a sampling error value of 6%, was 248 people.

The volume of the studied group of veterans of SRU who experienced IIRNT was increased compared to the calculated value to 259 people for the reason that this number is included in the cohort of these persons treated at the NWDSCC in the period 2017-2019. Since it was decided to conduct a continuous retrospective study of this cohort, the selection of candidates for the group was not carried out (they all entered it), which in this case means that there is no subjective component of the selection by the researcher and corresponds to random selection.

The volume of the control group of AC representatives who did not experience IIRNT also amounted to 259 people in order to ensure the best conditions for the application of the significance criterion used. The selection of candidates was carried out randomly from a large number of AC representatives treated at the NWDSCC during the same time period.

For the needs of statistical processing of the results of questionnaires or surveys, the value of the sampling error was assumed to be 10% – since in this case there is an influence of a subjective factor on the wording of the answers, and an increase in the sample size does not lead to a significant increase in the level of reliability of estimates. The minimum allowable sample size, calculated using the formula (1) with a sampling error value of 10%, was 94 people.

A sample of 103 people was used to survey veterans of SRU who experienced IIRNT.

A sample of 101 people was used to survey AC representatives who had not experienced IIRNT.

A sample of 101 people was used to survey AC representatives who experienced IIRNT.

2.2.2. Determination of the dominant diagnoses of people who have experienced IIRNT

For the five-year period 2015-2019, data on the primary morbidity of the studied group of veterans of SRU were obtained. These data were used for comparison with independent data on the primary morbidity of veterans of SRU for the five-year period 1997-2001, information on which was obtained from a literary source [60].

In the course of the study, the degree of coincidence of data on the list of dominant diagnoses and the dynamics of the dominance of diagnoses in the time periods under consideration, one of which is shifted relative to the other by 18 years, were determined.

For the studied group of veterans of SRU, data on primary and general morbidity for the period 2017-2019 were calculated. These data were used to compare primary and general morbidity in terms of the composition of the dominant diagnoses.

Data on the primary and general morbidity of the studied group of veterans of SRU for the period 2017-2019 were further used for comparison with similar data from the control group of AC representatives for the same period of time.

2.2.3. Determination of the dominant diagnoses of persons who have not experienced IIRNT

For the control group of AC representatives, data on primary morbidity for the period 2017-2019 were calculated. These data were used for comparison with data on the primary morbidity of veterans of SRU for the same period of time.

For the control group of AC representatives, data on general morbidity for the period 2017-2019 were calculated. These data were used to compare with data on the general morbidity of veterans of SRU for the same period of time.

2.2.4. Using Pearson's χ^2 criterion

The comparison of nominal data was carried out using

Pearson's criterion χ^2, which allows us to assess the significance of differences between the actual number of outcomes or qualitative characteristics of the sample falling into each category and the theoretical number that can be expected in the studied groups if the null hypothesis is valid [36, 53, 58].

As an element of the problem statement, a four-field conjugacy table was used, which is filled with data on the frequency of outcomes depending on the presence of a risk factor. The general view of the four-field conjugacy table is presented in table 12.

Table 12 – General view of the four-field table

The presence of a risk factor	**The presence of an outcome**		**Total:**
	There is an outcome	**There is no outcome**	
The risk factor is	A	B	A+B
There is no risk factor	C	D	C+D
Total:	A+C	B+D	A+B+C+D

In the present study, the conjugacy table was used as a set of input data for calculating criterion χ^2 in order to determine the possibility of dependence of the presence of a certain group of diseases on IIRNT in the past. Accordingly, the four-field conjugacy table was filled with applied information in accordance with the template given in table 13.

Table 13 – The four-field table template used in the study

The presence of a risk factor (ionizing radiation of nuclear technologies)	**The presence of an outcome (disease with the specified diagnosis)**		**Total**
	There is a disease	**There is no disease**	
There is an impact (the study group)			
No exposure (control group)			
Total:			

In general, the null hypothesis (H_0) claims that there is no difference between the two datasets, but an alternative (H_a) – That there is such a difference.

In this study, the null hypothesis asserts that the presence of the disease in question in the representatives of the study group does not depend on the occurrence of IIRNT in the past. As an argument, the data of the control group, which includes patients who have not experienced such an impact, are presented. An alternative hypothesis refutes this statement, proving that there is such a dependence for a given level of significance and number of degrees of freedom.

Initially, the expected number of observations in each of the cells of the conjugacy table was calculated, provided that the null hypothesis of the absence of a relationship was valid. To do this, the sums of rows and columns (marginal totals) were multiplied, followed by dividing the resulting product by the total number of observations. Then the value of the criterion χ^2 was calculated using the formula:

$$\chi^2 = \sum_{i=1}^{r} \sum_{j=1}^{c} \frac{(O_{ij} - E_{ij})^2}{E_{ij}} \qquad (2)$$

where i is the row number (from 1 to r), j is the column number (from 1 to c) O_{ij} – the actual number of observations in the cell ij, E_{ij} – expected number of observations per cell ij.

The value of the criterion χ^2 was compared with the critical values for $(r - 1) \times (c - 1)$ the number of degrees of freedom. If the obtained value of criterion χ^2 exceeded the critical value, it was concluded that there was a statistical relationship between the studied risk factor and the outcome at the appropriate level of significance [53, 58].

The application of criterion χ^2 has certain conditions and limitations:

– comparable indicators should be measured in nominal or ordinal scale;

– the compared groups should be independent, that is, the criterion χ^2 should not be applied when comparing observations «before» – «after»;

– when analyzing four-field tables, the expected values in each of the cells must be at least 10. In the event that at least one cell has an expected value less than 10, then it is better to use the exact Fisher criterion for analysis;

– if the lowest value of the expected phenomenon is in the range from 5 to 10, the criterion χ^2 should be used for comparison, adjusted for Yates continuity [27, 53, 119, 120].

2.2.5. Processing of data from the survey of veterans of SRU

To assess the quality of medical care provided to veterans of SRU who experienced the IIRNT and were treated at the NWDSCC, a survey of these persons in the sample size (103 patients) was used using an appropriate questionnaire [appendix A].

The survey was conducted in 2020, at the height of the Covid-19 pandemic, when a face-to-face meeting with veterans of SRU, most of whom were at risk, was impossible. In this regard, it was decided to conduct it remotely – using a phone. Subsequent events have shown the correctness of this approach: most veterans of SRU reacted with understanding to the situation and tried to fully answer the questions asked.

Data processing was performed using descriptive statistics methods. In cases where this is justified, the processing results are presented in the form of diagrams obtained using the Excel application.

2.2.6. Processing of the questionnaire data of the representatives of the AC NWDSCC

To assess the quality of medical care provided to representatives of the NWDSCC AC who have experienced IIRNT and have not experienced IIRNT, a questionnaire of these persons in the amount of two samples (101 patients each) was used using the questionnaire provided in appendix B.

The survey was carried out in 2022. Data processing was also performed using descriptive statistics methods. In cases where this is justified, the processing results are presented in the form of diagrams obtained using the Excel application.

CHAPTER 3. COMPARATIVE ESTIMATES OF THE INCIDENCE OF PERSONS WHO HAVE BEEN EXPOSED TO IONIZING RADIATION OF NUCLEAR TECHNOLOGIES AND PERSONS WHO HAVE NOT EXPERIENCED SUCH EXPOSURE

3.1. Analysis of data on the primary and general morbidity of persons from the study group of veterans of special risk units who have been exposed to ionizing radiation of nuclear technologies

3.1.1. Primary morbidity of veterans of SRU of the study group in the period 2015-2019

Primary morbidity (or morbidity itself) is one of the criteria for assessing the health status of the population.

Reducing the morbidity rate of the country's population is of great social and economic importance, and is a matter of special concern to the legislative and executive authorities, who regularly develop and implement state programs to strengthen the health of the nation.

According to previously published data (2020), in the period 2015-2019, 259 veterans of SRU living in St. Petersburg and the Leningrad Region received medical care in the KB122 hospital [67]. This group was selected for a comprehensive study based on medical records. The average age of SRU veterans was 71.2±10.2 years. By gender, the veterans of SRU were distributed as follows:

– women: 12 people (5%);

– men: 247 people (95%).

The data of the medical examination and the result of calculating the primary morbidity of veterans of SRU of the study group in 2015-2019 are shown in table 14.

Table 14 – Survey data (the number of newly registered diagnoses) and the result of calculating the primary morbidity of veterans of SRU of the study group in 2015 – 2019

The ICD-10 code	A group of diseases	Year of observation				
		2015	2016	2017	2018	2019
A	Some infectious and parasitic diseases	1	–	–	–	–
B		–	1	–	1	–
C	Malignant neoplasms	8	8	3	6	7
D	Benign neoplasms	1	3	5	9	7
E	Diseases of the endocrine system	2	2	–	–	1
G	Diseases of the nervous system	6	6	6	8	9
H	Diseases of the eye and its accessory apparatus	6	3	4	4	2
I	Diseases of the circulatory system	51	75	52	46	50
J	Diseases of the respiratory system	3	6	3	9	8
K	Diseases of the digestive system	2	5	12	9	10
L	Diseases of the skin and subcutaneous tissue	–	–	1	2	1
M	Diseases of the musculoskeletal system and connective tissue	4	2	7	6	7
N	Diseases of the genitourinary system	4	8	1	4	2
S	Injuries, poisoning and the effects of external causes	–	–	1	–	–
T		–	1	1	–	1
Z	Factors affecting the health of the population and treatment	–	–	1	–	–
The number of newly registered diseases per year		88	120	97	104	105
Primary morbidity (per 1000 people)		339,8	463,3	374,5	401,5	405,4

The dynamics of the primary morbidity of veterans of SRU of the study group in the period 2015 – 2019 is shown in figure 3.

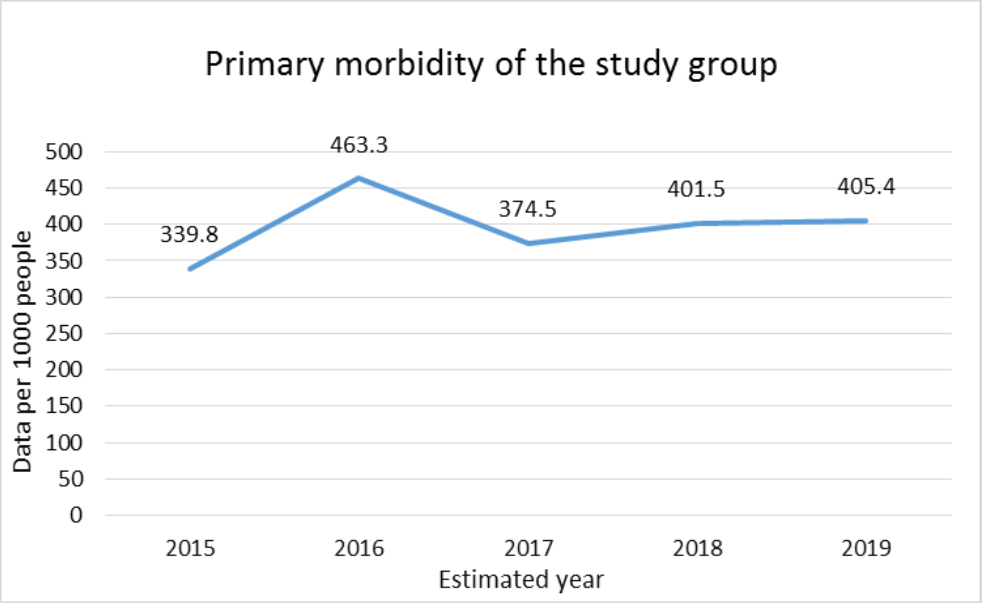


Figure 3 – Dynamics of primary morbidity of veterans of SRU of the study group in the period 2015 – 2019 (per 1000 people)

The primary morbidity of veterans of SRU of the study group in 2015 – 2019, distributed by diagnosis, is presented in table 15.

Table 15 – Primary morbidity of veterans of SRU of the study group in 2015 – 2019, distributed by diagnosis (per 1000 people)

The ICD-10 code	**A group of diseases**	**Year of observation**				
		2015	**2016**	**2017**	**2018**	**2019**
A	Some infectious and parasitic diseases	3,9	0,0	0,0	0,0	0,0
B		0,0	3,9	0,0	3,9	0,0
C	Malignant neoplasms	30,9	30,9	11,6	23,2	27,0
D	Benign neoplasms	3,9	11,6	19,3	34,7	27,0
E	Diseases of the endocrine system	7,7	7,7	0,0	0,0	3,9
G	Diseases of the nervous system	23,2	23,2	23,2	30,9	34,7
H	Diseases of the eye and its accessory apparatus	23,2	11,6	15,4	15,4	7,7
I	Diseases of the circulatory system	196,9	289,6	200,8	177,6	193,1
J	Diseases of the respiratory system	11,6	23,2	11,6	34,7	30,9
K	Diseases of the digestive system	7,7	19,3	46,3	34,7	38,6
L	Diseases of the skin and subcutaneous tissue	0,0	0,0	3,9	7,7	3,9
M	Diseases of the musculoskeletal system and connective tissue	15,4	7,7	27,0	23,2	27,0
N	Diseases of the genitourinary system	15,4	30,9	3,9	15,4	7,7
S	Injuries, poisoning and the effects of external causes	0,0	0,0	3,9	0,0	0,0
T		0,0	3,9	3,9	0,0	3,9
Z	Factors affecting the health of the population and treatment	0,0	0,0	3,9	0,0	0,0

3.1.2. Comparison of data on the primary morbidity of veterans of SRU of the study group in 2015 – 2019 with data on the primary morbidity of veterans of SRU of the study from a literary source

When comparing the data for the study group with the data from the literary source, it was found that the dynamics of the primary morbidity of veterans of SRU in the period 2015 – 2019 differs from that shown earlier in Figure 1 (chapter 1).

In Figure 1 (chapter 1), there is a steady and significant increase in primary morbidity in the period 1997 – 2001.

Figure 3 shows an oscillatory process asymptotically approaching the value of approximately 400 primary diseases per 1,000 people per year. In the time range under consideration, this can be interpreted as a transitional process, culminating in the stabilization of the primary morbidity of this category of citizens at the specified level.

To compare the results obtained on the structure of primary morbidity of veterans of SRU of the study group in the period 2015 – 2019 (table 15) with similar data in the period 1997 – 2001 (table 1 from chapter 1), the average values of primary morbidity for each diagnosis for the specified time periods were preliminarily calculated.

The comparison showed that four of the first five diagnoses of an earlier period fall into the list of the first five diagnoses of a later period. At the same time, the values of the average primary morbidity of the persons in the considered contingent were arranged in descending order as follows:

– the period 1997-2001: I, J, K, M, G;

– the period 2015-2019: I, K, G, C, J.

The structures and ratios of indicators (per 1000 people) of the five diagnoses of these periods considered differ somewhat [68].

The first position in the structures of both groups under consideration (with an increase of 12.9 ‰ in veterans of SRU of the later period) is steadily occupied by diseases of the circulatory system (I) [68].

According to this diagnosis, there is a minimal difference in the values of the primary morbidity of the categories of citizens under consideration.

Over time, digestive diseases (K) became more frequent and moved from the third position in veterans of SRU of the earlier period to the second position in veterans of SRU of the later period (with a decrease of 107.5 ‰).

Diseases of the nervous system (G) increased their influence, moving from the fifth position in veterans of SRU of the earlier period to the third position in veterans of SRU of the later period (with a decrease of 70.7 ‰).

Malignant neoplasms (C), which were first detected during examination in a later period, were immediately strongly manifested, taking the fourth position in the list of veterans of SRU of the later period [68].

Diseases of the respiratory system (J) have become less frequent and occupy the fifth position in veterans of SRU of the later period instead of the second position in veterans of SRU of the earlier period (with a decrease of 173.9 ‰ in veterans of SRU of the later period). According to this diagnosis, there is a maximum difference in the values of the primary morbidity of the categories of citizens under consideration.

The influence of diseases of the musculoskeletal system decreased, which moved from the fourth position in veterans of SRU of the earlier period beyond the five diagnoses under consideration (to the sixth position) in veterans of SRU of the later period (with a decrease of 116.7 ‰).

Conclusions on paragraph 3.1.2.

It follows from the comparison that the differences in the values of primary morbidity for the two subgroups of the considered contingent lie in the range from 12.9 ‰ to 173.9 ‰. To determine the degree of differences, a comparison is used with the median of this segment, equal to 80.5 ‰. Increases in primary morbidity values exceeding this value are considered significant, while the rest are considered simple. Similarly, decreases in primary morbidity values by an amount greater than the median are considered significant, and those that are less than it are considered simple.

1) An increase in the value of primary morbidity in veterans of SRU of the 2015 – 2019 period compared with veterans of SRU of the 1997 – 2001 period is observed when considering the following diagnosis:

– diseases of the circulatory system (I).

2) Significant decreases in the values of primary morbidity in veterans of SRU of the 2015 – 2019 period compared with veterans of SRU of the 1997 – 2001 period are observed when considering the following diagnoses:

– diseases of the digestive system (K);

– diseases of the respiratory system (J);

– diseases of the musculoskeletal system and connective tissue (M).

3) A decrease in the value of primary morbidity in veterans of SRU of the 2015 – 2019 period compared with veterans of SRU of the 1997 – 2001 period is observed when considering the following diagnosis:

– diseases of the nervous system (G).

3.1.3. Primary morbidity of veterans of SRU of the study group in the period 2017 – 2019

For subsequent comparisons with the control group, data on the primary morbidity of veterans of SRU from the study group in the specified time period, calculated on the basis of data from table 14 for this period, will be used.

The dynamics of the primary morbidity of veterans of SRU of the study group in the period 2017 – 2019 is shown in figure 4.

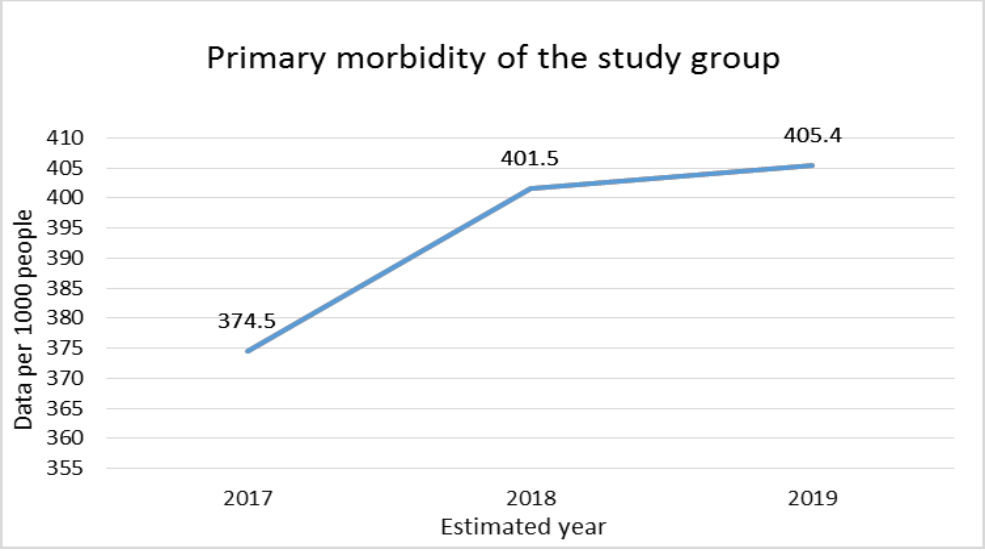


Figure 4 – Dynamics of primary morbidity of veterans of SRU of the study group in the period 2017-2019 (per 1000 people)

The primary morbidity of veterans of SRU of the study group in 2017 – 2019, distributed by diagnosis, is presented in table 16.

Table 16 – Primary morbidity of veterans of SRU of the study group in 2017 – 2019, distributed by diagnosis (per 1000 people)

The ICD-10 code	A group of diseases	Year of observation			Average for 3 years
		2017	2018	2019	
A	Some infectious and parasitic diseases	0,0	0,0	0,0	0,0
B		0,0	3,9	0,0	1,3
C	Malignant neoplasms	11,6	23,2	27,0	20,6
D	Benign neoplasms	19,3	34,7	27,0	27,0
E	Diseases of the endocrine system	0,0	0,0	3,9	1,3
G	Diseases of the nervous system	23,2	30,9	34,7	29,6
H	Diseases of the eye and its accessory apparatus	15,4	15,4	7,7	12,8
I	Diseases of the circulatory system	200,8	177,6	193,1	190,5
J	Diseases of the respiratory system	11,6	34,7	30,9	25,7
K	Diseases of the digestive system	46,3	34,7	38,6	39,9
L	Diseases of the skin and subcutaneous tissue	3,9	7,7	3,9	5,2
M	Diseases of the musculoskeletal system and connective tissue	27,0	23,2	27,0	25,7
N	Diseases of the genitourinary system	3,9	15,4	7,7	9,0
S	Injuries, poisoning and the effects of external causes	3,9	0,0	0,0	1,3
T		3,9	0,0	3,9	2,6
Z	Factors affecting the health of the population and treatment	3,9	0,0	0,0	1,3

3.1.4. Analysis of the structure of the primary morbidity of veterans of SRU of the study group in the period 2017 – 2019

The analysis showed that according to the values of the average primary morbidity (in ppm) for three years of the specified period, the diagnoses were as follows:

– diseases of the circulatory system (I): 190.5 ‰;

– diseases of the digestive system (K): 39.9 ‰;

– diseases of the nervous system (G): 29.6 ‰;

– benign neoplasms (D): 27.0 ‰;

– diseases of the musculoskeletal system (M): 25.7 ‰;

– diseases of the respiratory system (J): 25.7 ‰;

– malignant neoplasms (C): 20.6 ‰;

– diseases of the eye and its accessory apparatus (H): 12.8 ‰;

– diseases of the genitourinary system (N): 9.0 ‰;

– diseases of the skin and subcutaneous tissue (L): 5.2 ‰;

– injuries, poisoning and exposure to external causes (T): 2.6 ‰;

– some infectious and parasitic diseases (B): 1,3 ‰;

– diseases of the endocrine system (E): 1,3 ‰;

– injuries, poisoning and exposure to external causes (S): 1,3 ‰;

– factors affecting the health status of the population (Z): 1,3 ‰.

3.1.5. Total morbidity of veterans of SRU of the study group in the period 2017 – 2019

Earlier, in paragraph 3.1.3, the same study group of veterans of SRU was considered for primary morbidity in the period 2017 – 2019.

Table 17 shows the data of the medical examination and the result of calculating the total morbidity of veterans of SRU of the study group for the same period of time.

Table 17 – Survey data (the number of registered diagnoses) and the result of calculating the total morbidity of veterans of SRU of the study group in the period 2017 – 2019

The ICD-10 code	**A group of diseases**	**Year of observation**		
		2017	**2018**	**2019**
1	**2**	**3**	**4**	**5**
A	Some infectious and parasitic diseases	0	0	0
B		0	1	0
C	Malignant neoplasms	6	6	17
D	Benign neoplasms	5	10	7
E	Diseases of the endocrine system	0	0	1
G	Diseases of the nervous system	7	9	10
H	Diseases of the eye and its accessory apparatus	4	4	2
I	Diseases of the circulatory system	73	60	59
J	Diseases of the respiratory system	4	12	10
K	Diseases of the digestive system	14	11	11
L	Diseases of the skin and subcutaneous tissue	1	2	1

Table continuation 17

1	2	3	4	5
M	Diseases of the musculoskeletal system and connective tissue	9	6	7
N	Diseases of the genitourinary system	1	5	2
S	Injuries, poisoning and the effects of external causes	1	0	0
T		1	0	1
Z	Factors affecting the health of the population and treatment	1	0	0
The number of newly registered diseases per year		127	126	128
Primary morbidity (per 1000 people)		490,3	486,5	494,2

The dynamics of the general morbidity of veterans of SRU of the study group in the period 2017 – 2019 is shown in figure 5.

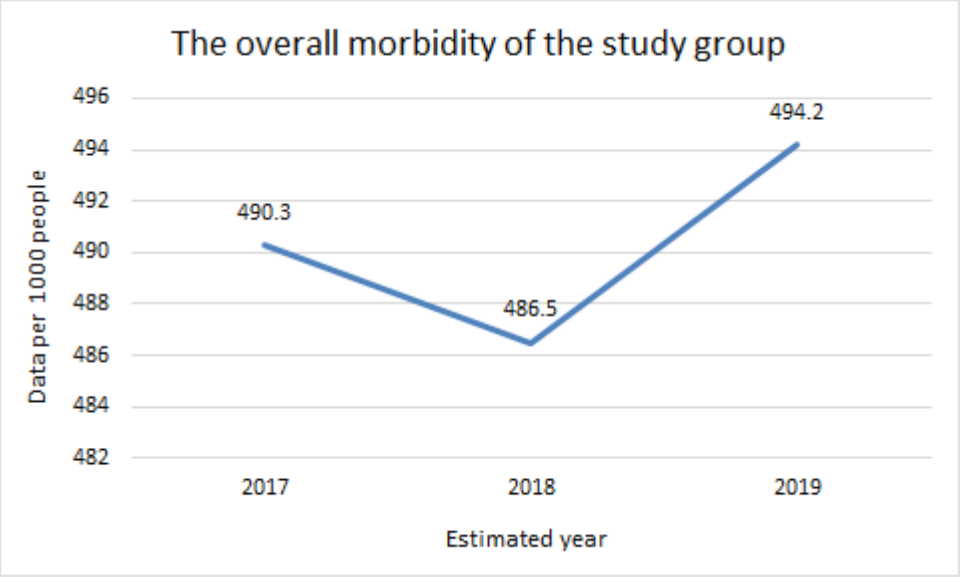


Figure 5 – Dynamics of the general morbidity of veterans of SRU of the study group in the period 2017 – 2019 (per 1000 people)

The total morbidity of veterans of SRU of the study group in 2017 – 2019, distributed by diagnosis, is presented in table 18.

Table 18 – Total morbidity of veterans of SRU of the study group in the period 2017 – 2019, distributed by diagnosis (per 1000 people)

The ICD-10 code	A group of diseases	Year of observation			Average for 3 years
		2017	2018	2019	
A	Some infectious and parasitic diseases	0,0	0,0	0,0	0,0
B		0,0	3,9	0,0	1,3
C	Malignant neoplasms	23,2	23,2	65,6	37,3
D	Benign neoplasms	19,3	38,6	27,0	28,3
E	Diseases of the endocrine system	0,0	0,0	3,9	1,3
G	Diseases of the nervous system	27,0	34,7	38,6	33,4
H	Diseases of the eye and its accessory apparatus	15,4	15,4	7,7	12,8
I	Diseases of the circulatory system	281,9	231,7	227,8	247,1
J	Diseases of the respiratory system	15,4	46,3	30,9	33,4
K	Diseases of the digestive system	54,1	42,5	42,5	46,4
L	Diseases of the skin and subcutaneous tissue	3,9	7,7	3,9	5,2
M	Diseases of the musculoskeletal system and connective tissue	34,7	23,2	27,0	28,3
N	Diseases of the genitourinary system	3,9	19,3	7,7	10,3
S	Injuries, poisoning and the effects of external causes	3,9	0,0	0,0	1,3
T		3,9	0,0	3,9	2,6
Z	Factors affecting the health of the population and treatment	3,9	0,0	0,0	1,3

3.1.6. Analysis of the structure of the general morbidity of veterans of SRU of the study group in the period 2017 – 2019

The analysis showed that according to the values of the average general morbidity over the three years of the specified period, the diagnoses were as follows:

– diseases of the circulatory system (I): 247.1 ‰;

– diseases of the digestive system (K): 46.4 ‰;

– malignant neoplasms (C): 37.3 ‰;

– diseases of the nervous system (G): 33.4 ‰;

– diseases of the respiratory system (J): 33.4 ‰;

– diseases of the musculoskeletal system (M): 28.3 ‰;

– benign neoplasms (D): 28.3 ‰.

– diseases of the eye and its accessory apparatus (H): 12.8 ‰;

– diseases of the genitourinary system (N): 10.3 ‰;

– diseases of the skin and subcutaneous tissue (L): 5.2 ‰;

– injuries, poisoning and exposure to external causes (T): 2.6 ‰;

– some infectious and parasitic diseases (B): 1,3 ‰;

– diseases of the endocrine system (E): 1,3 ‰;

– injuries, poisoning and exposure to external causes (S): 1,3 ‰;

– factors affecting the health status of the population (Z): 1.3 ‰.

3.1.7. Comparison of data on the primary and general morbidity of veterans of SRU of the study group in the period 2017 – 2019

When comparing data on the studied group of veterans of SRU in terms of primary and general morbidity, it was found that the dynamics of the primary morbidity of veterans of SRU in the period 2017-2019 (figure 4) differs slightly from the dynamics of the general morbidity (Figure 5) over the same period of time.

In figure 4, in the first section (2017 – 2018), primary morbidity increased by 27 ‰, and in the second section (2018 – 2019), there is an increase in primary morbidity by 3.9 ‰.

In figure 5, in the first section (2017 – 2018), there is a decrease of 3.8 ‰, and in the second section (2018 – 2019), there is an increase in the total morbidity by 7.7 ‰.

These differences are not as significant as the difference in the incidence rates, which are clearly visible in figure 6, where both graphs are combined.

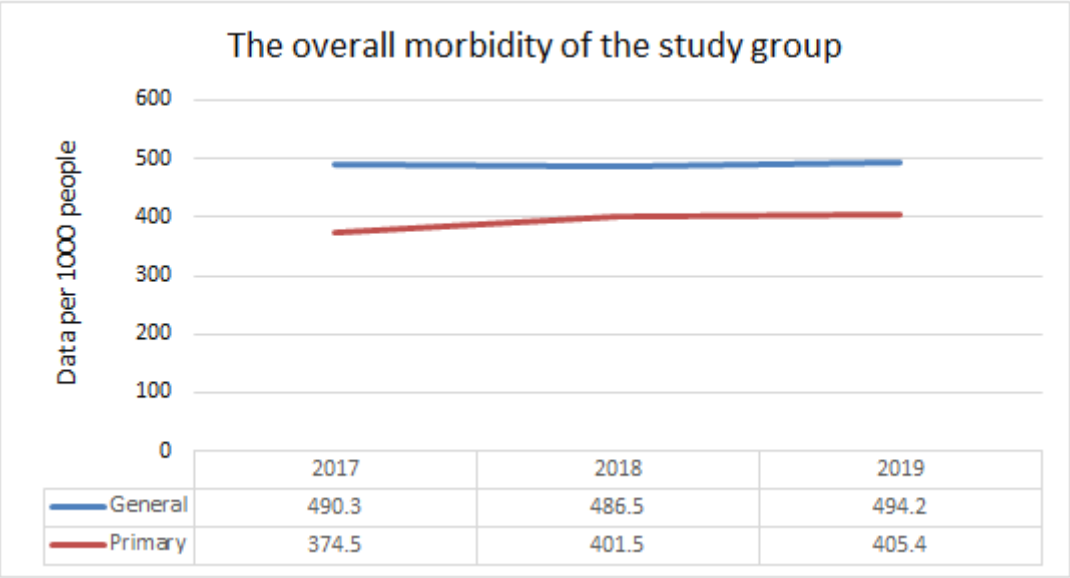


Figure 6 – Dynamics of the general and primary morbidity of veterans of SRU of the study group in the period 2017 – 2019 (per 1000 people)

The reasons for this difference, of course, are related to the fact that the indicator of general morbidity includes data on primary morbidity, which are supplemented by data on repeated requests for medical care during each year of the period under review.

To compare the results obtained on the structure of the primary morbidity of veterans of SRU of the study group in the period 2017 – 2019 (table 16) with data on the structure of the total morbidity of veterans of SRU of the study group for the same period of time, the average values of primary and general morbidity for each diagnosis were calculated.

As a result of the analysis of the structures of the two named indicators of the studied group of veterans of SRU, it was determined that according to the names of the first nine diagnoses, their lists completely coincide. At the same time, the values of morbidity indicators of the persons of the considered contingent according to diagnoses were arranged in descending order as follows:

– the structure of primary morbidity: I, K, G, D, M, J, C, H, N;

– the structure of general morbidity: I, K, C, G, J, M, D, H, N.

The first position in both morbidity structures (with excess diseases of the circulatory system (I) occupy 56.6 ‰ of the total). According to this diagnosis, there is a maximum difference in values.

The second position in both morbidity structures (with an excess of 6.5 ‰ in general) is occupied by diseases of the digestive system (K).

The third position in the primary structure and the fourth position in the general structure (with an excess of 3.8 ‰ in general) are diseases of the nervous system (G).

The fourth position in the primary structure and the seventh position in the structure of the total (with an excess of 1.3 ‰ in the total) is occupied by benign neoplasms (D).

Diseases of the musculoskeletal system and connective tissue (M) occupy the fifth position in the primary structure and the sixth position in the general structure (with an excess of 2.6 ‰ in the general).

Diseases of the respiratory system (J) occupy the sixth position in the primary structure and the fifth position in the general structure (with an excess of 7.7 ‰ in the general).

The seventh position in the structure of the primary and the third position in the general (with an excess of 16.7 ‰ in the general) are occupied by malignant neoplasms (C).

The eighth position in both structures (the differences are 0.0 ‰) is occupied by diseases of the eye and its accessory apparatus (H). According to this diagnosis, there is a minimal difference in the values of the indicators.

Diseases of the genitourinary system (N) occupy the ninth position in both structures (with an excess of 1.3 ‰ in the total).

Conclusions according to paragraph 3.1.7

It follows from the comparison that the differences in the values of the two morbidity indicators of the considered contingent lie in the range from 0.0 ‰ to 56.6 ‰. To determine the degree of differences, a comparison is used with the median of this segment, equal to 28.3 ‰. The values of differences exceeding this value are considered as significant predominances, the rest as simple predominances.

1) A significant predominance of differences in the values of general morbidity compared with the values of primary morbidity is observed when considering the following diagnoses:

– diseases of the circulatory system (I).

2) The predominance of differences in the values of general morbidity compared with the values of primary morbidity is observed when considering the following diagnoses:

– malignant neoplasms (C);

– diseases of the respiratory system (J);

– diseases of the digestive system (K);

– diseases of the nervous system (G);

– diseases of the musculoskeletal system and connective tissue (M);

– benign neoplasms (D);

– diseases of the genitourinary system (N).

3) There are no differences in the values of general morbidity compared with the values of primary morbidity when considering the following diagnosis:

– diseases of the eye and its accessory apparatus (H).

3.2. Analysis of data on the primary and general morbidity of persons from the control group of representatives of the attached contingent who have not been exposed to ionizing radiation of nuclear technologies

3.2.1. Primary morbidity of representatives of the attached contingent from the control group in the period 2017 – 2019

To analyze the health status of the representatives of the attached contingent (AC), a control group of people who had not experienced IIRNT was selected. The quantitative composition of the control group coincides with the same indicator of the study group and amounts to 259 people. Additionally, the groups were balanced by gender (women: 12 people; men: 247 people), as well as by the structure and quantitative composition of age groups.

A retrospective study of the selected control group was performed. For this purpose, factual materials from the clinical database of the NWDSCC were reviewed,

containing information on the provision of medical care to these persons in the period 2017-2019 [65].

Based on the data obtained, calculations were made of the primary morbidity of patients from the considered contingent.

The data of the medical examination and the result of calculating the primary morbidity of AC representatives from the control group in 2017 – 2019 are shown in table 19.

Table 19 – Survey data (the number of newly registered diagnoses) and the result of calculating the primary morbidity of AC representatives of the control group in the period 2017 – 2019

The ICD-10 code	**A group of diseases**	**Year of observation**		
		2017	**2018**	**2019**
A	Some infectious and parasitic diseases	–	1	–
B		1	–	–
C	Malignant neoplasms	6	6	5
D	Benign neoplasms	7	6	3
E	Diseases of the endocrine system	–	–	2
G	Diseases of the nervous system	3	2	5
H	Diseases of the eye and its accessory apparatus	16	10	1
I	Diseases of the circulatory system	31	31	34
J	Diseases of the respiratory system	3	4	1
K	Diseases of the digestive system	7	7	6
L	Diseases of the skin and subcutaneous tissue	1	1	1
M	Diseases of the musculoskeletal system and connective tissue	1	3	1
N	Diseases of the genitourinary system	2	–	1
R	Symptoms, signs and deviations	–	1	–
S	Injuries, poisoning and the effects of external causes	1	–	–
T		1	1	1
The number of newly registered diseases per year		80	73	61
Primary morbidity (per 1000 people)		308,9	281,9	235,5

The dynamics of the primary morbidity of representatives of the AC control group in the period 2017 – 2019 is shown in figure 7.

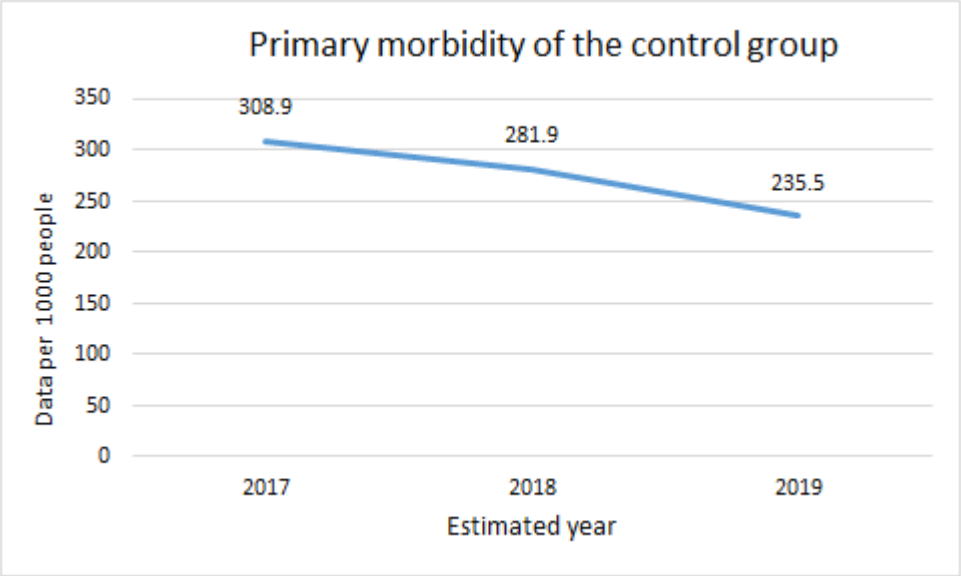


Figure 7 – Dynamics of primary morbidity of AC representatives of the control group in the period 2017 – 2019 (per 1000 people)

The primary morbidity of AC representatives of the control group distributed by diagnosis in 2017 – 2019 is presented in table 20.

Table 20 – Primary morbidity of AC representatives of the control group distributed by diagnosis in 2017 – 2019 (per 1000 people)

The ICD-10 code	A group of diseases	Year of observation			Average for 3 years
		2017	2018	2019	
A	Some infectious and parasitic diseases	0,0	3,9	0,0	1,3
B		3,9	0,0	0,0	1,3
C	Malignant neoplasms	23,2	23,2	19,3	21,9
D	Benign neoplasms	27,0	23,2	11,6	20,6
E	Diseases of the endocrine system	0,0	0,0	7,7	2,6
G	Diseases of the nervous system	11,6	7,7	19,3	12,9
H	Diseases of the eye and its accessory apparatus	61,8	38,6	3,9	34,8
I	Diseases of the circulatory system	119,7	119,7	131,3	123,6
J	Diseases of the respiratory system	11,6	15,4	3,9	10,3
K	Diseases of the digestive system	27,0	27,0	23,2	25,7
L	Diseases of the skin and subcutaneous tissue	3,9	3,9	3,9	3,9
M	Diseases of the musculoskeletal system and connective tissue	3,9	11,6	3,9	6,5
N	Diseases of the genitourinary system	7,7	0,0	3,9	3,9
R	Symptoms, signs and deviations	0,0	3,9	0,0	1,3
S	Injuries, poisoning and the effects of external causes	3,9	0,0	0,0	1,3
T		3,9	3,9	3,9	3,9

3.2.2. Analysis of the structure of the primary morbidity of AC representatives of the control group in the period 2017 – 2019

The analysis showed that according to the values of the average primary morbidity (in ppm) for three years of the specified period, the diagnoses were as follows:

– diseases of the circulatory system (I): 123.6 ‰;

– diseases of the eye and its accessory apparatus (H): 34.8 ‰;

– diseases of the digestive system (K): 25.7 ‰;

– malignant neoplasms (C): 21.9 ‰;

– benign neoplasms (D): 20.6 ‰.

– diseases of the nervous system (G): 12.9 ‰;

– diseases of the respiratory system (J): 10.3 ‰;

– diseases of the musculoskeletal system (M): 6.5 ‰;

– diseases of the genitourinary system (N): 3.9 ‰;

– diseases of the skin and subcutaneous tissue (L): 3.9 ‰;

– injuries, poisoning and exposure to external causes (T): 3.9 ‰;

– diseases of the endocrine system (E): 2.6 ‰;

– some infectious and parasitic diseases (A): 1,3 ‰;

– some infectious and parasitic diseases (B): 1.3 ‰;

– symptoms, signs and abnormalities (R): 1.3 ‰;

– injuries, poisoning and exposure to external causes (S): 1,3 ‰;

3.2.3. Comparison of data on the primary morbidity of the control group of AC representatives in the period 2017 – 2019 with data on the primary morbidity of the studied group of veterans of SRU in the same time period

When comparing the data for the control group with the data for the study group, it was found that the dynamics of the primary morbidity of AC representatives of the control group in the period 2017 – 2019 (figure 7) differs from the similar indicator of veterans of SRU of the study group in the same time period (figure 4).

In figure 4, in the first section (2017 – 2018), primary morbidity increased by 27.0 ‰, and in the second section (2018 – 2019), there is an increase in primary morbidity by 3.9 ‰.

In figure 7, in the first section (2017 – 2018), primary morbidity decreased by 27.0 ‰, and in the second section (2018 – 2019), there is a decrease primary morbidity by 46.4 ‰.

It can be assumed that such a picture corresponds to the presence of a risk factor in the form of IIRNT in the past in veterans of SRU of the studied group and the absence of such a factor in representatives of the AC control group.

When comparing the structures of primary morbidity of the studied group of veterans of SRU in the period 2017 – 2019 (table 16) and the control group of AC representatives in the same time period (table 20), it was determined that there is a complete coincidence in the composition of diseases occupying the first nine positions. At the same time, the enumeration of diseases in descending order of the indicator values is as follows:

– the study group in the period 2017-2019: I, K, G, D, M, J, C, H, N;

– control group in the period 2017-2019: I, H, K, C, D, G, J, M, N.

The ratios of the values of primary morbidity (per 1000 people) of the nine diagnoses considered differ [68].

The first position in the structures of both groups (with an excess of 66.9 ‰ in the studied group) is occupied by diseases of the circulatory system (I). According to this diagnosis, there is a maximum difference between the groups.

The second position in the study group and the third position in the control group (with an excess of 14.2 ‰ in the study group) are occupied by diseases of the digestive system (K).

The third position in the study group and the sixth position in the control group (with an excess of 16.7 ‰ in the study group) are occupied by diseases of the nervous system (G).

The fourth position in the study group and the fifth position in the control group (with an excess of 6.4 ‰ in the study group) are occupied by benign neoplasms (D).

The fifth position in the diseases of the musculoskeletal system and connective tissue (M) occupy the eighth position in the control group (with an excess of 19.2 ‰ in the study group).

Diseases of the respiratory system (J) occupy the sixth position in the study group and the seventh position in the control group (with an excess of 15.4 ‰ in the study group).

The seventh position in the study group and the fourth position in the control group (with an excess of 1.3 ‰ in the control group) are occupied by malignant neoplasms (C). According to this diagnosis, there is a minimal difference between the groups.

The eighth position in the study group and the second position in the control group (with an excess of 22.0 ‰ in the control group) are occupied by diseases of the eye and its accessory apparatus (H).

Diseases of the genitourinary system (N) occupy the ninth position in the structures of both groups (with an excess of 5.1 ‰ in the study group).

Conclusions on paragraph 3.2.3.

It follows from the comparison that the differences in the values of primary morbidity for the two subgroups of the considered contingent lie in the range from 1.3 ‰ to 66.9 ‰. To determine the degree of differences, a comparison is used with the median of this segment, equal to 32.8 ‰. The values of differences exceeding this value are considered as significant predominances, the rest as simple predominances.

1) A significant predominance of differences in the values of primary morbidity in veterans of SRU compared with AC representatives is observed when considering the following diagnosis:

– diseases of the circulatory system (I).

2) The predominance of differences in the values of primary morbidity in veterans of SRU compared with AC representatives is observed when considering the following diagnoses:

– diseases of the musculoskeletal system and connective tissue (M);

- diseases of the nervous system (G);

– diseases of the digestive system (K);

– diseases of the respiratory system (J);

– benign neoplasms (D);

– diseases of the genitourinary system (N).

3) The predominance of differences in the values of primary morbidity in AC representatives compared with veterans of SRU is observed when considering the following diagnoses:

– diseases of the eye and its accessory apparatus (H);

– malignant neoplasms (C).

3.2.4. Total morbidity of representatives of the attached contingent of the control group in the period 2017 – 2019

The data of the medical examination and the result of calculating the total morbidity of AC representatives of the control group in 2017 – 2019 are shown in table 21.

Table 21 – Survey data (number of registered diagnoses) and the result of calculating the total morbidity of AC representatives of the control group in the period 2017 – 2019

The ICD-10 code	**A group of diseases**	**Year of observation**		
		2017	**2018**	**2019**
1	**2**	**3**	**4**	**5**
A	Some infectious and parasitic diseases	–	1	–
B		1	–	–
C	Malignant neoplasms	7	6	6
D	Benign neoplasms	9	8	3
E	Diseases of the endocrine system	–	–	2
G	Diseases of the nervous system	3	3	6
H	Diseases of the eye and its accessory apparatus	17	10	1
I	Diseases of the circulatory system	38	34	34
J	Diseases of the respiratory system	4	5	1
K	Diseases of the digestive system	7	7	7
L	Diseases of the skin and subcutaneous tissue	1	1	1
M	Diseases of the musculoskeletal system and connective tissue	1	4	1
N	Diseases of the genitourinary system	2	–	1

Table continuation 21

1	2	3	4	5
R	Symptoms, signs and deviations	–	1	–
S	Injuries, poisoning and the effects of external causes	1	–	–
T		1	1	2
The number of newly registered diseases per year		92	81	65
Primary morbidity (per 1000 people)		355,2	312,7	251,0

The dynamics of the overall morbidity of representatives of the AC control group in the period 2017 – 2019 is shown in figure 8.

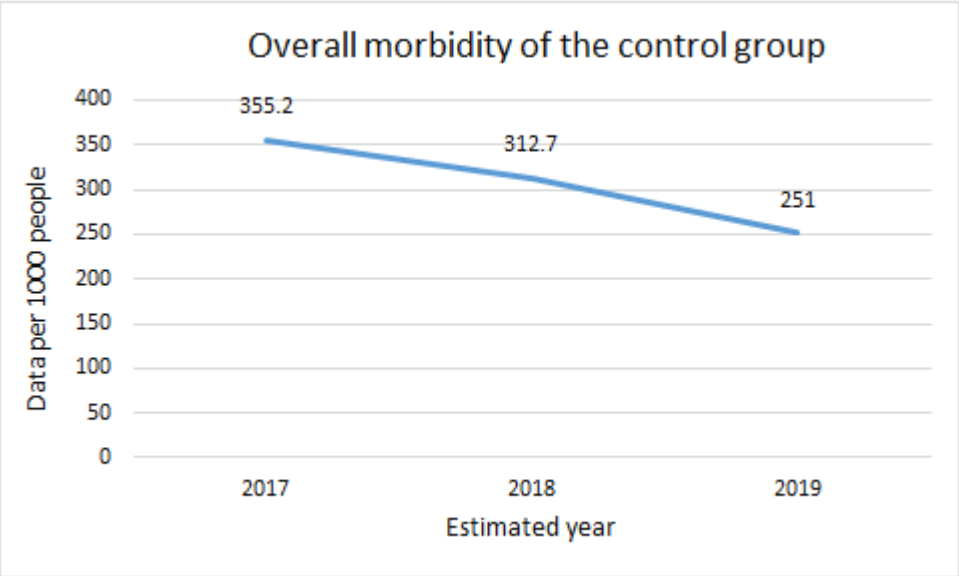


Figure 8 – Dynamics of the overall morbidity of AC representatives of the control group in the period 2017 – 2019 (per 1000 people)

The total morbidity of AC representatives of the control group distributed by diagnosis in 2017 – 2019 is presented in table 22.

Table 22 – Total morbidity of AC representatives of the control group distributed by diagnosis in 2017 – 2019 (per 1000 people)

The ICD-10 code	A group of diseases	Year of observation			Average for 3 years
		2017	2018	2019	
1	2	3	4	5	6
A	Some infectious and parasitic diseases	0,0	3,9	0,0	1,3
B		3,9	0,0	0,0	1,3
C	Malignant neoplasms	27,0	23,2	23,2	24,5

Table continuation 22

1	2	3	4	5	6
D	Benign neoplasms	34,7	30,9	11,6	25,7
E	Diseases of the endocrine system	0,0	0,0	7,7	2,6
G	Diseases of the nervous system	11,6	11,6	23,2	15,5
H	Diseases of the eye and its accessory apparatus	61,8	38,6	3,9	36,0
I	Diseases of the circulatory system	146,7	131,3	131,3	136,4
J	Diseases of the respiratory system	15,4	19,3	3,9	12,9
K	Diseases of the digestive system	27,0	27,0	23,2	27,0
L	Diseases of the skin and subcutaneous tissue	3,9	3,9	3,9	3,9
M	Diseases of the musculoskeletal system and connective tissue	3,9	15,4	3,9	7,7
N	Diseases of the genitourinary system	7,7	0,0	3,9	3,9
R	Symptoms, signs and deviations	0,0	3,9	0,0	1,3
S	Injuries, poisoning and the effects of external causes	3,9	0,0	0,0	1,3
T		3,9	3,9	7,7	5,2

3.2.5 Analysis of the structure of the general morbidity of AC representatives of the control group in the period 2017 – 2019

The analysis showed that according to the values of the average general morbidity over the three years of the specified period, the diagnoses were as follows:

– diseases of the circulatory system (I): 136.4 ‰;

– diseases of the eye and its accessory apparatus (H): 36.0 ‰;

– diseases of the digestive system (K): 27.0 ‰;

– benign neoplasms (D): 25.7 ‰;

– malignant neoplasms (C): 24.5 ‰;

– diseases of the nervous system (G): 15.5 ‰;

– diseases of the respiratory system (J): 12.9 ‰;

– diseases of the musculoskeletal system (M): 7.7 ‰;

– injuries, poisoning and exposure to external causes (T): 5.2 ‰;

– diseases of the skin and subcutaneous tissue (L): 3.9 ‰;

– diseases of the genitourinary system (N): 3.9 ‰;

– diseases of the endocrine system (E): 2.6 ‰;

– some infectious and parasitic diseases (A): 1,3 ‰;

– some infectious and parasitic diseases (B): 1.3 ‰;

– symptoms, signs and abnormalities (R): 1.3 ‰;

– injuries, poisoning and exposure to external causes (S): 1,3 ‰;

3.2.6. Comparison of data on the general morbidity of veterans of SRU of the study group and representatives of the AC control group in the period 2017 – 2019

In Figure 5, in the first section (2017 – 2018) there is a decrease of 3.8 ‰, and in the second section (2018 – 2019) there is an increase in the overall incidence of 7.7 ‰. Such values of decline and growth cannot be called significant.

In Figure 8, in the first section (2017 – 2018) there is a decrease of 42.5 ‰, and in the second section (2018 – 2019) there is a decrease in overall morbidity by 61.7 ‰.

When comparing the structures of the general morbidity of the studied group of veterans of SRU (table 18) and the control group of AC representatives (table 22), it was determined that according to the names of the first nine diagnoses, their lists coincide in eight cases. At the same time, the enumeration of diseases in descending order of the indicator values is as follows:

– the study group in the period 2017-2019: I, K, C, G, J, M, D, H, N;

– the control group in the period 2017-2019: I, H, K, D, C, G, J, M, T.

The ratios of the values of the total morbidity (in ppm) of the nine diagnoses considered differ.

The first position in the structures of both groups (with an excess of 110.7 ‰ in the study group) is occupied by diseases of the circulatory system (I). According to this diagnosis, there is a maximum difference between the groups.

The second position in the study group and the third position in the control group (with an excess of 19.4 ‰ in the study group) are occupied by diseases of the digestive system (K).

The third position in the study group and the fifth position in the control group (with an excess of 12.8‰ in the study group) are occupied by malignant neoplasms (C).

The fourth position in the study group and the sixth position in the control group (with an excess of 17.9 ‰ in the study group) are occupied by diseases of the nervous system (G).

The fifth position in diseases of the respiratory system (J) occupy the seventh position in the control group (with an excess of 20.5 ‰ in the study group).

Diseases of the musculoskeletal system and connective tissue (M) occupy the sixth position in the study group) and the eighth position in the control group (with an excess of 20.6 ‰ in the study group).

Benign neoplasms occupy the seventh position in the study group and the fourth position in the control group (with an excess of 2.6 ‰ in the study group) (D). According to this diagnosis, there is a minimal difference between the groups in the nine diagnoses considered.

The eighth position in the study group and the second position in the control group (with an excess of 23.2 ‰ in the control group) are occupied by diseases of the eye and its accessory apparatus (H).

The ninth position in the study group is occupied by diseases of the genitourinary system (N). There is no such position in the control group.

The ninth position in the control group is occupied by injuries, poisoning and the effects of external causes (T). There is no such position in the study group.

Conclusions on paragraph 3.2.6

It follows from the comparison that the differences in the values of total morbidity for the study and control groups range from 2.6 ‰ to 110.7 ‰. To determine the degree of differences, a comparison is used with the median of this segment, equal to 42.4 ‰. The values of differences exceeding this value are considered as significant predominances, the rest as simple predominances.

1) A significant predominance of differences in the values of general morbidity in veterans of SRU compared with representatives of the AC is observed when considering the following diagnosis:

– diseases of the circulatory system (I).

2) The predominance of differences in the values of general morbidity in veterans of SRU compared with representatives of the AC is observed when considering the following diagnoses:

– diseases of the musculoskeletal system and connective tissue (M).

– diseases of the respiratory system (J);

– diseases of the digestive system (K);

– diseases of the nervous system (G);

– malignant neoplasms (C);

– benign neoplasms (D).

3) The predominance of differences in the values of general morbidity in AC representatives compared with veterans of SRU is observed when considering the following diagnosis:

– diseases of the eye and its accessory apparatus (H).

3.3. Comparison of accounting characteristics of the studied and control groups using statistical criteria

3.3.1. Analysis of the distribution of patients in the study and control groups by diagnosis

To compare the study and control groups, the time interval was selected when representatives of both groups received medical care at the same time, and this happened in the period 2017 – 2019.

The comparison of the frequencies of diagnoses of primary morbidity of veterans of SRU of the study group and representatives of the AC control group was carried out according to the total data for these 3 years.

Diagnoses for which the total frequency values for the period 2017 – 2019 in the study group exceeded the value of 10 were selected as accounting features. Thus, seven diagnoses were selected.

For each selected diagnosis, according to the data on the actual number of observations from tables 14 and 19, a four-field conjugacy table was filled in. Filling in the fields with the actual values of the frequencies of diseases of the circulatory system and the total values by rows and columns is shown in table 23.

Table 23 – Filling in the fields of the four-field table with the actual frequency values for the analysis of diseases of the circulatory system

The presence of exposure to ionizing radiation	**The presence of the disease with a diagnosis of «I»**		**Total**
	There is a disease	**There is no disease**	
The impact was	148	111	259
There was no impact	96	163	259
Total:	244	274	518

Next, the theoretically expected number of observations was calculated, provided that the null hypothesis about the absence of differences between the groups was valid. Filling in the fields with theoretically expected values of the frequency of observations of the diagnosis is shown in table 24.

Table 24 – Filling in the fields of the four-field table with theoretically expected frequency values for the analysis of diseases of the circulatory system

The presence of exposure to ionizing radiation	**The presence of the disease with a diagnosis of «I»**		**Total:**
	There is a disease	**There is no disease**	
The impact was	122	137	259
There was no impact	122	137	259
Total:	244	274	518

Then, according to the theoretically expected frequency values from the four fields of table 24, the choice of a statistical criterion for assessing the significance of differences in the compared features was clarified. If the data of the four calculated fields in table 24 exceeded the value «10», then the option of using the criterion $\chi 2$ was finally approved.

For all seven selected diagnoses, the conditions for the application of criterion $\chi 2$ are met.

After that, according to the data of the actually observed frequency values from the four fields of table 23 and according to the theoretically expected frequency values from the four fields of table 24, the value of the criterion χ^2 was calculated.

In this study, only four-field tables are used, so the number of degrees of freedom will always be f = (2-1)*(2-1) = 1.

In such circumstances:

1) the Yates correction is introduced into the formula for calculating the criterion χ^2;

2) the critical values of criterion χ^2, taken from the corresponding table, are as follows:

– for the significance level p = 0.05, the critical value is 3.841;

– for the significance level p = 0.01, the critical value is 6.635.

The calculated values of the criterion χ^2 were compared with the critical values of the criterion. If the calculated value of the criterion for the studied diagnosis exceeded the critical value, the null hypothesis was rejected in favor of an alternative hypothesis.

In general, the null hypothesis (H_0) of the criterion asserts that there is no difference between the two data sets, and the alternative (H_a) asserts that there is such a difference.

In this study, the null hypothesis asserts that the presence of the considered diagnosis of the disease in representatives of the study group does not depend on the past IIRNT. As an argument, the data of the control group, which includes patients who have not experienced such an impact, are presented. An alternative hypothesis refutes this statement, proving that there is such a dependence for a given level of significance and number of degrees of freedom.

The actual frequency of diagnoses of the studied group of veterans of SRU and the control group of AC representatives, the results of the calculation of criterion χ^2 and the location of the significance level of the calculated value of the criterion relative to the significance levels of the critical values of the criterion are shown in table 25.

Table 25 – Initial data and results of the calculation of criterion χ^2 to assess the statistical significance of differences in the frequency values of the same diagnoses in the study and control groups

The ICD-10 code	A group of diseases	Total data for 3 years (from 2017 to 2019)			
		V of SRU, quantity	ACR, quantity	χ^2	p
I	Diseases of the circulatory system	148	96	20,153	p < 0,01 (0,000007)
K	Diseases of the digestive system	31	20	2,175	p > 0,05 (0,140)
G	Diseases of the nervous system	23	10	4,661	p < 0,05 (0,031)
D	Benign neoplasms	21	16	0,466	p > 0,05 (0,495)
M	Diseases of the musculoskeletal system and connective tissue	20	5	8,238	p < 0,01 (0,004)
J	Diseases of the respiratory system	20	8	4,568	p < 0,05 (0,033)
C	Malignant neoplasms	16	17	0,000	p > 0,05 (1,000)

Notes. 1. V of SRU – the frequency of registration of the diagnosis of the disease of veterans of special risk units; 2. ACR – the frequency of registration of the diagnosis of the disease of representatives of the attached contingent; 3. $\chi 2$ – calculated value of the criterion $\chi 2$; 4. p is the significance level of the calculated criterion value $\chi 2$ (the exact significance level of the calculated criterion is shown in parentheses)

Conclusions according to paragraph 3.3.1.

1) Statistically significant results confirming the possibility of dependence of the presence of the disease on the risk factor were obtained for diagnoses:

– I Diseases of the circulatory system $p < 0.01$ (0.000007);

– G Diseases of the nervous system $p < 0.05$ (0.031);

– M Diseases of the musculoskeletal system and connective tissue

$p < 0.01$ (0.004);

– J Diseases of the respiratory system $p < 0.05$ (0.033).

The exact significance level of the calculated criterion is shown in parentheses.

2) The following diagnoses are not statistically significant for rejecting the null hypothesis (there are no differences between the groups):

– K Diseases of the digestive system $p > 0.05$ (0.140);

– D Benign formations $p > 0.05$ (0.495);

– C Malignant neoplasms $p > 0.05$ (1,000).

The exact significance level of the calculated criterion is shown in parentheses.

3.3.2. Consideration of the relationship between the statistical and clinical significance of the study results

According to A.G. Kochetov and others (2012), the values of «p» obtained in the course of the study are a quantitative characteristic of only statistical, but not clinical significance. If there is statistical significance, the specialist must still decide on the clinical importance of the identified differences, if this fact occurs [54].

As for the citizens who have experienced IIRNT, the dose received is far from always documented, but even if such data is available, in the distant past they could be determined quite approximately due to the lack of necessary devices on site.

According to V.Yu. Nugis, A.Yu. Bushmanov and co-authors (2016 – 2017), cytogenetic analysis of peripheral blood, which is used to evaluate the doses received based on the detected frequencies of FISH chromosome translocations, has a good prospect in terms of clarifying the degree of IIRNT for a particular patient [18, 108].

In essence, this method evaluates not only the dose received, but even more so the degree of its effect on the patient's body, which allows you to correctly build a strategy and tactics of preventive and therapeutic measures.

According to N.M. Oganesyan (2012 – 2016), bad habits are of great importance in the development of diseases of the cardiovascular system: smoking, alcohol consumption and others. The combination of several risk factors increases the likelihood of clinical manifestations of the disease or its complications. It is impossible to deny the possibility of direct radiation damage to the vascular endothelium in those who have undergone IIRNT in the dose range that have reached and exceeded the threshold level. However, in the range of low doses, a regular increase in the frequency of diseases of the circulatory system with an increase in dose has not been established [11, 21].

Conclusions according to paragraph 3.3.2

1) The decision on the clinical significance of the dependence of the presence of diagnoses obtained with IIRNT, and for which statistical significance has been proven, should be made by interdepartmental expert councils to establish the causal relationship of diseases.

2) In daily clinical activities, the statistical significance of the results obtained for characteristic diagnoses can and should be used in the development of therapeutic and preventive algorithms for providing medical care to persons who have undergone IIRNT.

CHAPTER 4. WAYS AND METHODS OF ORGANIZING A SYSTEM OF MEDICAL CARE FOR PERSONS WHO HAVE BEEN EXPOSED TO IONIZING RADIATION OF NUCLEAR TECHNOLOGIES

4.1. Substantiation of the model of the medical care system and algorithms of its functioning

4.1.1. Organizational structure of the model of the medical care system for persons who have been exposed to ionizing radiation of nuclear technologies

The model of the system of medical care for people who have experienced IIRNT is presented using three main types of elements:

– the process;

– procedure;

– database.

A process is understood as an element of the system, the operation of which can be described using an algorithm that displays its functionality.

A process may include other (nested) processes, procedures, and databases.

A procedure is understood as an element of the system, the functionality of which is described by its name, without specifying the content. This is due to the fact that the implementation of procedures depends on the specific contractor.

A database is understood as an element of a system that performs the function of accumulating information with the possibility of its subsequent extraction for analysis.

The relationships between the elements of the system are shown using the arrows.

Figure 9 shows a block diagram of the model of the medical care system for people who have experienced IIRNT.

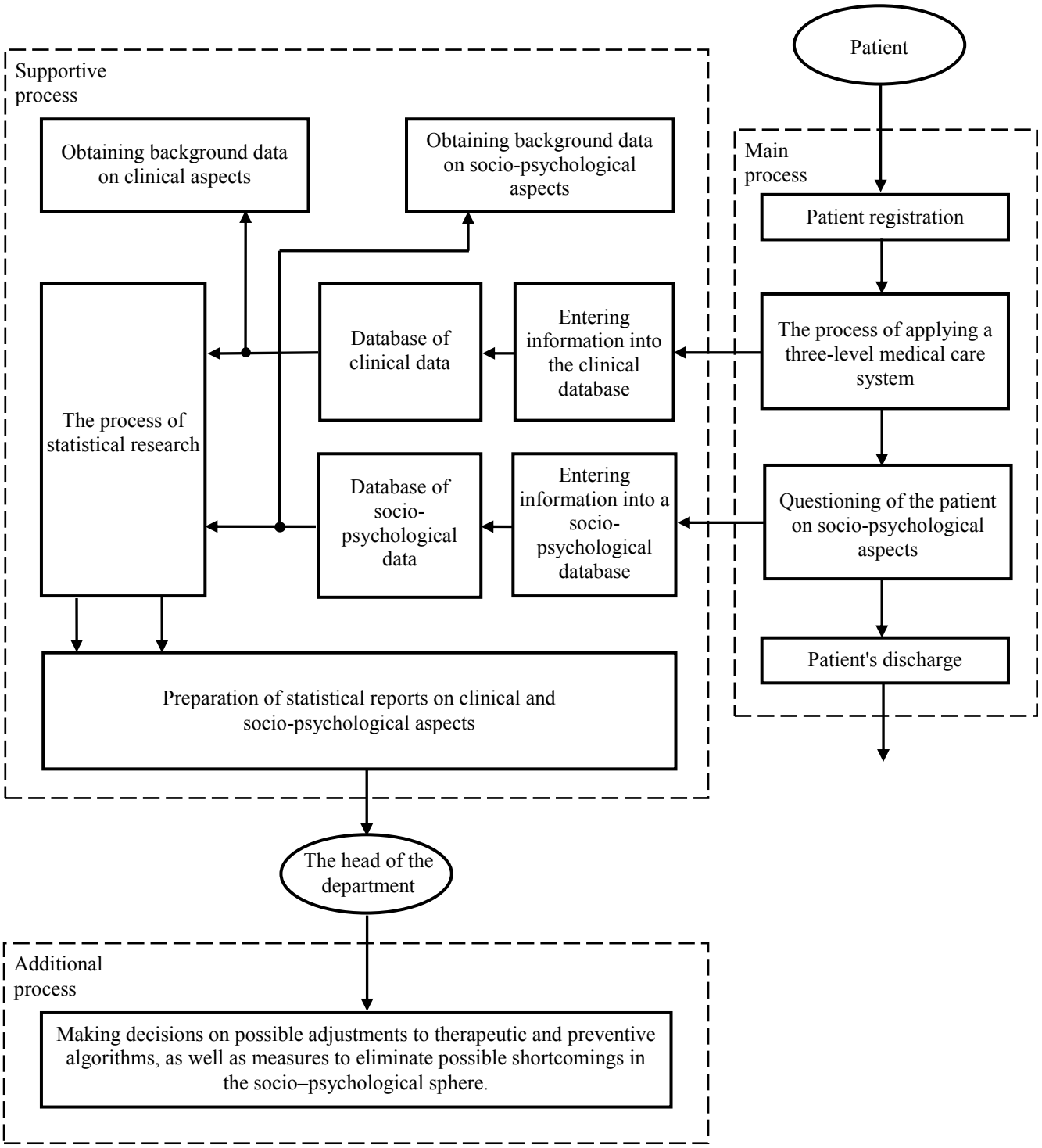


Figure 9 – Structural diagram of the model of the medical care system for persons who have been exposed to ionizing radiation of nuclear technologies

The right side of the system shows the main process of providing medical care to the patient (hereinafter referred to as the main process). It consists of the following elements:

– patient registration procedure;

– the process of applying a three-level medical care system;

– the procedure for questioning the patient on socio-psychological aspects;

– the procedure of discharge of the patient.

An auxiliary process is shown to the left of the main process. It includes:

– a database of clinical data;

– the procedure for entering information into the clinical database;

– procedure for obtaining background data on clinical aspects;

– a database of socio-psychological data;

– the procedure for entering information into the database of socio-psychological data;

– the procedure for obtaining background data on socio-psychological aspects;

– the process of statistical research;

– the procedure for compiling statistical reports on clinical and socio-psychological aspects (hereinafter referred to as the procedure for compiling statistical reports).

An additional process is located below the auxiliary process, which presents the decision–making procedure on possible adjustments to therapeutic and preventive algorithms, as well as measures to eliminate possible shortcomings in the socio–psychological sphere (hereinafter referred to as the decision-making procedure) [68].

4.1.2. The algorithm of functioning of the main process

1) At the entrance of the main process, a service request is received in the form of a request for medical help from a person who has experienced IIRNT (patient). The patient registration procedure is being performed.

2) After registration is completed, the process of applying a three-level medical care system starts, starting from the first level.

3) During the implementation of the process of applying a three-level medical care system, clinical information is entered into the appropriate database.

4) Upon completion of the process of applying the three-level medical care system, the procedure of questioning the patient on socio-psychological aspects is

performed. The result of the survey is recorded in the database for socio-psychological information on the contingent in question.

5) After the questionnaire, the treated person gets to the entrance of the patient's discharge procedure.

6) After completion of the discharge procedure, the treated person who has experienced IIRNT in the past returns to his normal activities [68].

4.1.3. Algorithms for the operation of the auxiliary process

When working with databases, at least two maintenance algorithms are required:

– data accumulation algorithm;

– algorithm(s) for extracting accumulated data [68].

The data accumulation algorithm is described as follows:

1) clinical data from the main process using the user's terminal gets to the input of the procedure for entering information into the clinical database;

2) the procedure for entering information of this type places it in the clinical database for subsequent long-term storage;

3) socio-psychological data from the main process using the user's terminal gets to the input of the procedure for entering information into the database of socio-psychological data [68];

4) the procedure for entering information of this type places it in a database of socio-psychological data for subsequent long-term storage.

There are several algorithms for data extraction in this case:

a) The algorithm for extracting accumulated clinical data at arbitrary points in time looks like this:

1) upon request from the user's terminal, the required information from the clinical database enters the procedure for obtaining reference data on clinical aspects;

2) the procedure for obtaining reference data on clinical aspects issues it to the user's terminal [68].

b) The algorithm for extracting accumulated socio-psychological data at arbitrary points in time looks like this:

1) upon request from the user's terminal, the required information from the database of socio-psychological data enters the procedure for obtaining reference data on socio-psychological aspects;

2) the procedure for obtaining reference data on socio-psychological aspects issues it to the user's terminal [68].

c) The algorithm for extracting accumulated data on request from the statistical research process for the reporting period is as follows:

1) At the end of the next reporting period, the information recorded in the database of clinical data and in the database of socio-psychological data is received at the input of the statistical research process.

2) The statistical research process processes two streams of independent data. The results of processing two data streams are received at the input of the statistical reporting procedure.

3) Information from the output of the procedure for compiling statistical reports is made available to the head of the department.

4.1.4. Operation of the additional process

The work of the additional process, which is launched by the head of the department, consists in the fact that, based on data from the received statistical reports, a package of procedures is performed to make the required decisions on possible adjustments to the clinical and socio-psychological aspects of medical care [68].

4.1.5. Application of a three-tier medical care system

Within the main process, there is a nested process of applying a three-level medical care system. Let's consider the structure of a three-level medical care system and the algorithm of its application process.

Figure 10 shows in general the structure of the NWDSCC, which initially contained all the necessary elements for the formation of a three-level medical care system. The advantage of this option is that there is no need to move the patient over long distances to provide him with medical care at different levels.

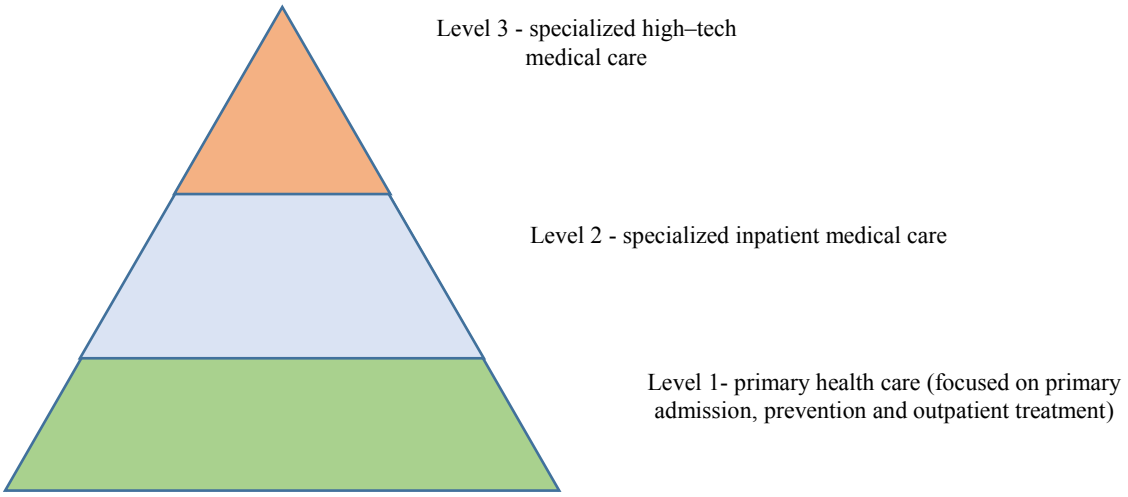


Figure 10 – The three-level system of medical care in the NWDSCC

Knowledge of the structure of a three-level medical care system is not enough to understand the algorithm of its operation. It is also necessary to consider the dependence between the elements in the process of its functioning over time.

To display the process of applying the three-level medical care system carried out in the NWDSCC, an algorithm was used containing decision-making nodes (shown in the form of diamonds with the formulation of the switching condition) and selectable levels of medical care (shown in the form of rectangles with the corresponding text). The algorithm describing the sequence of actions in the process of providing medical care to the patient is shown in figure 11.

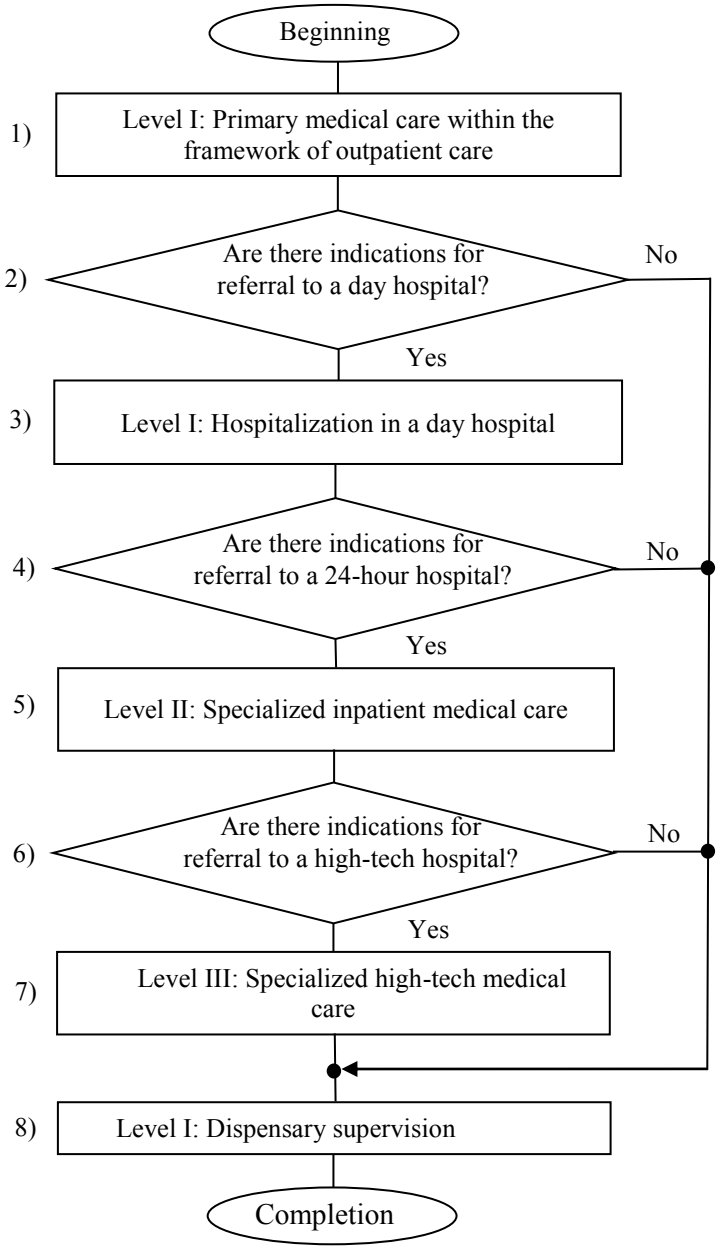


Figure 11 – Algorithm for the functioning of the process of applying a three-level medical care system

1) At the beginning of the process, the patient enters the first level of the system, where he receives primary medical care as part of outpatient care.

2) At the end of primary medical care, it is checked whether there are indications for referring the patient to a day hospital. If there are no such indications, then the patient is assigned a first-level dispensary (8). If such indications are available, the patient is sent to a day hospital of the first level (3).

3) Medical care is provided in a day hospital (first level).

4) Upon completion of medical care in a day hospital, the question is considered whether there are indications for referral to a 24-hour hospital. If the answer is negative, then the patient is assigned a dispensary observation of the first level (8). If such indications are available, the patient is sent to a round-the-clock hospital of the second level (5).

5) Specialized inpatient medical care is provided in a round-the-clock hospital (second level).

6) After the completion of medical care in a 24-hour hospital, it is considered whether there are indications for referring the patient to a high-tech hospital. If the answer to the question is negative, the patient is transferred to a first-level dispensary (8). If such indications are available, the patient is sent to provide specialized high-tech medical care of the third level (7).

7) Specialized high-tech medical care is being provided (third level). After completion of treatment at this level, the patient is transferred to a first–level dispensary (8).

8) Dispensary observation (first level) will continue for as long as necessary until a conclusion is reached and an appropriate decision is made to achieve a sustainable result for the patient's health. In this case, the work of the three-level medical care system is completed [68].

Conclusions on subsection 4.1.

1) The main process implements the functions of interaction between the staff of a medical institution and patients at the level of direct communication. As a result of such interaction, information is obtained on clinical indicators, information on socio-psychological indicators, and decisions are made on methods of providing medical care. All the indicators taken into account are recorded on paper, and electronically transmitted to the auxiliary process.

2) The auxiliary process provides long-term storage, analysis and statistical processing of all information received from patients during direct communication, which is implemented in the main process.

3) An additional process ensures the implementation of the system decision-making function based on the analysis of reports on statistical information obtained from the auxiliary process.

4.2. Features of the functioning of the auxiliary process of the model of the medical care system for the persons of the contingent in question

4.2.1. Formation and functioning of the auxiliary process

For the auxiliary process, as well as for the process of implementing a three-level system of medical care, in addition to its structure, functioning over time should be considered.

The auxiliary process receives, stores and processes two types of data:

1) clinical information;

2) socio-psychological information.

Information about the health status of the examined patients is accumulated in clinical databases based on the results of diagnosis, treatment, special examinations and preventive measures [68].

Information about the quality of medical care and other socio-psychological aspects is accumulated in databases of socio-psychological data as a result of conducting surveys or questioning patients according to a pre-developed list of questions.

Practical experience of such events shows that it is advisable to use surveys and questionnaires only to collect subjective data, since respondents, due to different levels of education and different life experiences, may distort data or simply leave some questions unanswered.

The survey or questionnaire can be performed either individually, for example, upon discharge of a patient, or as a result of organizing an appropriate event for a group of selected persons at any time of interest. The option of an individual questionnaire is preferable, because in this case we will receive an assessment «in hot pursuit», otherwise the patient's real feelings may be distorted over time.

To form the planned functionality of the auxiliary process, it is necessary to perform the following preliminary preparation:

– make a decision on the development of the auxiliary process;

– to develop parameter structures for the required databases of clinical data on the state of health of patients;

– to develop questionnaires and parameter structures for the required databases of socio-psychological data of surveys and questionnaires;

– formulate requirements for the frequency of research and reporting.

An auxiliary process is a process with a conditionally infinite loop. It can be stopped either due to a hardware failure or by order.

Figure 12 shows the principles of the auxiliary process functioning over time.

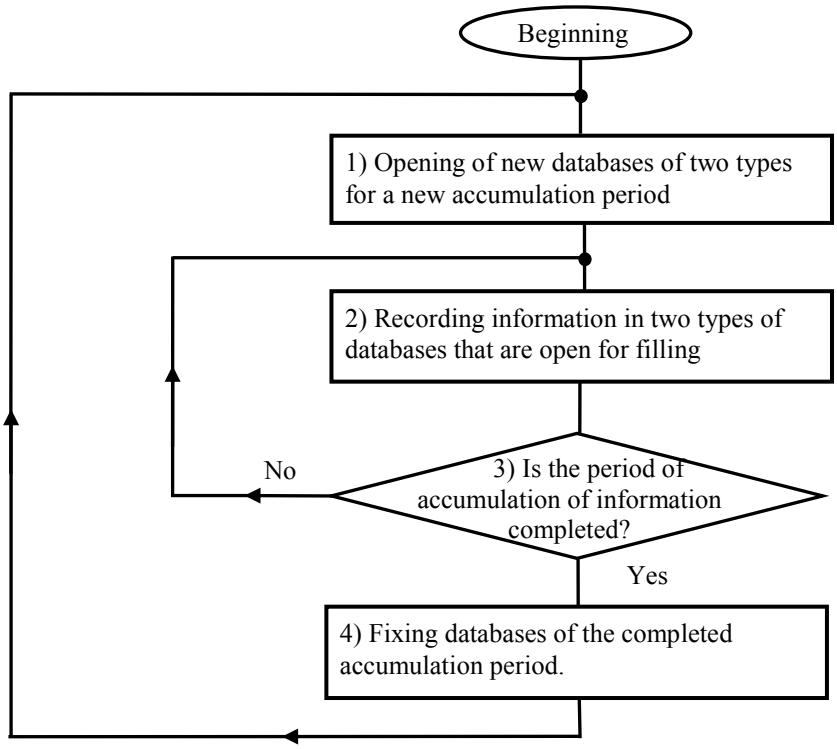


Figure 12 – Principles of the auxiliary process functioning in time

1) At the beginning of the operation of the process, the procedures of stage 1 are performed, in which new databases of two types are opened for recording for a new accumulation period. After that, the transition to stage 2 takes place.

2) At stage 2 of the process, the next portion of information is recorded in open databases. After the recording is completed, the transition to stage 3 takes place.

3) In stage 3, a check is performed to ensure that the end of the specified data accumulation period has been reached. If the accumulation period is completed, the transition to stage 4 takes place. If the accumulation period is not completed, the return to stage 2 is carried out, that is, the accumulation of information continues.

4) At stage 4, the databases of the completed accumulation period are being fixed. After the database commit is completed, the transition to stage 1 occurs, which means the opening of new databases of two types and the beginning of a new accumulation period. The main loop closes, and will continue to be executed conditionally indefinitely, except in cases of possible breakdown or a decision to stop.

The committed databases will no longer be used for writing data, but will be available only in read mode. In this version, they will be used to carry out the statistical research process, on the basis of which statistical reports are compiled, which are transmitted to the head of the department for making appropriate decisions.

The principles of functioning of the auxiliary process considered are applicable to any contingent, regardless of the type of disease and the circumstances of morbidity. All necessary features should be taken into account at the stages of developing structures of clinical databases, questionnaires, structures of databases of socio-psychological data, as well as at the stages of subsequent analysis of clinical and socio-psychological aspects of the study, taking into account existing risk factors.

In this study, the presence of IIRNT is considered as a risk factor.

After starting the auxiliary process, data accumulation should become permanent, and data processing should be periodic. It is recommended to link the frequency of data processing to a standard reporting period, for example, once a year. The morbidity structure of the contingent may change over time. In this case, it will be necessary to adjust the therapeutic and preventive algorithms. Assessments of the quality of medical care may also change as a result of timely adoption of necessary measures, and relevant comments will no longer be relevant.

4.2.2. Statistical research process

After the accumulation of information in the databases of clinical and socio-psychological data during the reporting period, the work of the statistical research process becomes possible.

The structure of the statistical research process is shown in figure 13.

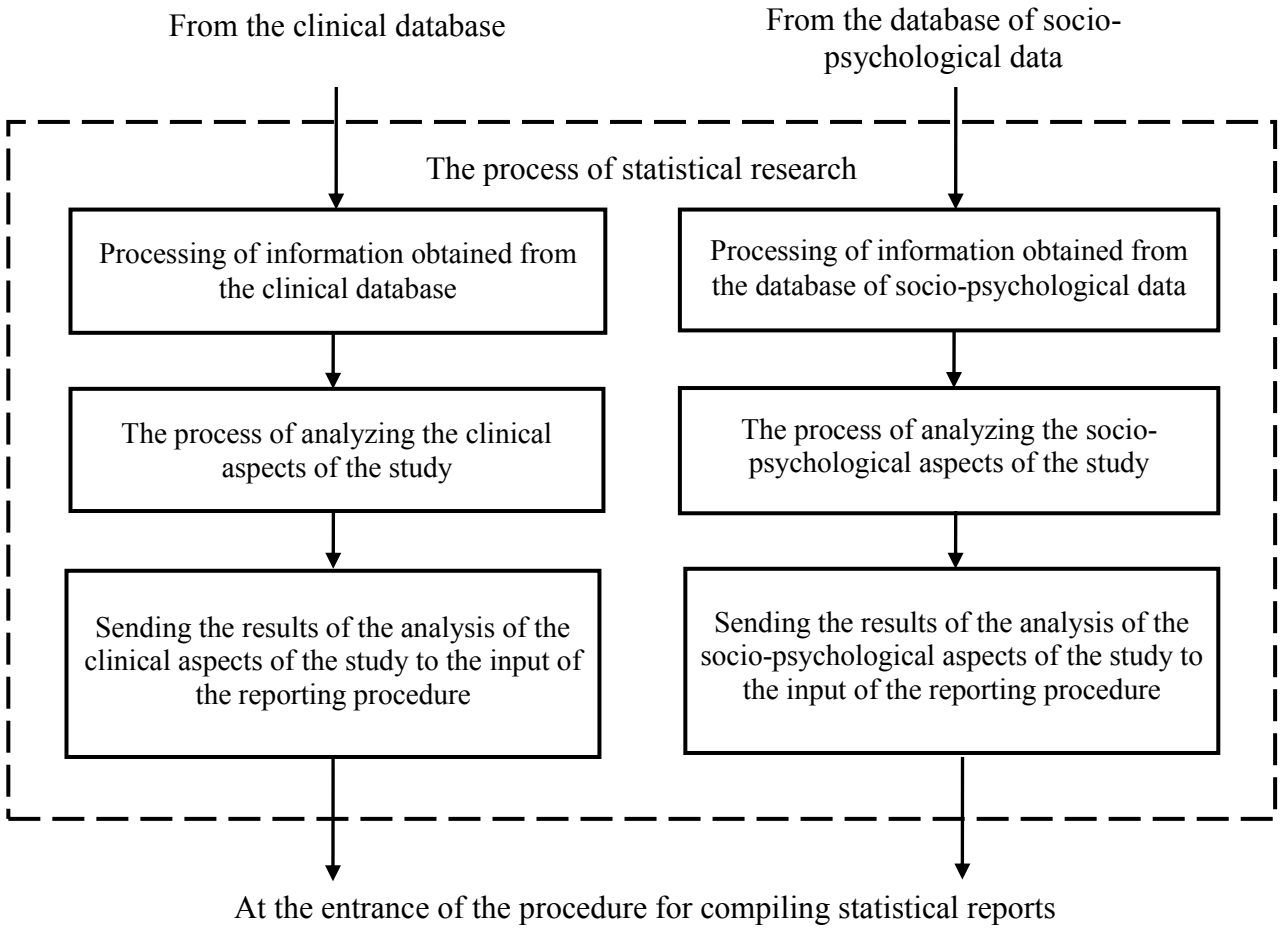


Figure 13 – Structure of the statistical research process

Statistical research is conducted separately for clinical databases and for databases of socio-psychological data.

Information from the clinical database is received at the input of the procedure for its processing. After the statistical processing of the information is completed, the process of analyzing the clinical aspects of the study is activated.

Information from the database of socio-psychological data is received at the input of its processing procedure. After completing the statistical processing of information, the process of analyzing the socio-psychological aspects of the study is included.

The results of the analysis of both types of statistical data are sent to the input of the reporting procedure.

4.2.3. The process of analyzing the clinical aspects of the study.

Figure 14 shows the structure of the process of analyzing the clinical aspects of the study of people who have experienced IIRNT.

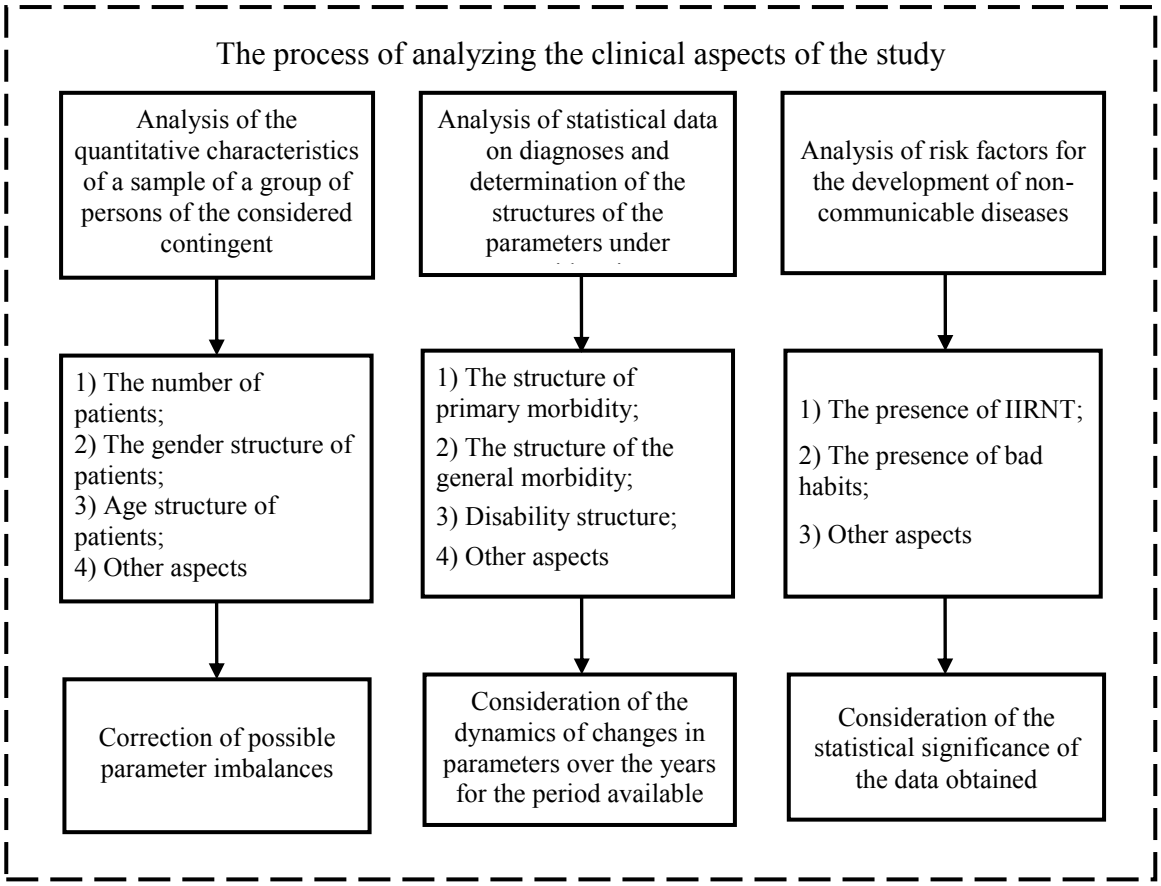


Figure 14 – The structure of the process of analyzing the clinical aspects of the study

The analysis of the clinical aspects of the study can be sufficiently represented by three components:

– analysis of the quantitative characteristics of a sample of a group of persons of the considered contingent;

– analysis of statistical data on diagnoses and determination of the structures of morbidity, disability and other parameters under consideration;

– analysis of risk factors for the development of non-communicable diseases.

Figure 14 shows the minimum lists of the main issues that should be considered in the analysis.

4.2.4.The process of analyzing the socio-psychological aspects of the study.

Figure 15 shows the structure of the process of analyzing the socio-psychological aspects of the study

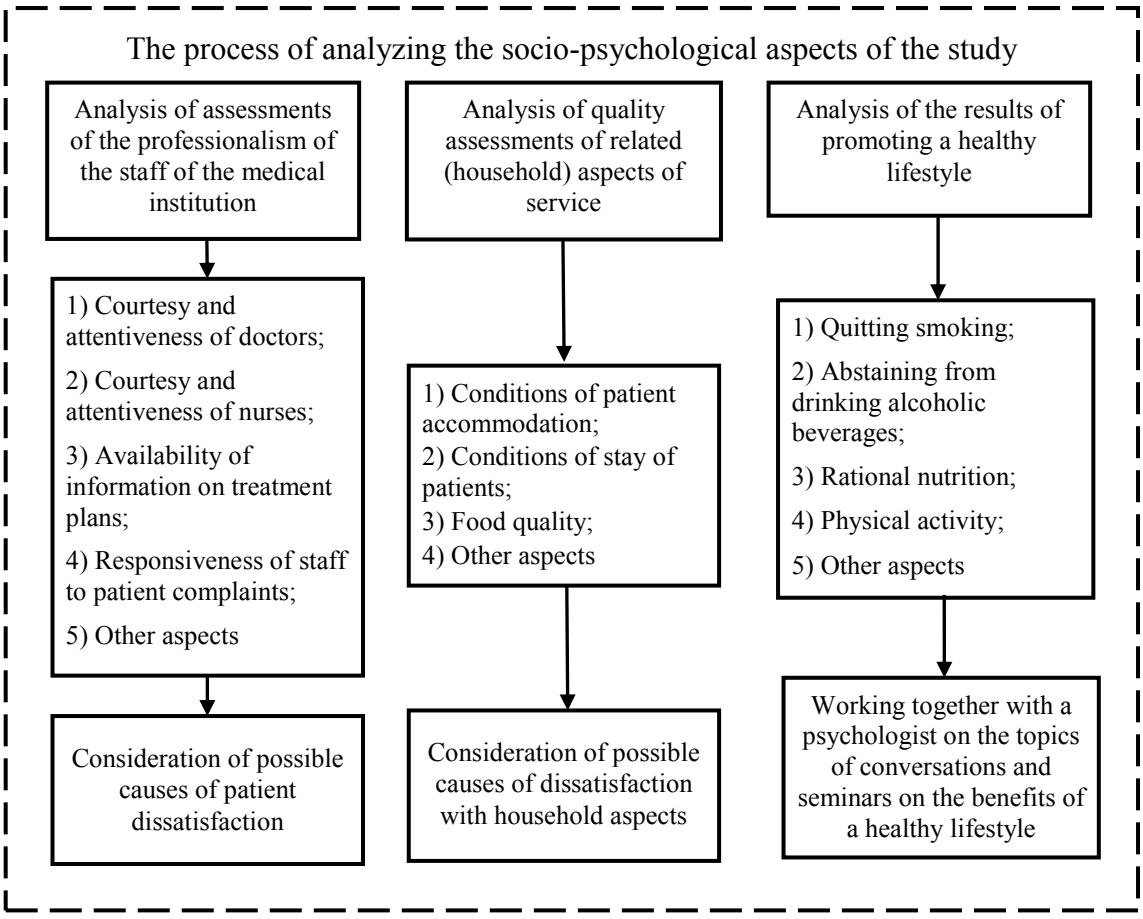


Figure 15 – The structure of the process of analyzing the socio-psychological aspects of the study

All the necessary features of the studied contingent should be taken into account in specialized questionnaires.

Questionnaires on the subject under consideration are given in Appendices A and B.

The analysis of the socio-psychological aspects of the study can be sufficiently represented by three components:

– analysis of assessments of the professionalism of the staff of the medical institution;

– analysis of quality assessments of related (household) aspects of service;

– analysis of the results of promoting a healthy lifestyle.

Figure 15 shows the minimum lists of the main questions that should be considered during the survey and which largely determine the real assessment of the respondents.

In particular, according to the results of the survey, it was found that:

– the professional behavior of the institution's staff is of crucial importance when assessing the quality of medical care provided by patients in a medical organization;

– patients' assessments of the quality of solving everyday issues related to the processes of providing medical care are also important: the correct solution of such issues creates the necessary emotional and psychological background, which is no less important for successful treatment.

If patients are dissatisfied with the state of any socio-psychological aspects of the medical care system, measures should be taken to eliminate the noted shortcomings.

If the staff of the medical institution is dissatisfied with the results of the promotion of healthy lifestyle, additional talks and seminars on the benefits of a healthy lifestyle should be organized.

4.2.5. Patient routing

The proposed system of providing medical care to people who have experienced the IIRNT contains the process of applying a three-level system of medical care, which in this study was implemented in a large regional center containing all three levels of medical care. This approach eliminated the need for patient routing related to his physical movements between institutions of different levels.

However, this system of medical care will be just as effective if there is such a routing. Figure 16 shows an approximate patient routing scheme with the ability to select the most appropriate medical institutions according to the profile.

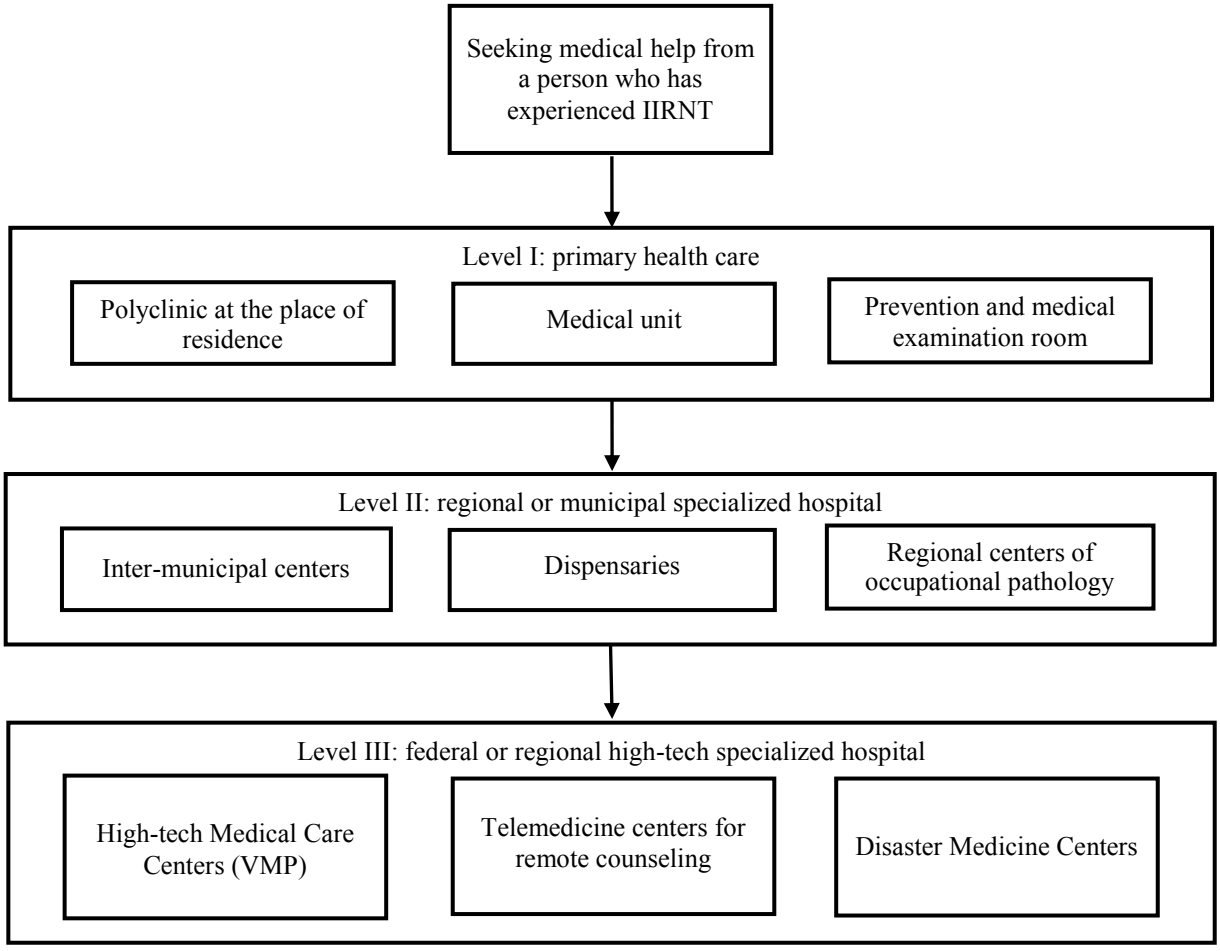


Figure 16 – An approximate patient routing diagram

Conclusions according to subsection 4.2.

1) For the auxiliary process, as well as for the process of implementing a three-level system of medical care, in addition to its structure, functioning over time should be considered.

2) In order to form the planned functionality of the auxiliary process, it is necessary to perform the following preliminary preparation:

– make a decision on the development of the auxiliary process;

– to develop parameter structures for the required databases of clinical data on the state of health of patients;

– to develop questionnaires and parameter structures for the required databases of socio-psychological data of surveys and questionnaires;

– formulate requirements for the frequency of research and reporting.

3) After starting the auxiliary process, data accumulation should become permanent, and data processing should be periodic.

4.3. Analysis of the results of the application of a three-level medical care system

4.3.1. The application of a three-tier medical care system to veterans of special risk units who have experienced IIRNT

In connection with the 75th anniversary of the A.I. Burnazyan Federal State Budgetary Scientific Research Center of the FMBA of Russia, on November 16 and 17, 2021, the jubilee international scientific and practical conference «A.I. Burnazyan Federal State Budgetary Scientific Research Center of the FMBA of Russia: 75 years of protecting people's health.»

The report (2021), devoted to the application of a three-level system of medical care for veterans of SRU, considered the practical aspects of this approach [66].

The practical application of the three-level system of medical care can be traced in the activities carried out in the process of servicing veterans of SRU living in St. Petersburg and the Leningrad region.

As part of the interaction of the NWDSCC hospital with the NWDSCC outpatient polyclinic complex, medical care was provided for 11374 applications from 2012 to 2021. The number of requests should be considered taking into account the time interval of consideration and the presence of more than one diagnosis per person (in reality, these are 2-3 diagnoses). Thus, the number of veterans of SRU served amounted to 446 people.

Financing of work at all levels of the three-level system of medical care was carried out according to the compulsory medical insurance.

Data on the practical result of the application of a three-level system of medical care for veterans of SRU are shown in table 26.

Table 26 – The result of the application of the three-level system of medical care for veterans of SRU for the period from 2012 to 2021

Level number	Level name	Number of patients	Type of medical care provided
Level 1	Outpatient treatment	446	Primary diagnosis and treatment
		259	Referral to a specialized hospital
Level 2	Specialized hospital	259	Clarification of the diagnosis and treatment
		182	Referral to a specialized high-tech hospital
Level 3	Specialized high-tech hospital	182	Clarification of the diagnosis and treatment

4.3.2. The application of a three-level medical care system to representatives of the AC of the NWDSCC who have not experienced IIRNT

At the second scientific and practical conference «Primary health care: modern approaches and best practices», which took place on October 6 and 7, 2022 in St. Petersburg, a report was presented on the application of a three-level system of medical care to representatives of the AC NWDSCC.

The report examines the result of the interaction of the system links in the process of diagnosing and providing medical care to patients.

The relevance of the topic of the report is confirmed by the results of a statistical study conducted on the basis of hospital data for the period from 2017 to 2022, and the results of the subsequent compilation and application of algorithms for providing medical care for the most popular diagnosis – diseases of the circulatory system (I).

The use of the selective coronary angiography method showed its high effectiveness in clarifying the dominant diagnosis of today's statistics [12].

Financing of work at all levels of the three-tier medical care system was carried out within the framework of the state task.

Data on the practical result of the application of a three-level system of medical care for AC representatives in 2022 are shown in table 27.

Table 27 – The result of the application of a three-level system of medical care for AC representatives in 2022

Level number	Level name	Number of patients	Type of medical care provided
Level 1	Outpatient treatment	15000	Primary diagnosis and treatment
		1100	Referral to a specialized occupational pathology hospital
Level 2	Specialized hospital of occupational pathology	1100	Clarification of the diagnosis and treatment
		80	Referral to a specialized cardiology hospital
	Specialized Cardiology Hospital	80	Clarification of the diagnosis and treatment: - performing coronary angiography.
		48	Referral to a specialized high-tech hospital
Level 3	Specialized high-tech hospital	48	Clarification of the diagnosis and treatment: - coronary stenting (28 patients); - coronary artery bypass grafting (CABG) (20 patients).

Conclusions on subsection 4.3.

1) The application of a three-level system of organization of medical care in relation to veterans of SRU has demonstrated the high effectiveness of applying the method to persons of the specified contingent. The total number of successfully treated veterans of SRU at all three levels amounted to 446 people.

2) The three-level system of organization of medical care was applied for the first time in relation to veterans of SRU. The achieved result allows us to recommend this method for use in relation to all persons who have been subjected to IIRNT [68].

3) Since the application of a three-level system of organization of medical care in relation to the AC of the NWDSCC was supported by the state task, it was possible to organize full-fledged monitoring of the health status of this category of citizens [68].

4) In the monitoring process, the method of selective coronary angiography was actively used for diagnosis. It was found that the use of the selective coronary

angiography method provides the necessary level of detail in clarifying the dominant diagnosis of today's statistics – «Diseases of the circulatory system» (I) [68].

5) In all examined patients, drug therapy was adjusted to the optimal level, which allowed PC representatives to return to their previous place of work upon completion of treatment.

4.4. Analysis of the results of the use of statistical surveys and questionnaires to obtain assessments of the quality of medical care

4.4.1. Survey of a group of veterans of SRU treated at the NWDSCC

To assess the quality of medical care and other aspects of the life of veterans of SRU, a questionnaire was developed (appendix A).

Based on it, a telephone survey of a group of veterans of SRU was conducted. An article has been published on the topic of assessing the quality of medical care for veterans of SRU [64]. The number of the survey group was 103 people selected at random.

The survey data were entered into the database, which is officially registered by the Federal Service for Intellectual Property (appendix A).

The gender distribution of the veterans of SRU from the considered group showed that the vast majority of the respondents were men (96%), and the rest were women (4%). Such a sharp difference is due to the fact that veterans of SRU, for the most part, are former military personnel, and this category of citizens is characterized by a predominance of men [64, 79].

This fact should be taken into account when drawing up preventive and curative algorithms for medical care.

The age values of the veterans of SRU are in the range from 53 years to 92 years, the average value of the indicator is 75± 9 years. In Figure 17, the age indicator data are ranked in five categories: «50-59» years, «60-69» years, «70-79» years, «80-89» years, «90-99» years.

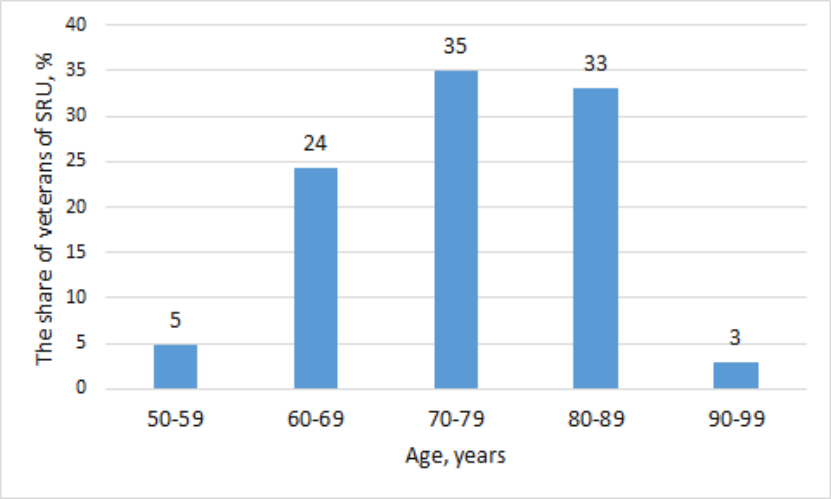


Figure 17 – Distribution of veterans of SRU from the surveyed group by age categories

Most of the veterans of SRU in the surveyed group belong to the age categories of «70-79» years and «80-89» years. This is 68% of the respondents.

The fact of the predominance of these age groups in the above statistics should be taken into account when compiling preventive and curative algorithms.

According to the results of the survey, the types of SRU in which veterans performed their official duties at the time of an emergency situation were identified [64, 79] (figure 18).

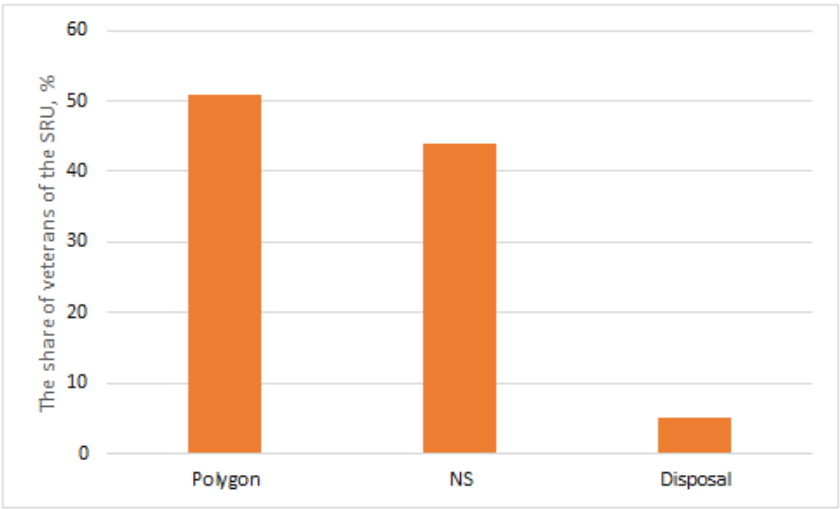


Figure 18 – Distribution of veterans of SRU of the surveyed group by type of units («Landfill» – nuclear weapons tests; «NS» – nuclear submarine; «Disposal» – disposal of radioactive waste)

According to the data obtained, 95% of the veterans of SRU of the surveyed group belonged to the types «Polygon» and «NS».

The structure of the incidence of veterans of SRU, obtained as a result of the survey, is shown in figure 19.

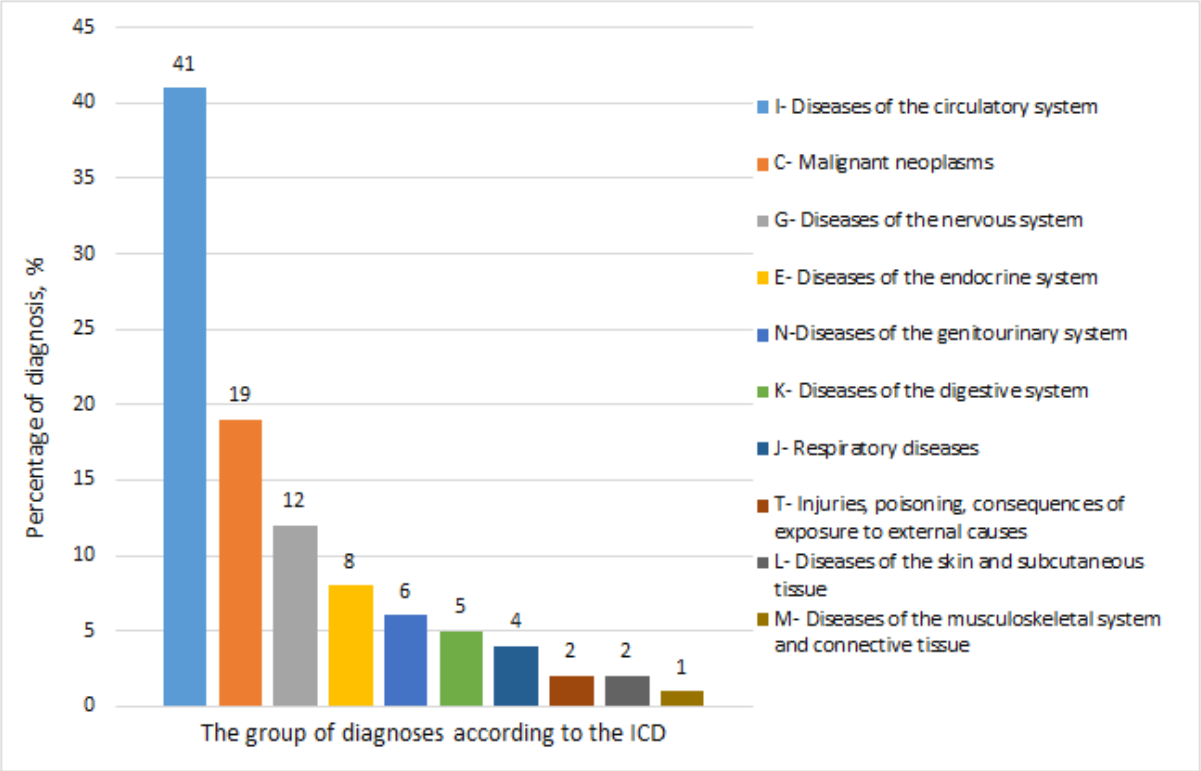


Figure 19 – The structure of the incidence of veterans of SRU in the surveyed group (ICD – International Classification of Diseases)

The analysis of this structure showed that the first seven places in terms of the frequency of manifestation of each of the diagnoses are occupied by:

– diseases of the circulatory system (I): 41 %;

– malignant neoplasms (C): 19 %;

– diseases of the nervous system (G): 12 %;

– diseases of the endocrine system (E): 8 %;

– diseases of the genitourinary system (N): 6 %;

– diseases of the digestive system (K): 5 %;

– respiratory diseases (J): 4%.

Five of the seven diagnoses coincide with the diagnoses recognized as dominant.

Diseases are located in positions 8-10, each of which has a frequency of less than 4%.

The data on the structure of disability of veterans of SRU, obtained as a result of the survey, are shown in figure 20.

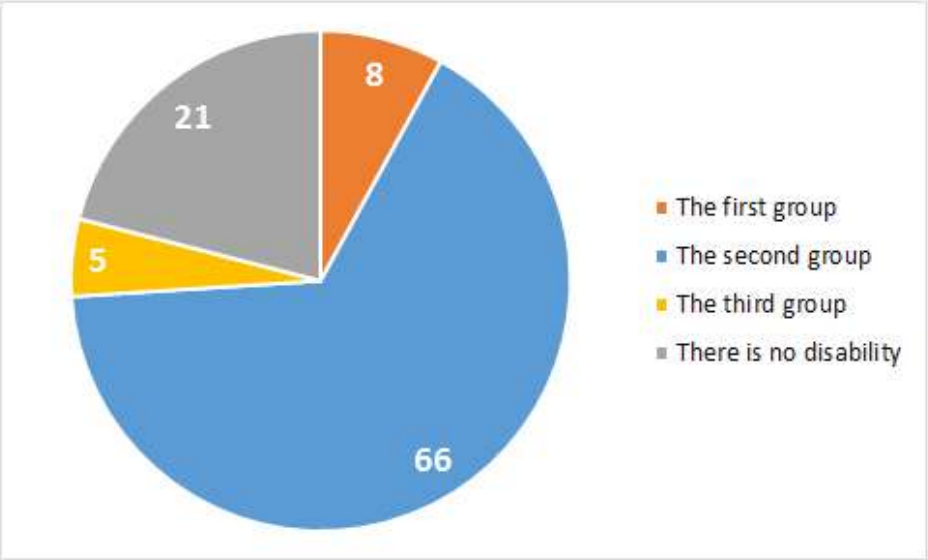


Figure 20 – Structure of disability of veterans of SRU of the surveyed group, %

The distribution of veterans of SRU by disability groups is as follows: the first and third groups include a relatively small number of veterans of SRU (8% and 5%, respectively), and the predominant result (66%) is the number of veterans of SRU with the second disability group. Some of the respondents (21%) have no disability.

In terms of awareness of the benefits provided, most of the surveyed veterans of SRU consider their level of knowledge sufficient (62%), but some people (38%) do not have such information in the required volume.

From the survey data on the quality of medical care, it follows that the majority of veterans of SRU in the surveyed group (53%) are completely satisfied with the available quality. This is a good result, however, some of the respondents (13%) rated this indicator extremely low [64,79] (figure 21).

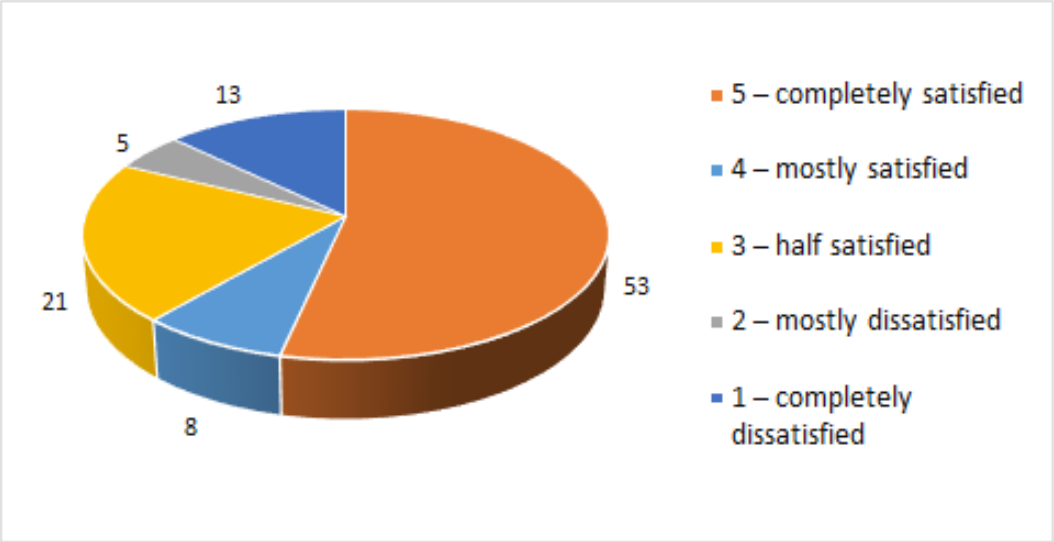


Figure 21 – Assessment of satisfaction with the quality of medical care provided to veterans of SRU of the surveyed group of medical care

When recalculating partial satisfaction and partial dissatisfaction in accordance with the weighting coefficients of each such assessment, we get that the total satisfaction will be about 71%, and the total dissatisfaction – 29%, respectively [68].

Within the framework of general dissatisfaction, the share of dissatisfaction with the quantity and quality of food is 13%, dissatisfaction with the conditions of accommodation and stay does not exceed 7%, and insufficient awareness of planned therapeutic measures has a level of 5%. The minimum claims of the respondents were attributed to insufficient attention of the institution's staff (4%).

4.4.2. Survey of the representatives of the AC of the NWDSCC.

To assess the quality of medical care for AC representatives and to clarify their attitude to the requirements of a healthy lifestyle, a questionnaire was developed (appendix B).

Two groups were selected as participants in the survey, the numerical composition of which is the same (101 people each). The representatives of the AC of the first group differ in that in the process of performing their work duties they did not experience IIRNT (hereinafter referred to as representatives of AC from the group without IIRNT). Representatives of the AC of the second group were exposed to such effects (hereinafter referred to as representatives of AC from the group with IIRNT).

An analysis of the distribution of AC representatives from the group without IIRNT by gender showed that most of the respondents were men (86%), and the rest were women (14%). Such a significant difference is due to the fact that, for the most part, representatives of the male part of society are involved in jobs with harmful working conditions.

The gender distribution of AC representatives from the IIRNT group has a similar structure: 84% are men, and 16% are women.

An analysis of the age distribution of AC representatives showed the results shown in table 28.

Table 28 – Distribution of AC representatives by age

AC representatives	Age range, years	Average value, years
A group without IIRNT	22-83	54±13
Group with IIRNT	23-85	54±13

Notes. 1. AC is the attached contingent of the NWDSCC; 2. IIRNT – impact of ionizing radiation of nuclear technologies

The average ages of both groups of AC representatives are the same, and compared with veterans of SRU, they are 21 years lower, which is understandable, since AC representatives are for the most part the current staff of the relevant institutions.

A visual representation of the distribution of AC representatives of both groups (without IIRNT and with IIRNT) by age group is shown in figure 22, in which the data are ranked by categories «20-29» years, «30-39» years, «40-49» years, «50-59» years, «60-69» years, «70-79» years, «80-89» years.

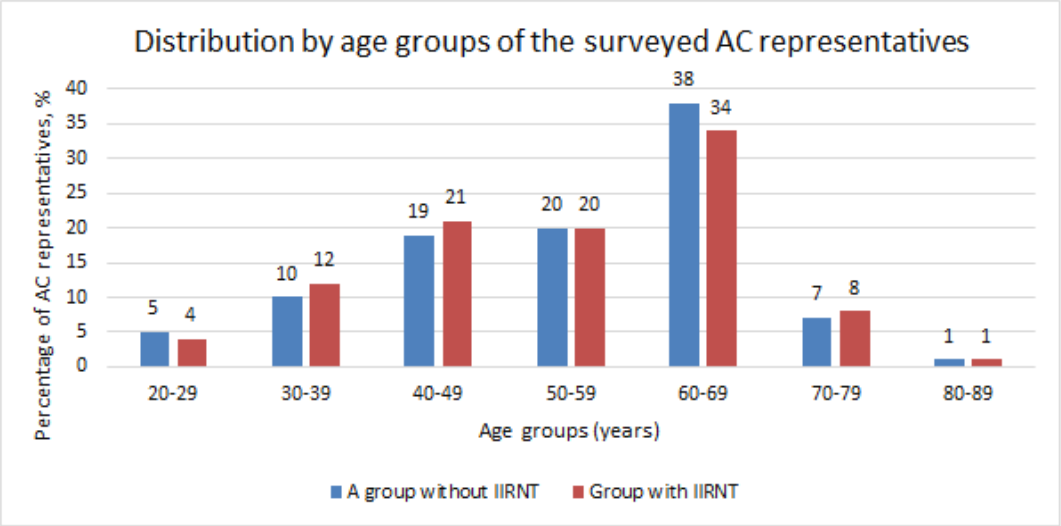


Figure 22 – Distribution of the surveyed AC representatives from the group without IIRNT (blue color) and from the group with IIRNT (brown color) by age groups

The largest number of AC representatives from the non-IIRNT group is concentrated in the age group of «60-69» years (38%). The largest number of AC representatives from the group with IIRNT belong to the same age group, but this value is slightly less (34%).

As a result of the survey, the types of institutions with harmful working conditions were identified in which representatives of the AC of both groups performed their official duties. This data is shown in figure 23.

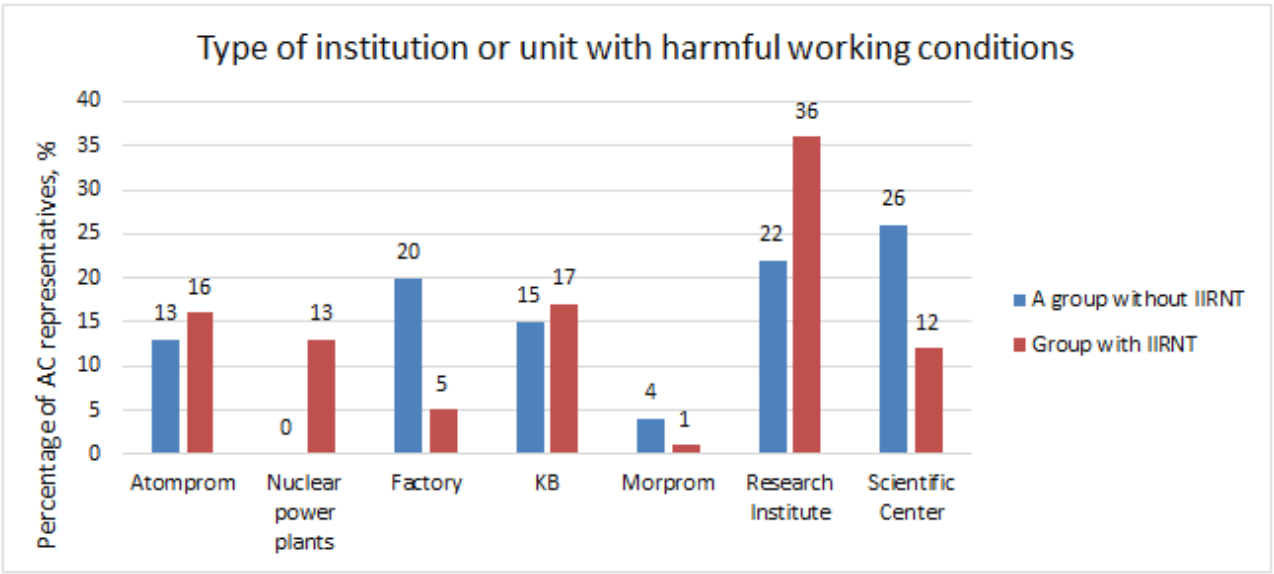
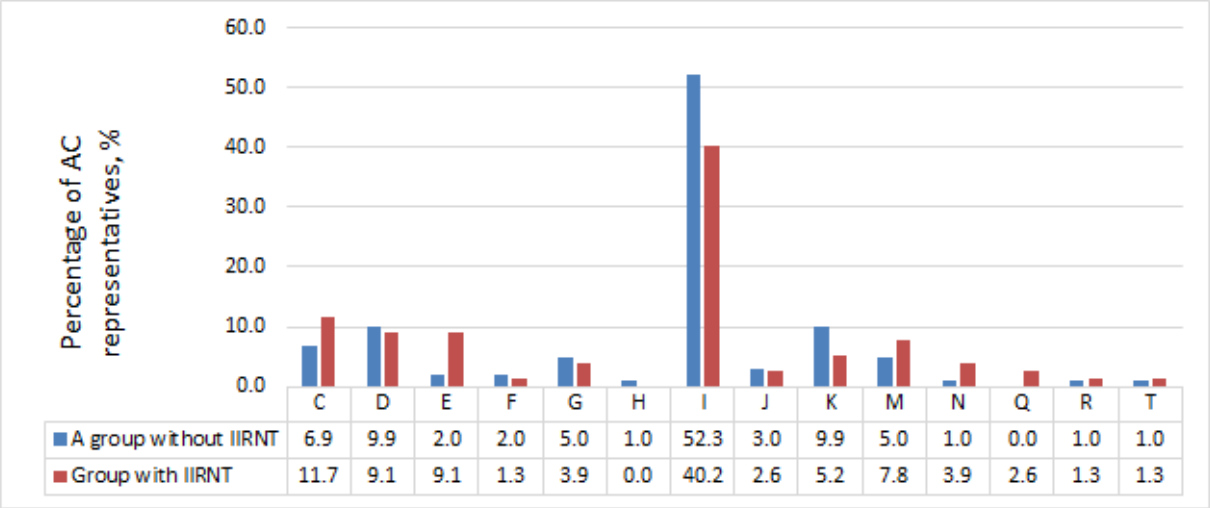


Figure 23 – Distribution of the surveyed AC representatives of two groups (without IIRNT and with IIRNT) by types of institutions with harmful working conditions

The maximum number of AC representatives surveyed from the group without IIRNT (27%) works at the scientific center (NSC). The maximum number of AC representatives from the IIRNT group (37%) works at a research institute (SRI). This may have nothing to do with the level of harmfulness of working conditions, but may indicate a slightly greater need and available capabilities of these institutions for the reception of employees.

The distribution of the AC representatives surveyed by diagnosis (ICD-10) is shown in figure 24.



	C	D	E	F	G	H	I	J	K	M	N	Q	R	T
A group without IIRNT	6.9	9.9	2.0	2.0	5.0	1.0	52.3	3.0	9.9	5.0	1.0	0.0	1.0	1.0
Group with IIRNT	11.7	9.1	9.1	1.3	3.9	0.0	40.2	2.6	5.2	7.8	3.9	2.6	1.3	1.3

Figure 24 – Distribution of the surveyed AC representatives of two groups (without IIRNT and with IIRNT) by diagnosis (ICD-10)

The highest value among all the proportions of diagnoses in both groups are diseases of the circulatory system (I). In the group without IIRNT, this proportion is 52.3%, exceeding the value of the group with IIRNT (40.2%) by about 12%. This result confirms the conclusions about the significant prevalence of this disease, made according to all the studies performed and described in this work.

The following diseases exceed the five percent threshold in the group without IIRNT, which took the second to sixth positions of the general list:

– D benign formations (9.9%);

– K diseases of the digestive system (9.9%);

– C malignant neoplasms (6.9%);

– G diseases of the nervous system (5.0%);

– M diseases of the musculoskeletal system and connective tissue (5.0%).

The same threshold for the group with IIRNT determines the list of those who took the second to sixth positions, in which four out of five diseases coincide with the data of a similar list of the group without IIRNT, although they occupy different positions:

– C malignant neoplasms (11.7%);

– D benign tumors (9.1%);

– E diseases of the endocrine system (9.1%);

– M diseases of the musculoskeletal system and connective tissue (7.8%);

– K diseases of the digestive system (5.2%).

Malignant neoplasms took the second position in this group, and diseases of the digestive system moved to the sixth position. The fourth position was occupied by diseases of the endocrine system, which replaced diseases of the nervous system that left the list of the five percent threshold. Diseases of the musculoskeletal system and connective tissue have increased their influence, taking the fifth position in the general list of diagnoses.

According to the presence of disability of AC representatives of both groups, the following data were obtained:

– for AC representatives from the group without IIRNT: 6% (only the third group);

– for AC representatives from the group with IIRNT: 4% (only the third group).

This is a very low indicator compared to all other population groups considered earlier in this study. The reason for this is that persons with disabilities of the first or second group are not allowed to work with harmful working conditions under an individual rehabilitation program.

The structure of the social package provided to the surveyed AC representatives of both groups is discussed in table 29.

Table 29 – Structure of the social package provided to the AC representatives surveyed

Name of the benefit	For representatives of AC from the group without IIRNT, who have a benefit (%)	For representatives of AC from the group with IIRNT, who have a benefit (%)
1) Extended vacation time	21	38
2) Shortened working day	11	27
3) Salary allowances for harmful working conditions	29	48
4) Therapeutic and preventive nutrition	7	29
5) Other	21	20
6) Do not have benefits or did not answer the questionnaire question	44	25

Notes. 1. The total number of percentages in columns 2 and 3 is not equal to 100%, because the number of benefits per person is not normalized; 2. The availability of benefits or their number per person is determined by the specific workplace and the work performed

From the data given in rows 1-4 of table 29, it follows that the proportion of AC representatives from the group with IIRNT has a significantly higher level of benefits than representatives of AC from the group without IIRNT. This state of affairs is explained by the fact that they have significantly different working conditions in terms of harmfulness.

Several questions of the questionnaire are devoted to the topic of maintaining a healthy lifestyle (HLS).

According to the information provided in the order of the Ministry of Health of the Russian Federation dated January 15, 2020 № 8 «On approval of the Strategy for the formation of a healthy lifestyle of the population, prevention and control of noncommunicable diseases for the period up to 2025», the most important aspects that need to be addressed during the transition to a healthy lifestyle are:

– quitting smoking;

– refusal to drink alcoholic beverages;

– rational nutrition;

– physical activity (abandoning a sedentary lifestyle).

The answers to the questionnaire of AC representatives «Have you received recommendations from a doctor about the need to lead a healthy lifestyle?» are shown in figure 25.

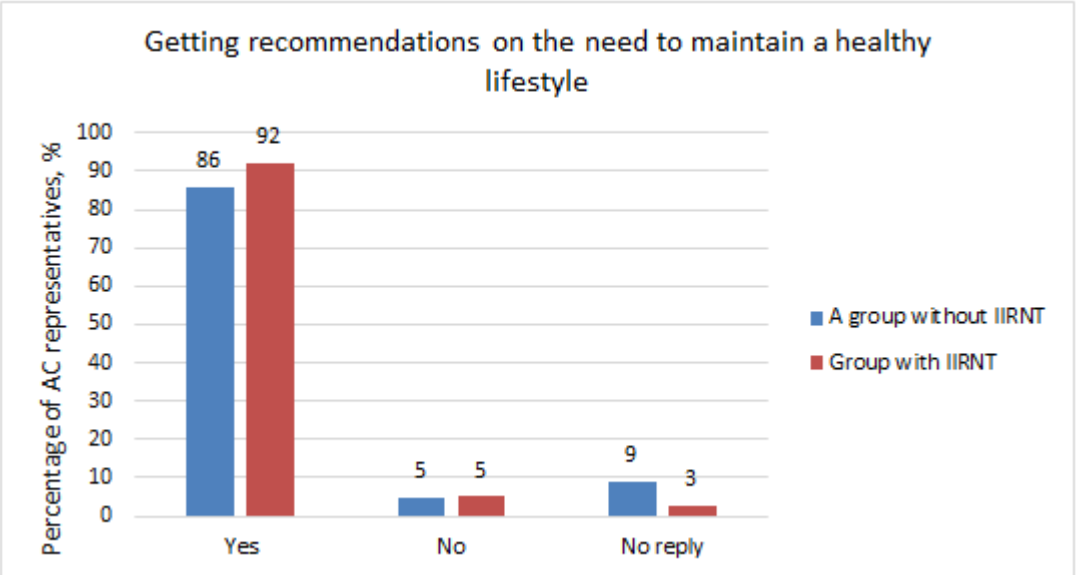


Figure 25 – Information on receiving recommendations on the need to maintain a healthy lifestyle in the response of representatives of the AC of two groups (without IIRNT and with IIRNT)

The maximum number of respondents in both groups answered this question in the affirmative (86% in the group without IIRNT, and 92% in the group with IIRNT). The «No» responses were at the level (5%) for the groups without IIRNT and with IIRNT, respectively. Some of the respondents did not answer this question. In any case, such work should be strictly carried out, since the duration and quality of life of patients depends on it.

The next question of the questionnaire clarifies the situation with the attitude of the respondents to smoking.

Answers to the questionnaire of AC representatives «Do you currently smoke? If not, then specify: have you smoked before, but quit or have you never smoked?» are shown in figure 26.

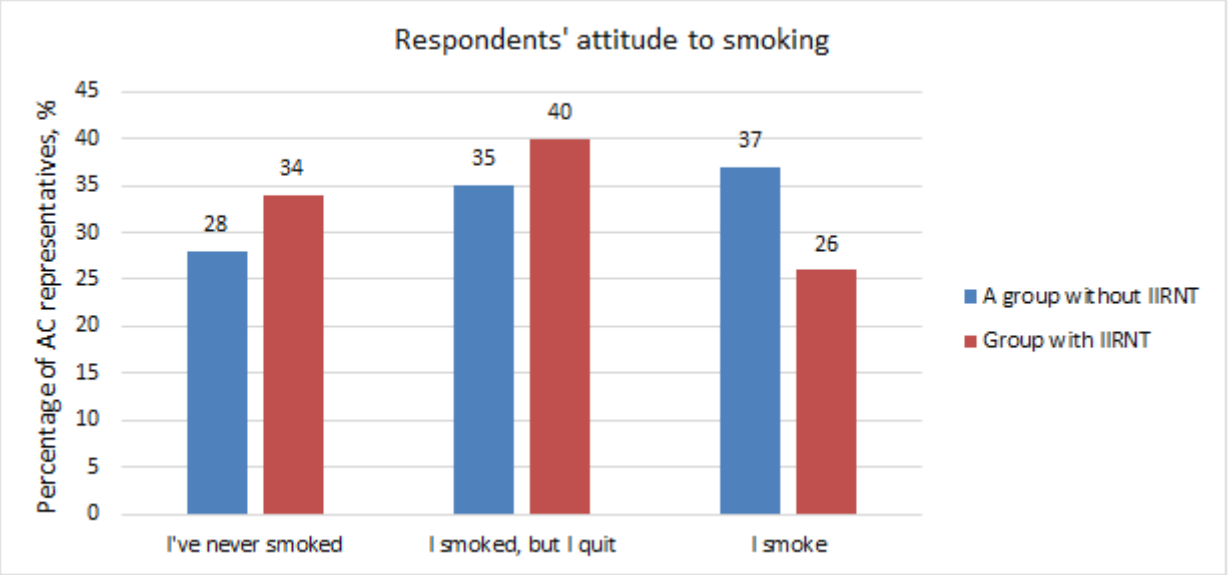


Figure 26 – Attitude of AC representatives of two groups to smoking (without IIRNT and with IIRNT)

The answer «I smoke» (37%) has the maximum value in the group of representatives of AC without IIRNT, and the answer «I have never smoked» (28%) has the minimum value. The value «Smoked but quit» occupies an intermediate position (35%).

In the group with VIIAT, the maximum value is for the answer «I smoked, but I quit» (40%), and the minimum value is for the answer «I smoke» (26%). The answer «Never smoked» has an intermediate value (34%).

From these data, it follows that the group with IIRNT takes the issue of quitting smoking more seriously. Perhaps this is due to the psychological pressure of the factor of the incident of IIRNT.

At the same time, in both groups it can be noted that there is an excess of the proportion of people who smoked but quit in relation to those who never smoked. For the group without IIRNT, the excess share of such persons is 7%, and in the group with IIRNT – 6%.

After adding up those who have never smoked and those who quit, it turns out that those who do not smoke today are 63% in the group without IIRNT, and in the group with IIRNT – 74%. This is an encouraging result, however, the work on the

promotion of smoking cessation should be continued, further strengthening it in the group without IIRNT.

There is evidence of another bad habit. Answers to the questionnaire of AC representatives «Do you drink alcoholic beverages (vodka, wine, beer or similar listed)? If so, how often?» are shown in figure 27.

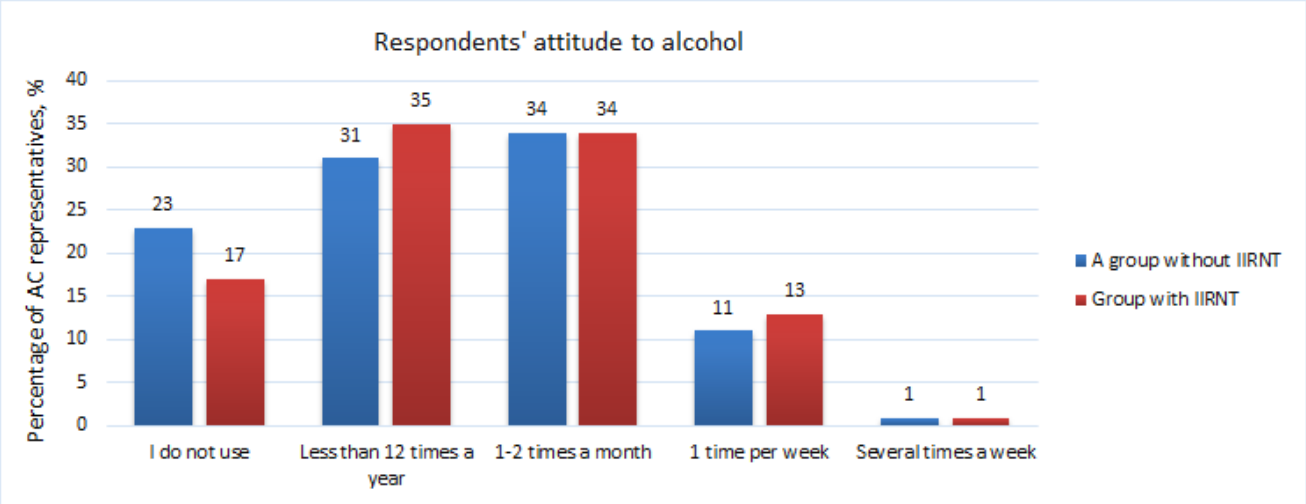


Figure 27 – Attitude to alcohol of PC representatives of two groups (without IIRNT and with IIRNT)

In the group of AC representatives without IIRNT, the maximum value is the proportion of people who consume alcoholic beverages «1-2 times a month» (34%), and the minimum value is «Several times a week» (1%). The value of «Do not use» was 23%, and the value of «Less than 12 times a year» gained 31%, which took an intermediate position between «Do not use» and «1-2 times a month». The value «Once a week» (11%) occupied an intermediate position between the values «1-2 times a month» and «Several times a week».

There is a similar response structure in the group of AC representatives with IIRNT, but the maximum value falls on the option «Less than 12 times a year» (35%). The proportion of the answer «I do not use» (17%) is less than that of the group without IIRNT, by 6%. The answer option «1-2 times a month» (34%) coincides with the answer of the group without IIRNT, the answers «Once a week» (13%) do not differ much and «Several times a week» (1%) do not differ at all.

There are very few people in both groups who do not drink alcoholic beverages at all. The rest adhere to some kind of consumption rate of such drinks.

Two gradations of consumption rates «Less than 12 times a year» and «1-2 times a month» actually set two consumption options: «on big holidays» and «on family holidays», respectively. In total, 65% of respondents indicated the observed values for the group without IIRNT, and for the group with IIRNT – 69% of the respondents. These are the traditional norms accepted in our society. It is extremely difficult to change the traditions that have developed in society, but it is for people with the consumption gradations indicated in this paragraph that there are prospects for complete abstinence from alcoholic beverages, since the probability of physical dependence on alcohol is low for them.

Two gradations of consumption norms «once a week» and «Several times a week» are already beyond the traditional norm, and are much more likely to lead to serious diseases, including alcohol dependence. In any case, the promotion of abstinence from alcoholic beverages should be continued, no matter how remote the results would seem.

In addition to giving up bad habits, maintaining a healthy lifestyle implies positive aspects: proper nutrition that does not lead to obesity, physical mobility, and sports. The answers to the questionnaire question «What recommendations on the positive aspects of a healthy lifestyle have you received from a doctor?» show how things are with these indicators (figure 28).

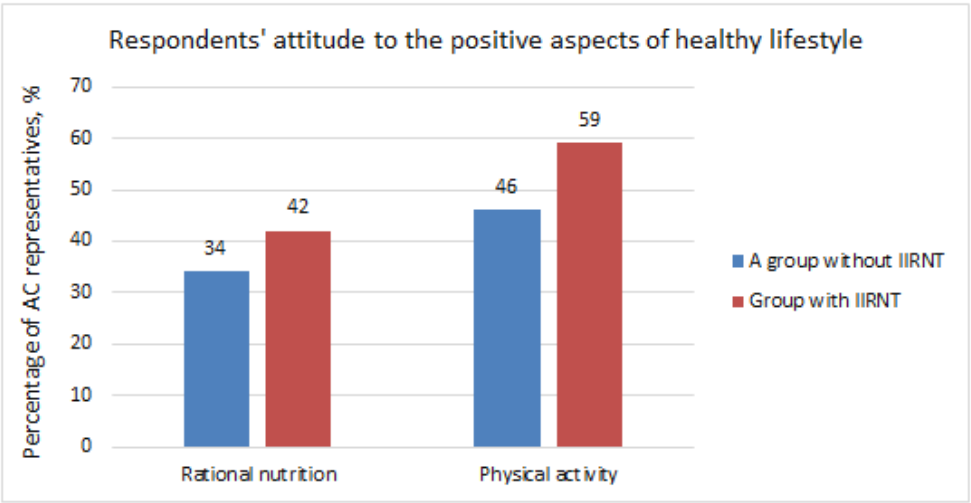


Figure 28 – Respondents' attitude to the positive aspects of healthy lifestyle

The analysis of the responses showed that 34% of the representatives of the group without IIRNT and 42% of the representatives of the group with IIRNT remembered the recommendations on rational nutrition. Not such a bad result, considering that to achieve it requires a real restructuring of the diet, which requires certain costs. A somewhat large number of AC representatives recalled physical activity: 46% from the group without IIRNT and 59% from the group with IIRNT. Perhaps this is due to the fact that financial costs are not required to implement the simplest physical activity options.

The statistics on the implementation of the considered recommendations, shown in figure 29, are also of interest.

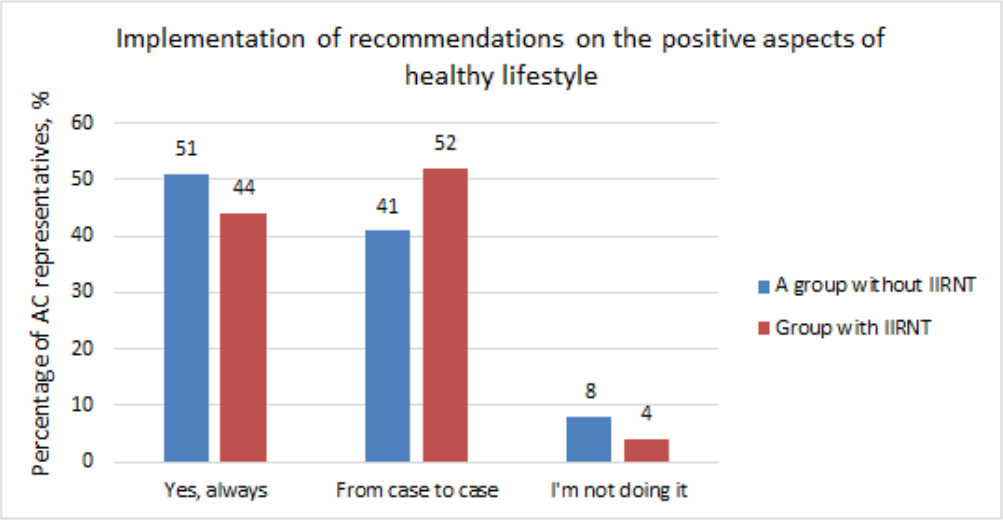


Figure 29 – Implementation of recommendations on the positive aspects of healthy lifestyle by representatives of the AC of two groups (without IIRNT and with IIRNT)

The answer «Yes, always» was given by both groups approximately the same: 51% – the group without IIRNT and 44% – the group with IIRNT.

Some respondents admitted that they follow the recommendations «On a case-by-case basis.» There were slightly fewer of them in the first group (41%), and significantly more in the second group (52%). There is something to work on with new patient visits.

I am glad that the answer «Not fulfilling» was received from the minimum number of AC representatives of both groups (8% and 4%, respectively).

Another response from respondents, which is presented on

Figure 30, reveals the reasons for non-compliance with recommendations on the positive aspects of healthy lifestyle.

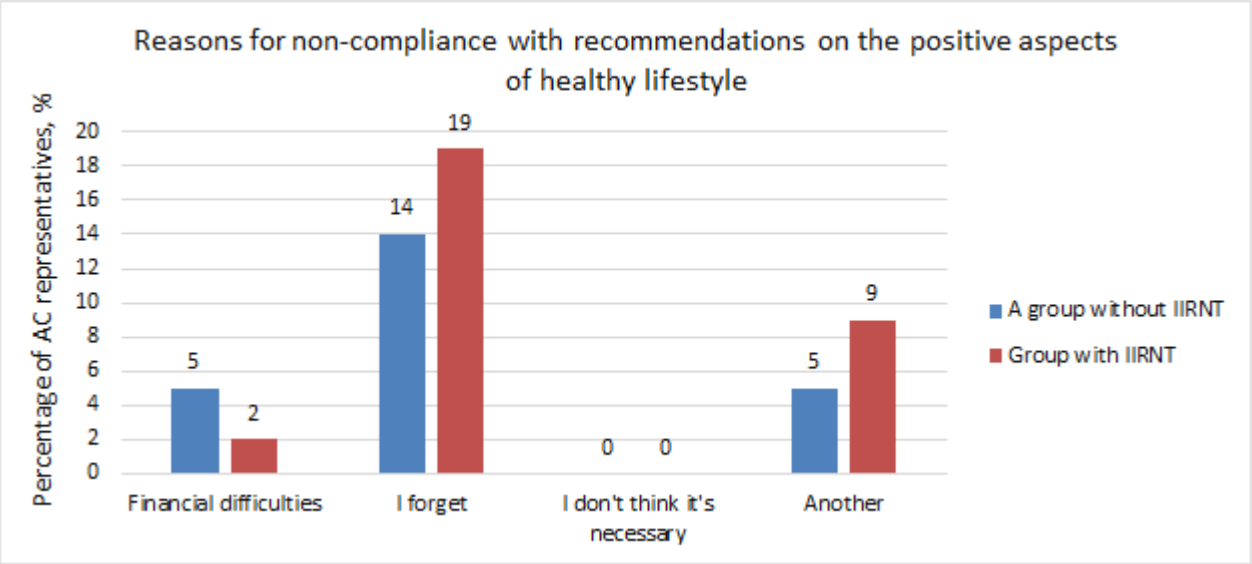


Figure 30 – Reasons for non-compliance with recommendations on positive aspects of healthy lifestyle by representatives of the AC of two groups (without IIRNT and with IIRNT)

Representatives of both groups cite financial difficulties as one of the reasons for non-compliance (or implementation on a case-by-case basis) with recommendations on the positive aspects of healthy lifestyle: 5% for the group without IIRNT and 2% for the group with IIRNT. This is not a very large part of the respondents, although some of them believe that in order to realize physical activity, it is necessary to enroll in a fitness club. This is their right, but there are also less expensive ways. Patients should pay attention to such possibilities.

The most numerous team (14% of the group without IIRNT and 19% of the group with IIRNT) gave the reason for «Forgetting» in the answer. This is, of course, a possible option, the reaction to which should be taken into account by medical professionals in the form of a periodic reminder.

The reason «Other» was used in 5% of cases by the group without IIRNT and in 9% by the group with IIRNT. Unfortunately, none of them revealed what is included in this concept. None of the respondents gave the answer «I don't think it's necessary».

Some of the questions in the questionnaire relate to the quality of medical care.

The patients were asked the general question «Are you satisfied with the attitude of doctors and nurses during your stay in a medical organization? Rate it on a 5-point scale, where: 1 – «extremely bad»; 2 – «bad»; 3 – «satisfactory»; 4 – «good»; 5 – «excellent».

Within the framework of the general question, four aspects are considered:

– courtesy and attentiveness of doctors;

– courtesy and attentiveness of nurses;

– informing patients about planned treatment activities;

– prompt response of staff to patient complaints.

AC representatives' assessments of various indicators of the quality of medical care are shown in table 30.

Table 30 – AC representatives' assessments of the quality of medical care

Indicator	Group type	Score, %				
		1	2	3	4	5
Courtesy and attentiveness of doctors	without IIRNT	–	–	–	16	84
	with IIRNT	–	–	–	19	81
Courtesy and attentiveness of nurses	without IIRNT	–	–	–	17	83
	with IIRNT	–	–	2	16	82
Informing patients about planned treatment measures	without IIRNT	–	–	2	17	81
	with IIRNT	–	–	4	14	82
Prompt response to complaints from patients	without IIRNT	–	–	–	18	82
	with IIRNT	–	–	2	18	80

Notes. 1. The numbers 1, 2, 3, 4, 5 in the subheadings of the heading of the table «Assessment» indicate the following quality ratings: «extremely bad», «bad», «satisfactory», «good», «excellent» – respectively; 2. IIRNT – impact of ionizing radiation of nuclear technologies

On the issue of politeness and attentiveness of doctors, the assessments of both groups are quite close. Thus, 84% of the respondents from the group without IIRNT and 81% of the members of the group with IIRNT scored «excellent». And the rating «good» appears in the responses of 16% and 19% of representatives of groups without and with IIRNT, respectively. The AC representatives did not need the other three categories of ratings in this case.

When assessing the politeness and attentiveness of nurses, the shares of «excellent» and «good» ratings given by representatives of the AC of both groups remain very close to the estimates on the previous question, and among themselves: in the group without IIRNT, these are 83% and 17%, and in the group with IIRNT – 82% and 16% accordingly.

In the group with IIRNT, the rating «satisfactory» appears, but the value of this category is small: 2%. This category is not used in the assessments of the group without IIRNT, as well as the two lower categories for both groups.

Satisfaction with the quality of informing patients about planned treatment measures is generally just as high: the «excellent» rating is applied in 81% and 82%, and the «good» rating is applied in 17% and 14% of representatives of groups without IIRNT and with IIRNT, respectively.

However, there are ratings of the category «satisfactory» for 2% of the representatives of the group without IIRNT and for 4% of the members of the group with IIRNT. Grades of lower categories are not applied.

AC representatives' assessments of the responsiveness of medical personnel to current complaints about the state of patients' health are also high: «excellent» occurs in 82% of the group without IIRNT and in 80% of the group with IIRNT, and the score «good» was set in 18% of respondents in both groups.

There is a very small number of patients in the group with IIRNT (2%) who rated «satisfactory». There are no lower grades.

At the end of the questionnaire, the issues of AC representatives' assessment of the quality of solving issues related to medical care processes were considered.

The correct solution of such issues creates the necessary emotional and psychological background, which is also important for successful treatment.

Two aspects are considered on this issue:

– satisfaction with the quantity and quality of food;

– satisfaction with the conditions of accommodation and stay.

Statistical data on the aspects under consideration are given in table 31.

Table 31 – AC representatives' assessments of the quality of solving household issues

Indicator	Group type	Score, %			
		4	3	2	1
Satisfaction with the quantity and quality of food	without IIRNT	–	1	23	76
	with IIRNT	–	3	26	71
Satisfaction with the conditions of accommodation and stay	without IIRNT	–	1	3	96
	with IIRNT	–	–	6	94

Notes. 1. The numbers 1, 2, 3, 4, in the subheadings of the heading of the «Assessment» table indicate the following quality ratings: «fully satisfied», «partially satisfied», «rather not satisfied», «completely dissatisfied» – respectively; 2. IIRNT – impact of ionizing radiation of nuclear technologies

Here, the inverse 4-point rating scale is used in the questionnaire. The value «1» means the degree of quality «fully satisfied», «2» corresponds to the rating «partially satisfied», «3» means «rather not satisfied», and «4» means «completely dissatisfied».

On the issue of satisfaction with the quantity and quality of food, there are the following answers: the score «fully satisfied» is 76% and 71%, and the score «partially satisfied» is 23% and 26% for representatives of groups without IIRNT and with IIRNT, respectively. A small number of patients (1% from the group without IIRNT and 3% from the group with IIRNT) rated «rather dissatisfied». The rating «completely dissatisfied» is not used.

A very high level of agreement has been reached on the issue of accommodation and stay by representatives of both groups: 96% of the group without IIRNT and 94% of the group with IIRNT are completely satisfied. To assess «partially satisfied», only 3% of the votes remained for the group without IIRNT and 6% for the group with IIRNT. However, in the group without IIRNT, a part of the patients (1%) rated «rather dissatisfied». The lower rating of «completely dissatisfied» is not used.

The final question of the questionnaire was: «Would you recommend this medical organization to your friends and relatives?»

Here, the reverse 3-point rating scale is used in the questionnaire.

The number «1» means the assessment «yes», «2» corresponds to the assessment «no», «3» means «I don't know yet».

The estimates given by the AC representatives on this issue are shown in table 32.

Table 32 – Estimates of AC representatives on the issue of issuing recommendations to use this medical organization to friends and relatives

Indicator	Group type	Score, %		
		3	2	1
Willingness to recommend a medical organization to friends and relatives	without IIRNT	5	–	95
	with IIRNT	4	1	95

Notes. 1. The numbers 1, 2, 3 in the subheadings of the headline of the table «Assessment» indicate the following answers: «yes», «no», «I don't know yet» – respectively; 2. IIRNT – exposure to ionizing radiation of nuclear technologies

In the answers to this question, a very high level of assessment and agreement between the groups was obtained. The answer «yes» was received from 95% of representatives of both groups.

The answer «no» was given only by representatives of the group with IIRNT (1%), and the option «I don't know yet» was used by 5% of the group without IIRNT and 4% of the group with IIRNT.

Conclusions on subsection 4.4.

1) Numerical indicators of disability of persons who have experienced IIRNT (taking into account its rank representations) should be taken into account when developing therapeutic and preventive algorithms for providing medical care to persons of this contingent. According to the results of a survey of veterans of SRU in 2020, the following data are available:

– disability of group I: 8 %;

– disability of group II: 66 %;

– disability of group III: 5%;

– no disability: 21%.

2) The indicator of insufficient awareness of benefits for this category of the population was 38%. There is a significant reserve for improving service. Perhaps this is due to the existing level of technical support for primary health care and social protection institutions with information processing tools [64,79].

3) The distribution of veterans of SRU from the surveyed group by gender showed that the vast majority of the respondents were men (96%), and the rest were women (4%) [64, 79]. This fact should be taken into account when drawing up preventive and curative algorithms for medical care.

4) Most of the veterans of SRU of the surveyed group belong to the age categories of «70-79» years and «80-89» years. This is 68% of the respondents. The fact of the predominance of these age groups in the above statistics should be taken into account when compiling preventive and curative algorithms.

5) The number of fully satisfied veterans of SRU with the quality of medical care was 53%. 13% were completely dissatisfied. When recalculating partial satisfaction and partial dissatisfaction in accordance with the weighting coefficients of each such assessment, we get that the total satisfaction will be about 71%, and the total dissatisfaction – 29%, respectively [68,79].

Of these, the share of dissatisfaction with the quantity and quality of food is 13%, dissatisfaction with the conditions of accommodation and stay does not exceed 7%, and insufficient awareness of planned therapeutic measures has a level of 5%. The minimum claims of the respondents were attributed to insufficient attention of the institution's staff (4%).

6) Clinical aspects of medical care have been and remain the main tools for restoring health, and they are widely considered in this study, however, it has been known for a long time that for a successful cure it is necessary to take into account socio-psychological aspects that help the patient tune in to recovery.

7) Note that if the survey in question did not exist, then information about any claims of a part of the surveyed group of veterans of SRU to the quality of medical care would not be available to us.

8) The distribution of AC representatives from the group with IIRNT by gender: 84% are men, and 16% are women. The distribution of AC representatives from the group without IIRNT by gender: 86% are men, and 14% are women [68]. This fact should be taken into account when drawing up preventive and curative algorithms for medical care.

9) The largest number of AC representatives from the group without IIRNT is concentrated in the age group of «60-69» years (38%). The largest number of PC representatives from the group with IIRNT belong to the same age group, but this value is slightly less (34%). The fact of the predominance of these age groups in the above statistics should be taken into account when compiling preventive and curative algorithms.

10) Satisfaction with the quality of medical care among AC representatives is significantly higher than among veterans of SRU. For example, 84% of AC without IIRNT and 81% of AC with IIRNT rated the politeness and attentiveness of doctors as «excellent». Very similar data were obtained on other questions posed by the questionnaire on this topic. It follows from this that the assessment of the quality of medical care does not depend on the availability of IIRNT.

11) The attitude of AC representatives to the recommendations of a healthy lifestyle (hereinafter – healthy lifestyle) is considered in several aspects:

– the question of attitudes to smoking revealed that 26% of AC representatives from the group with IIRNT and 37% of AC representatives from the group without IIRNT currently smoke, while the rest either never smoked or quit. This is an encouraging result.;

– on the issue of attitudes to alcohol consumption, the data are as follows: 17% of AC representatives from the group with IIRNT and 23% of AC representatives from the group without IIRNT do not drink alcoholic beverages, and the rest are subject to this habit to varying degrees;

– on the issue of implementing the recommendations of the positive aspects of healthy lifestyle (rational nutrition, physical activity, sports), 44% of AC representatives from the group with IIRNT and 51% of AC representatives from the group without IIRNT always follow these recommendations, and the rest – on a case-by-case basis, or even not at all;

12) If there is a periodic survey of the contingent in question in the process of medical care, it becomes possible to detect areas of deficiencies in the implementation

of the recommendations of the healthy lifestyle, which allows timely decisions to strengthen propaganda in the relevant areas [68].

13) There is an increase in the number of malignant neoplasms, benign formations, diseases of the endocrine system in the contingent in question.

14) The availability of benefits or their number per person among the persons of this contingent is determined by the specific workplace and the work performed, which have a different degree of impact of the considered negative factors.

15) AC representatives are well informed about the need to lead a healthy lifestyle in order to improve its quality and increase its duration.

16) The level of implementation of the recommendations on the management of healthy lifestyle is not as high as the level of knowledge about the need for their implementation.

17) Forgetfulness is often cited as the reasons for non-fulfillment or occasional fulfillment of recommendations on healthy lifestyle. This option should be taken into account by medical professionals and countered in the form of a periodic reminder.

18) As a reason for non-compliance with the recommendations on healthy lifestyle, none of the respondents gave the answer «I do not consider it necessary», which indicates that the work on promoting a healthy lifestyle was done at the proper level.

19) AC representatives' assessments of the quality of solving everyday issues related to medical care processes are also important: the correct solution of such issues creates the necessary emotional and psychological background, which is no less important for successful treatment.

20) The data obtained as a result of a survey of veterans of SRU and a survey of AC representatives raise a natural question: «Why do veterans of SRU have higher claims to the quality of medical care than representatives of the AC?» As it turned out earlier, the assessment of the quality of medical care does not depend on the availability of IIRNT. What is the difference then? If we consider the question of sources of funding, it turns out that the financing of medical care for veterans of SRU is carried out according to the compulsory health insurance system, and representatives of the AC –

within the framework of a special state assignment. From these possibilities, the system of medical care for each of these categories of citizens is built, up to the extent of using a three-level system [68].

It would be desirable that, taking into account the merits of veterans of SRU for the development of nuclear technologies, including for the needs of the country's defense capability, a decision was made to finance the medical care provided to them within the framework of a state assignment used for AC representatives or as part of another state assignment with similar properties.

Thus, according to indirect data from surveys and questionnaires, the issue of dependence of patients' satisfaction with the quality of medical care on the method of financing medical care has emerged.

21) Another point that raises the question of the need for regular questioning of persons of the specified contingent is a statistical study of the success of promoting a healthy lifestyle.

Lifestyle is a field of activity of patients that is not directly controlled by a medical institution, since it occurs outside its borders. The issue of promoting healthy lifestyle is raised by medical staff only when patients visit a medical institution [68]. At the same time, meeting the requirements of the healthy lifestyle system actually contributes to improving the quality of life and its duration.

If there is a periodic survey of the contingent in question, it becomes possible to detect areas of flaw in the implementation of the recommendations of the HLS, which will allow timely decisions to be made on strengthening propaganda in the relevant areas [68].

CONCLUSION

The aim of the study is to develop an organizational structure for the system of medical care for persons who have been exposed to ionizing radiation of nuclear technologies.

During the research, all the tasks have been solved. Each task corresponds to a separate stage of the study.

At the first stage of the study, the currently dominant diagnoses of the incidence of people who have experienced IIRNT in the past were determined.

To achieve the result, a retrospective review of the registered diagnoses of morbidity of individuals from the studied group of veterans of SRU and the control group of AC representatives was applied. Data selection, statistical data processing and analysis of the results of their processing were performed. In the course of the study, information extracted from the clinical databases of the NWDSCC was used.

The primary and general morbidity of individuals from the study group of veterans of SRU who experienced IIRNT in the past was analyzed. Depending on the subtasks being solved, two different time intervals are considered:

– (2015 – 2019) years (to compare data on the primary morbidity of the studied group of veterans of SRU with data on the primary morbidity of veterans of SRU from a literary source [64] for the five years 1997 – 2001);

– (2017 – 2019) years (to compare data on the primary morbidity of the studied group of veterans of SRU with data on the general morbidity of the same group of veterans of SRU for the same period of time. Data on the primary and general morbidity of the studied group of veterans of SRU for the specified period of time were also used for comparison with similar data from the control group of AC representatives for the same period of time).

The primary and general morbidity of individuals from the control group of AC representatives who did not experience IIRNT was analyzed.

The time interval (2017 – 2019) was considered to compare data on the primary morbidity of the control group of AC representatives with data on the primary morbidity of the studied group of veterans of SRU for the same period of time.

The same time interval (2017 – 2019) was used to compare data on the general morbidity of the control group of AC representatives with data on the general morbidity of the studied group of veterans of SRU for the same period of time.

A comparison of data on the primary morbidity of the studied group of veterans of SRU with data on the primary morbidity of veterans of SRU from a literary source [64] for the five years 1997 – 2001 showed that all five diagnoses from an earlier period fall into the list of the first seven diagnoses of a later period. The values of the averages for the corresponding five–year period of the primary morbidity of the persons in the contingent under consideration were arranged in descending order as follows:

– the period 1997 – 2001: I, J, K, M, G;

– the period 2015 – 2019: I, K, G, C, J, M, D [126].

In a reverse comparison, it was determined that among the first five diagnoses out of seven considered in the period 2015 – 2019, four diagnoses of the list of the period 1997 – 2001 are included.

Thus, it was determined that there is a significant degree of continuity of data on the dominant diagnoses for individuals of the considered contingent, whose studies were conducted with a time difference of approximately 18 years.

It has been established that the first position in the structures of primary morbidity in both cases is occupied by diseases of the circulatory system (I).

The enumeration of the three-year average proportions of the structures of primary diseases of veterans of SRU of the studied group and representatives of the AC control group in 2017 – 2019 (in descending order of the values of the proportions) was obtained:

– the study group in the period 2017-2019: I, K, G, D, M, J, C, H, N;

– the control group in the period 2017-2019: I, H, K, C, D, G, J, M, N.

The comparison showed that there is a complete coincidence in the composition of the diseases occupying the first nine positions. From this, it can be concluded that the

composition of the dominant diagnoses of the patient's region of residence does not depend much on the type of the studied contingent. Additional research is required on the statistical significance of the differences in the frequencies of the diagnoses under consideration in the compared groups.

A comparison of the main accounting characteristics of the studied group of veterans of SRU and the control group of AC representatives using the statistical criterion χ^2 was performed.

Statistically significant results confirming the possibility of dependence of the presence of the disease on the risk factor were obtained for diagnoses:

- I Diseases of the circulatory system $p < 0.01$ (0.000007);

- G Diseases of the nervous system $p < 0.05$ (0.031);

- M Diseases of the musculoskeletal system and connective tissue

$p < 0.01$ (0.004);

- J Diseases of the respiratory system $p < 0.05$ (0.033).

The exact significance level of the calculated criterion is shown in parentheses.

The following diagnoses are not statistically significant for rejecting the null hypothesis (there are no differences between the groups):

- K Diseases of the digestive system $p > 0.05$ (0.140);

- D Benign tumors $p > 0.05$ (0.495);

- C Malignant neoplasms $p > 0.05$ (1,000).

The exact values of the significance level of the calculated criterion are shown in parentheses.

The question of the correlation between the statistical and clinical significance of the study results is considered. It is concluded that the decision on the clinical significance of the dependence of the presence of diagnoses obtained with IIRNT, and for which statistical significance has been proven, should be made by interdepartmental expert councils to establish the causal relationship of diseases.

In daily clinical activities, information on the statistical significance of differences in registered frequencies according to characteristic diagnoses can and

should be used in the development of therapeutic and preventive algorithms for providing medical care to people who have undergone IIRNT.

At the second stage of the study, the substantiation of the model of the system of medical care for people who have experienced IIRNT, taking into account clinical and socio-psychological aspects, was carried out. A block diagram of the system with the level of detail required for the study has been developed.

The model of the system of medical care for people who have experienced IIRNT is presented using three main types of elements:

– the process;

– procedure;

– database.

A process is understood as an element of the system, the operation of which can be described using an algorithm that displays its functionality.

A process may include other (nested) processes, procedures, and databases.

A procedure is understood as an element of the system, the functionality of which is described by its name, without specifying the content. This is due to the fact that the implementation of procedures depends on the specific contractor.

A database is understood as an element of a system that performs the function of accumulating information with the possibility of its subsequent extraction for analysis.

The relationships between the elements of the system are shown using the arrows.

The system model includes the following elements:

– the main process;

– auxiliary process;

– an additional process.

The main process ensures the implementation of the function of interaction between the staff of a medical institution and patients at the level of direct communication. As a result of such interaction, information is obtained on clinical indicators, information on socio-psychological indicators, and decisions are made on methods of providing medical care. All the indicators taken into account are recorded on paper, and electronically transmitted to the auxiliary process.

The auxiliary process provides long-term storage, analysis and statistical processing of all information received from patients during direct communication, which is implemented in the main process.

An additional process ensures the implementation of the system decision-making function based on the analysis of reports on statistical information obtained from the auxiliary process.

The compositions of processes and algorithms of their functioning are considered. In particular, the main process includes a nested process of applying a three-level medical care system. An algorithm for the functioning of this process has been developed, taking into account the passage of time and the presence of decision-making elements.

Much attention is paid to the auxiliary process, the specifics of its creation and functioning, taking into account the passage of time and the presence of decision-making elements.

Thus, at the second stage of the study, the structure of the model of the medical care system is justified, taking into account clinical and socio-psychological aspects.

At the third stage of the study, an assessment of the implementation of the clinical aspects of the functioning of the medical care system model was obtained. Data selection, statistical data processing and analysis of the results of their processing are carried out here.

The practical application of the three-level system of medical care was carried out in the activities carried out in the process of servicing veterans of SRU living in St. Petersburg and the Leningrad region.

As part of the interaction of the NWDSCC hospital with the NWDSCC outpatient polyclinic complex, medical care was provided for 11374 applications from 2012 to 2021. The number of requests should be considered taking into account the time interval of consideration and the presence of more than one diagnosis per person (in reality, these are 2-3 diagnoses). Thus, the number of veterans of SRU served amounted to 446 people.

Financing of work at all levels of the three-level medical care system was carried out under the compulsory medical insurance.

The three-level system of organization of medical care was applied for the first time in relation to veterans of SRU. The achieved result allows us to recommend this method for use in relation to all persons who have been subjected to IIRNT [68].

The result of the interaction of the system links in the process of diagnosing and providing medical care to AC representatives is considered.

The relevance of the topic is confirmed by the results of a statistical study conducted on the basis of hospital data for the period from 2017 to 2022, and the results of the subsequent compilation and application of algorithms for providing medical care for the most popular diagnosis – diseases of the circulatory system (I).

The use of the method of selective coronary angiography in the process of providing medical care showed its high effectiveness in clarifying the dominant diagnosis of today's statistics.

Financing of work at all levels of the three-tier medical care system was carried out within the framework of the state task. In this regard, it was possible to organize a more detailed monitoring of the health status of this category of citizens. In all the examined patients, drug therapy was adjusted to the optimal level, which allowed the AC representatives to return to their previous place of work upon completion of treatment.

At the fourth stage of the study, an assessment was made of the implementation of the socio-psychological aspects of the functioning of the model of the medical care system. Data selection, statistical data processing and analysis of the results of their processing were carried out. The information for the assessment was obtained from the data of surveys and questionnaires of patients in the considered cohort.

A questionnaire (Appendix A) has been developed to assess various aspects of the life of veterans of SRU. In addition to general issues (gender, age, type of institution, diagnoses), the issues of assessing the quality of medical care are considered. The number of the survey group was 103 people selected at random.

The survey data is included in the database, which is officially registered by the Federal Service for Intellectual Property (appendix D).

From the survey data on the quality of medical care, it follows that the majority of veterans of SRU in the surveyed group (53%) are completely satisfied with the available quality. This is a good result, however, some of the respondents (13%) rated this indicator extremely low [64].

When recalculating partial satisfaction and partial dissatisfaction in accordance with the weighting coefficients of each such assessment, it was found that the total satisfaction is about 71%, and the total dissatisfaction is 29%, respectively [68, 79].

Within the framework of general dissatisfaction, the share of dissatisfaction with the quantity and quality of food was 13%, dissatisfaction with the conditions of accommodation and stay did not exceed 7%, and insufficient awareness of planned therapeutic measures has a level of only 5%. The minimum claims of the respondents were attributed to insufficient attention of the institution's staff (4%).

A questionnaire has been developed to assess various aspects of the life of AC representatives (appendix B).

A survey of AC representatives was conducted for two quantitatively identical groups (101 people each), in one of which patients were exposed to IIRNT.

In addition to general issues (gender, age, type of institution, diagnoses), the issues of maintaining a healthy lifestyle (HLS), which are of particular importance in terms of their impact on quality and life expectancy, as well as issues of assessing the quality of medical care, are considered.

Survey data related to the quality of medical care include:

– courtesy and attentiveness of doctors;

– courtesy and attentiveness of nurses;

– informing patients about planned treatment activities;

– prompt response to patient complaints.

On the issue of politeness and attentiveness of doctors, the assessments of both groups are quite close. Thus, 84% of the respondents from the group without IIRNT and 81% of the members of the group with IIRNT scored «excellent». And the rating

«good» appears in the responses of 16% and 19% of representatives of groups without and with IIRNT, respectively. The AC representatives did not need the other three categories of ratings in this case.

When assessing the politeness and attentiveness of nurses, the shares of «excellent» and «good» ratings given by representatives of the AC of both groups remain very close to the estimates on the previous question, and among themselves: in the group without IIRNT, these are 83% and 17%, and in the group with IIRNT – 82% and 16% accordingly.

Satisfaction with the quality of informing patients about planned treatment measures is generally just as high: the «excellent» rating is applied in 81% and 82%, and the «good» rating is applied in 17% and 14% of representatives of groups without IIRNT and with IIRNT, respectively.

AC representatives' assessments of the responsiveness of medical personnel to current complaints about the state of patients' health are also high: «excellent» occurs in 82% of the group without IIRNT and in 80% of the group with IIRNT, and the score «good» was set in 18% of respondents in both groups.

At the end of the questionnaire, the issues of AC representatives' assessment of the quality of solving issues related to medical care processes were considered.

The correct solution of such issues creates the necessary emotional and psychological background, which is also important for successful treatment.

Two aspects are considered on this issue:

– satisfaction with the quantity and quality of food;

– satisfaction with the conditions of accommodation and stay.

On the issue of satisfaction with the quantity and quality of food, there are the following answers: the score «fully satisfied» is 76% and 71%, and the score «partially satisfied» is 23% and 26% for representatives of groups without IIRNT and with IIRNT, respectively. A small number of patients (1% from the group without IIRNT and 3% from the group with IIRNT) rated «rather dissatisfied». The rating «completely dissatisfied» is not used.

A very high level of agreement has been reached on the issue of accommodation and stay by representatives of both groups: 96% of the group without IIRNT and 94% of the group with IIRNT are completely satisfied.

INFERENCES

1) Numerical indicators of disability of persons who have experienced IIRNT (taking into account its rank representations) should be taken into account when developing therapeutic and preventive algorithms for providing medical care to persons of this contingent. According to the results of a survey of veterans of SRU in 2020, the following data are available:

– disability of group I: 8 %;

– disability of group II: 66 %;

– disability of group III: 5%;

– no disability: 21%.

2) Statistically significant results confirming the possibility of dependence of the presence of the disease on the risk factor were obtained for diagnoses:

– I Diseases of the circulatory system $p < 0.01$ (0.000007);

– G Diseases of the nervous system $p < 0.05$ (0.031);

– M Diseases of the musculoskeletal system and connective tissue

$p < 0.01$ (0.004);

– J Diseases of the respiratory system $p < 0.05$ (0.033).

The exact significance level of the calculated criterion is shown in parentheses.

The following diagnoses are not statistically significant for rejecting the null hypothesis (there are no differences between the groups):

– K Diseases of the digestive system $p > 0.05$ (0.140);

– D Benign formations $p > 0.05$ (0.495);

– C Malignant neoplasms $p > 0.05$ (1,000).

The exact values of the significance level of the calculated criterion are shown in parentheses.

The decision on the clinical significance of the dependence of the presence of diagnoses obtained with IIRNT, and for which statistical significance has been proven,

should be made by interdepartmental expert councils to establish the causal relationship of diseases.

In everyday clinical activities, the statistical significance of the results obtained for characteristic diagnoses can and should be used in the development of therapeutic and preventive algorithms for providing medical care to people who have undergone IIRNT.

3) The application of a three-level system of organization of medical care in relation to veterans of SRU has demonstrated the high effectiveness of applying the method to persons of the specified contingent. The total number of successfully treated veterans of SRU at all three levels amounted to 446 people. The use of a three-level system of medical care organization in relation to AC representatives has also shown high efficiency. The total number of successfully treated AC representatives at all three levels amounted to 15,000 people. The achieved results allow us to recommend this method for use in relation to all persons who have been subjected to IIRNT [68].

4) The distribution of veterans of SRU of the surveyed group by gender showed that the vast majority of the respondents were men (96%), and the rest were women (4%) [64]. This fact should be taken into account when drawing up preventive and curative algorithms for medical care.

5) Most of the veterans of SRU of the surveyed group belong to the age categories of «70-79» years and «80-89» years. This is 68% of the respondents. The fact of the predominance of these age groups in the above statistics should be taken into account when compiling preventive and curative algorithms.

6) The number of fully satisfied veterans of SRU with the quality of medical care was 53%. 13% were completely dissatisfied. When recalculating partial satisfaction and partial dissatisfaction in accordance with the weighting coefficients of each such assessment, we get that the total satisfaction will be about 71%, and the total dissatisfaction – 29%, respectively [68].

7) The distribution of representatives of the attached contingent (hereinafter referred to as AC) from the group with IIRNT by gender: 84% are men, and 16% are women. The distribution of AC representatives from the group without IIRNT by

gender: 86% are men, and 14% are women [68]. This fact should be taken into account when drawing up preventive and curative algorithms for medical care.

8) The largest number of AC representatives from the group without IIRNT is concentrated in the age group of «60-69» years (38%). The largest number of AC representatives from the group with IIRNT belong to the same age group, but this value is slightly less (34%). The fact of the predominance of these age groups in the above statistics should be taken into account when compiling preventive and curative algorithms.

9) Satisfaction with the quality of medical care among AC representatives is significantly higher than among veterans of SRU. For example, 84% of AC without IIRNT and 81% of AC with IIRNT rated the politeness and attentiveness of doctors as «excellent». Very similar data were obtained on other questions posed by the questionnaire on this topic. It follows from this that the assessment of the quality of medical care does not depend on the availability of IIRNT [68].

10) The attitude of AC representatives to the recommendations of a healthy lifestyle (hereinafter – healthy lifestyle) is considered in several aspects:

– the issue of attitudes to smoking revealed that 26% of AC representatives from the group with IIRNT and 37% of AC representatives from the group without IIRNT currently smoke, while the rest either never smoked or quit. This is an encouraging result.;

– on the issue of attitudes to alcohol consumption, the data are as follows: 17% of AC representatives from the group with IIRNT and 23% of AC representatives from the group without IIRNT do not drink alcoholic beverages, and the rest are subject to this habit to varying degrees;

– on the issue of implementing the recommendations of the positive aspects of healthy lifestyle (rational nutrition, physical activity, sports), 44% of AC representatives from the group with IIRNT and 51% of AC representatives from the group without IIRNT always follow these recommendations, and the rest – on a case-by-case basis, or even not at all;

If there is a periodic questionnaire survey of the considered contingent in the process of medical care, it becomes possible to detect areas of deficiencies in the implementation of the recommendations of the HLS, which allows timely decisions to strengthen propaganda in the relevant areas [68].

11) The organization of the system of medical care for persons who have experienced IIRNT should provide for the possibility of assessing the quality of medical care as a clinical component, and according to the socio-psychological component [68].

12) The topic of the organization of the medical care system for people who have experienced IIRNT will remain relevant in the future – as long as nuclear technologies are used in the world [68].

PRACTICAL RECOMMENDATIONS

Recommendations to the executive authorities in the field of healthcare of the city of St. Petersburg and the Leningrad region

1) To spread the use of the methodology for identifying the dominant diagnoses of diseases of people who have experienced IIRNT to determine the strategy and tactics of providing medical care in the region.

2) To disseminate the use of the developed model of the medical care system in accordance with the proposals of this study, taking into account the need to maintain databases separately on clinical and socio-psychological aspects of medical care for people who have experienced IIRNT.

3) Apply to the higher Federal bodies of the healthcare system to provide medical institutions with the possibility of wider application of the three–level system of medical care for veterans of SRU – through the development of financing for this category of citizens on a state assignment.

Recommendations to medical organizations in the region

1) To introduce into the practice of the medical organization the periodic conduct of statistical research of persons who have experienced IIRNT in order to achieve the following goals:

– definition and timely correction of therapeutic and preventive algorithms;

– receiving assessments of the quality of medical care from patients;

– identification of the results of promoting a healthy lifestyle.

2) Use the developed model of the medical care system, which takes into account the need to maintain databases separately on clinical and socio-psychological aspects of medical care for people who have experienced IIRNT.

3) To implement the clinical aspects of medical care, continue (or begin, if not previously used) the use of a well–established three-tier medical care system, taking into account the resource capabilities of medical institutions, possibly by routing patients.

4) To implement the socio-psychological aspects of medical care, in accordance with the recommendations of this study, to develop the structure of an appropriate database and questionnaires for the survey of the contingent in question.

5) Therapeutic and preventive algorithms for people who have experienced IIRNT should be developed taking into account gender, age, and existing risk factors.

6) If possible, include medical psychologists in the staff of the medical institution for anti-stress consultations, as well as specialists in the development and maintenance of databases to improve the quality of information accumulation and processing.

Recommendations to higher medical educational institutions

1) It is advisable to use the results of this study in the educational process in the training of doctors of all medical specialties, doctors-specialists in practical healthcare, specialists in the specialty «Public health, organization and sociology of healthcare, medical and social expertise».

2) Special attention of the trainees should be paid to the application in the study:

– methods for identifying the dominant diagnoses of diseases of people who have experienced IIRNT;

– methods for considering algorithms for the functioning of processes that take into account the sequence of events over time and the presence of decision-making elements;

– methods of developing and maintaining databases separately on clinical and socio-psychological aspects of medical care.

3) To introduce an understanding of the special importance of considering the quality of medical care and promoting a healthy lifestyle.

PROSPECTS FOR FURTHER DEVELOPMENT OF THE TOPIC

A very promising direction for further development of the topic is a retrospective analysis of biological estimates of radiation exposure doses received by veterans of special risk units [68].

At the initiative of the NWDSCC and with the direct participation of the author of this study, in 2021, a technical specification was developed and an application was submitted to the Russian Academy of Sciences (RAS) for conducting research work «Assessment of the results of radiation exposure to the health status of veterans of special risk units using cytogenetic research methods» [68].

In 2022, the RAS reviewed and approved an application for conducting the specified research work at the NWDSCC (hereinafter referred to as RW).

Within the framework of this RW, a retrospective analysis of biological estimates of radiation exposure doses received by veterans of special risk units will be performed using cytogenetic methods [68].

The results of the analysis will be used to:

– develop forecasts of individual risks of developing diseases;

– compilation of therapeutic and preventive algorithms for the provision of medical care;

– creation of a register of veterans of special risk units.

To obtain the actual material, a cytogenetic analysis of the peripheral blood of patients is required at the beginning of research. The analysis requires high-tech specialized equipment and specially trained high-class laboratory staff. This part of the research is supposed to be performed in the leading laboratory of the FMBA on this topic, and samples for analysis will be provided by the NWSCC. The results of the development will be used to further deepen scientific knowledge on this topic and for clinical practice.

The results of the RW will make it possible to detect diseases in a timely and possibly proactive manner and create conditions for improving the quality of medical care for both veterans and active personnel of SRU, as well as other categories of persons associated with activities in the risk zone of IIRNT.

The economic effect of the implementation of the planned work will be to optimize the resource and time costs for providing medical care to people who have experienced IIRNT.

The social effect of the work will be to preserve the health and ensure longevity of persons of these categories, which is a confirmation of the value of the work that they have done and are doing for the benefit of the country's security [64].

The research conducted within the framework of this research can become the basis for further study of the aspects of providing medical care to all categories of people who have experienced IIRNT for in-depth clinical examination [68].

LIST OF ABBREVIATIONS

NS	–	nuclear submarines
NPP	–	nuclear power plant
IIRNT	–	impact of ionizing radiation of nuclear technologies
ARCERM	–	All-Russian Center of Emergency and Radiation Medicine named after A.M. Nikiforov of the Ministry of Emergency Situations of Russia
SSC	–	State Scientific Center
HLS	–	healthy lifestyle
IAEA	–	International Atomic Energy Agency
ICD	–	international classification of diseases
MES	–	Ministry of Emergency Situations
RW	–	research work
SMC	–	Scientific and Medical Center
SMC CVSRU	–	Scientific and Medical Center of the Committee of Veterans of Special Risk Units
NRER	–	National Radiation Epidemiological Register
CMI	–	compulsory medical insurance
AC	–	the attached contingent
SRU	–	special risk units
RAS	–	Russian Academy of Sciences
RF	–	Russian Federation
NWDSCC	–	Northwest District Scientific and Clinical Center named after L.G. Sokolov of the Federal Medical and Biological Agency of Russia
SPb	–	St. Petersburg
SPb and LR	–	St. Petersburg and the Leningrad Region
FSBI	–	Federal State Budgetary Institution
FSHI	–	Federal State Healthcare Institution
FMBA	–	Federal Medical and Biological Agency
FMBC		Federal Medical Biophysical Center
Chernobyl NPP	–	Chernobyl Nuclear Power Plant
EEG	–	electroencephalogram

LIST OF LITERATURE

1. 25 years after Chernobyl: state of health, pathogenetic mechanisms. The experience of medical support for liquidators of the consequences of the Chernobyl nuclear power plant accident (a guide for doctors) (in Russ.) / S. S. Aleksanin; St. Petersburg : Medkniga. – 2011. – 736 p.

2. 25 years of the Chernobyl accident. The results and prospects of overcoming its consequences in Russia. 1985–2011 : The Russian National Report (in Russ.) / S. K. Shoigu, L. A. Bolshova.; M. – 2011. – 160 p.

3. 30 years after Chernobyl: pathogenetic mechanisms of the formation of somatic pathology, medical support for participants in the liquidation of the consequences of the accident at the Chernobyl nuclear power plant (in Russ.) / S. S. Aleksanina; St. Petersburg : Politechnika-print. – 2016. – 506 p.

4. 5-year experience in the functioning of the NRER as a state information system for monitoring the radiological consequences of the Chernobyl disaster (in Russ.) / V. K. Ivanov, M. A. Maksyutov, K. A. Tumanov [et al.] // Radiation and risk (Bulletin of the National Radiation and Epidemiological Register). – 2021. – Vol. 30, No. 1. – P. 7-39.

5. Alexeyevskaya, T. And. Basic medical statistics: educational and methodological toolkit (in Russ.) / T. And. Alexeyevskaya, S. V. Makarov; Irkutsk : Irkutsk State University. – 2012. – 125 p.

6. Aliyeva, Z. D. Features serdechno-sousudistoy and cerebrovascular pathologies in liquidatorov Chernobavlskoy crash. : dis. ... kand. honey. science (in Russ.) / Z. D. Aliyev; Dushanbe. – 2013. – 126 p.

7. Balonov, M. I. Consequences of Chernobyl: 20 years later (in Russ.) / M. I. Balonov // Radiation and risk. – 2006. – Vol. 15, No. 3. – P. 97-119.

8. Belozerova, L. M. Assessment of biological age by computer electroencephalography (in Russ.) / L. M. Belozerova // Successes of gerontology. – 2013. – Vol. 26, No. 4. – P. 666-670.

9. Biological indication of radiation effects on the human body using cytogenetic methods (medical technology No. FS2007/015U) (in Russ.) / G. P. Snigireva, A. N. Bogomazova, N. N. Novitskaya [et al.]. – M. – 2007. – 29 p.

10. Brodovskaya, T. O. Assessment of the long–term effects of ionizing radiation on the course of hypertension and endothelial function in liquidators of the consequences of the Chernobyl accident (in Russ.) / T. O. Brodovskaya, O. V. Teplyakova, L. A. Sokolova // Ural Medical Journal. – 2007. – No. 7. – P. 83-87.

11. Comparative analysis of factors and indicators of the quality of life of liquidators of the consequences of the Chernobyl accident (in Russ.) / N. M. Oganesyan, E. G. Gevorkyan, E. G. Poghosyan [et al.] // Medical radiology and radiation safety. – 2012. – vol. 57, No. 2. – P. 15-25.

12. Comparative coronarographic screening of workers of harmful industries as an indicator of the effectiveness of diagnosis and treatment (in Russ.) / N. Y. Semigolovsky, S. O. Mazurenko, E. V. Balukova, **E. I. Pershina**, E. M. Nikolskaya, T. T. Berdikulova // Collection of mat. XVIII All-Russian. Congress «Health is the basis of human potential: problems and solutions». – 2023. – Vol. 18, No. 1. – P. 294-303.

13. Cytogenetic analysis of peripheral blood lymphocytes in those living in radionuclide-contaminated areas of the Kaluga region (in Russ.) / N. P. Bochkov, L. D. Katosova, V. A. Sapacheva [et al.] // Med. radiol. – 1991. – Vol. 36, No. 1. – P. 50-52.

14. Cytogenetic characteristics of children affected by the Chernobyl accident (in Russ.) / I. E. Vorobtsova, S. N. Kolyubaeva, M. V. Vorobyova [et al.] // Med. radiol. – 1993. – Vol. 38, No. 10. – P. 25-28.

15. Cytogenetic effect in peripheral blood lymphocytes as an indicator of the effect of Chernobyl accident factors on humans (in Russ.) / M. A. Pilinskaya, A. M. Shemetun, S. S. Dybsky [et al.] // Radiobiology. – 1992. – Vol. 32, No. 6. – P. 632-639.

16. Cytogenetic examination of various groups of children living in areas of the Bryansk region contaminated as a result of the Chernobyl accident (in Russ.) / E. K. Khandogina, V. A. Ageikin, S. V. Zvereva [et al.] // Radiats. biology. Radioecology. – 1995. – Vol. 35, No. 5. – P. 618-625.

17. Cytogenetic indexing of the radiation dose approximately 30 years after the Chernobyl accident (in Russ.) / V. Yu. Nugis, A. Yu. Bushmanov, M. G. Kozlova [et al.] // Medical radiology and radiation safety. – 2017. – Vol. 62, No. 3. – P. 26-32.

18. Cytogenetic studies 28-29 years after the Chernobyl accident (in Russ.) / V. Yu. Nugis, A. Yu. Bushmanov, E. E. Zapadinskaya [et al.] // Medical radiology and radiation safety. – 2016. – Vol. 61, No. 4. – P. 35-42.

19. Dmitriev, O.V. Study of cognitive functions in veterans of special risk units of elderly and senile age : dis. ... candidate of Medical Sciences (in Russ.) / O. V. Dmitriev; St. Petersburg : VMedA. – 2013. – 138 p

20. Domracheva, E.V. Individual radiation doses determined by two methods of biological dosimetry in residents of the Chernobyl region and participants in the liquidation of the accident (in Russ.) / E. V. Domracheva, G. A. Klevezal, V. V. Nechai [et al.] // Hematol. and transfusiol. – 1991. – vol. 36, No. 12. – pp. 18-20.

21. Epidemiology of the medical consequences of the Chernobyl accident. To the 30th anniversary of the accident (in Russ.) / N. M. Oganesyan, N. R. Davidyan, A. G. Karapetyan [et al.] // Medical radiology and radiation safety. – 2016. – Vol. 61, No. 3. – P. 89-97.

22. Evaluation of the effectiveness of psychophysiological adaptation of personnel working in contact with ionizing radiation for a long time (in Russ.) / N. A. Metlyaeva, M. A. Lartsev, O. V. Shcherbatykh [et al.] // Medical radiology and radiation safety. – 2010. – Vol. 55, No. 6. – P. 8-13.

23. Evdokimov, V. I. Development of research on biomedical and psychological problems of liquidators of the consequences of the Chernobyl accident (2005-2015) (in Russ.) / V. I. Evdokimov // Med.-biol. and social psychology. The security problem is in the future. situations. – 2016. – No. 1. – P. 108-119.

24. Evdokimov, V. I. Liquidation of the consequences of the Chernobyl accident: a bibliographic index of book publications (1987-2010) (in Russ.) / V. I. Evdokimov, T. V. Ermolenko; St. Petersburg : Polytechnic-service. – 2011. – 158 p.

25. Fundamentals of medical statistics : An educational and methodological manual (in Russ.) / V. S. Glushanko, A. P. Gruznevich, S. L. Garanicheva [et al.] // Vitebsk : Vitebsk State Medical University. – 2012. – P. 155.

26. Gerontological problem Apostille veteran Sub-Division Special risk: monograph (in Russ.) / N. V. Alyshev, A. A. Vaskevich., B. A. Drabkin [et al.]; SPB. – 2008. – 167 p.

27. Glants, S. Biomedical statistics. / S. Glants : Translated from English. – M. : Praktika. – 1998. – 459 p.

28. Grebenyuk, A. N. Radiation accidents: experience of medical protection and modern strategy of pharmacological provision (in Russ.) / A. N. Grebenyuk, V. I. Legeza, V. V. Zatsepin // Radiats. hygiene. – 2012. – Vol. 5, No. 3. – P. 53-57.

29. Grinhalkh, T. Fundamentals of evidence–based medicine (in Russ.) / T. Grinhalkh; M. : GEOTAR-MED. – 2004. – 240 p.

30. Gubarev, V. How to create a nuclear shield for the Motherland (in Russ.) / V. Gubarev // Rodina. – 2010. – No. 12. – P. 66-69.

31. Guskova, A. K. Acute effects of radiation in victims of the Chernobyl accident (in Russ.) / A. K. Guskova // Med. radiol. and radiats. safety. – 1987. – Vol. 32, No. 12. – P. 3-18.

32. Guskova, A. K. Medical consequences of the Chernobyl accident. The main results and unresolved problems (in Russ.) / A. K. Guskova // Med. radiol. and radiats. safety. – 2010. – Vol. 55, No. 3. – P. 17-28.

33. Immunity and health: accelerated aging of the immune system in veterans of special risk units (in Russ.) / E. I. Puchkova, N. V. Alishev, B. A. Drabkin [et al.] // Successes of gerontology. – 2011. – Vol. 24, No. 4. – P. 631-644.

34. Ivanov, V. K. Analysis of mortality among participants in the liquidation of the consequences of the Chernobyl disaster (observation period 1991-1998) (in Russ.) / V. K. Ivanov [et al.] // Med. radiol. and radiats. safety. – 2002. – Vol. 47, No. 4. – P. 34-42.

35. Ivanov, V. K. The problem of thyroid cancer: lessons from Chernobyl and the forecast for Fukushima (in Russ.) / V. K. Ivanov, A.F. Tsyb // Vestn. Ross. Academy of Medical Sciences. – 2013. – No. 5. –P. 38-44.

36. Junkerov, V. I. Mathematical and statistical processing of medical research data (in Russ.) / V. I. Junkerov, S. E. Grigoriev; St. Petersburg : VMedA. – 2002. – 266 p.

37. Koichubekov, B.K. Determining the sample size when planning a scientific study (in Russ.) / B. K. Koichubekov, M. A. Sorokina, K. E. Mkhitaryan // International Journal of Applied and Fundamental Research. – 2014. – No. 4. – P. 71-74.

38. Kolenchukova, O. A. The state of the immune status and normal microflora of the throat in people living in the area of anthropogenic influence (in Russ.) / O. A. Kolenchukova, A. A. Savchenko // Hygiene and sanitation. – 2006. – No. 6. – P. 8-11.

39. Koroleva, T. M. Primary morbidity of participants in the liquidation of the consequences of the Chernobyl accident (in Russ.) / T. M. Koroleva, V. N. Nuralov, I. E. Bronstein // Radiation hygiene. – 2008. – Vol. 1, No. 2. – P. 28-31.

40. Kudritsky, Yu. K. Adaptation to ionizing radiation (in Russ.) / Yu. K. Kudritsky, A. B. Georgievsky, V. I. Karpov // Newsletter of the Scientific meeting of the USSR Academy of Sciences on problems of radiobiology. – 1987. – No. 34. – P. 13-17.

41. Kulichkov, V. K. From the history of submarine design in the Central Design Bureau of MT Rubin (in Russ.) / V. K. Kulichkov // Scientific Bulletin of the military-industrial complex of Russia. – 2020. – No. 2. – P. 85-93.

42. Lang, T. A. Description of statistics in medicine. A guide for authors, editors and reviewers (in Russ.) / T. A. Lang, M. Sesik; M. : Practical medicine. – 2011. – 477 p.

43. Legeza, V. I. Liquidators of the consequences of the Chernobyl accident – 10 years later (in Russ.) / V. I. Legeza // Terap. archive. – 1997. – No. 1. – P. 77-79.

44. Legeza, V. I. On the question of the features of the long–term dynamics of the level of diseases of the circulatory system in military personnel liquidators of the consequences of the Chernobyl accident (in Russ.) / V. I. Legeza, V. M. Reznik, V. F.

Pimbursky // Med.-biol. and social psychology. The security problem is in the future. situations. – 2016. – No. 1. – P. 34-40.

45. Long-term consequences of radiological and other activities in the U.S.: a monograph (in Russ.) / N. V. Alyshev [et al.]; SPB. – 2010. – 195 p.

46. Long-term medical consequences of the Chernobyl accident in Armenia. Assessment of the quality of life and accelerated biological aging of the liquidators of the accident (in Russ.) / N. M. Oganesyan, N. R. Davidyan, E. G. Gevorkyan [et al.] // Radiation Biology. Radioecology. – 2011. – Vol. 51, No. 1. – P. 91-100.

47. Lyubchenko, P. N. The state of the cardiovascular system in the liquidators of the consequences of the Chernobyl accident (in Russ.) / P. N. Lyubchenko, L. I. Kovaleva, E. B. Shirokova // Clinical medicine. – 2004. – Vol. 82, No. 6. – P. 30-33.

48. Malignant tumors of the oral cavity, pharynx and larynx. (in Russ.) / A.I. Paches [et al.]; M. : Medicine. – 1988. – 302 p.

49. Mechanisms of development of somatic pathology and long-term medical consequences of the Chernobyl accident (in Russ.) / S. S. Aleksanin [et al.] // Biomedical and socio-psychological problems of safety in emergency situations. – 2016. – No. 2. – P. 5-15.

50. Medical and statistical characteristics of military personnel who sought medical help in the aftermath of the Chernobyl accident in the near future (in Russ.) / R. N. Lemeshkin [et al.] // Med.-biol. and social psychology. The security problem is in the future. situations. – 2016. – No. 2. – P. 16-24.

51. Medical radiological consequences of Chernobyl: prognosis and actual data after 30 years (in Russ.) / under the general editorship of V. K. Ivanov, A.D. Kaprina; M.: GEOS. – 2015. – 450 p.

52. Medical radiological consequences of Chernobyl: prognosis and actual data after 30 years (in Russ.) / V. F. Stepanenko [et al.]. – M.: GEOS. – 2015. – 449 p.

53. Medical statistics. Electronic resource. URL: https://medstatistic.ru (date of application: 09.09.2023). Access mode: free.

54. Methods of statistical processing of medical data : Methodological recommendations for residents and postgraduates of medical educational institutions,

researchers (in Russ.) / comp.: A. G. Kochetov, O. V. Liang, V. P. Masenko [et al.]; M. : RKNPK. – 2012. – 42 p.

55. Nakatis, Ya. A. Generalization of scientific data on the state of health and organization of medical care for veterans of special risk units (in Russ.) / Ya. A. Nakatis, K. G. Dobretsov // Medline.ru. Russian Biomedical Journal. – 2020. – Vol. 21, No. 3 – P. 1227-1236.

56. National Radiation Epidemiological Register (NER). Electronic resource. URL: http://nrer.ru/information.html (date of application: 08/27/2023). Access mode: free.

57. Novik, A. A. Guidelines for the study of quality of life in medicine (in Russ.) / A. A. Novik, T. I. Ionova; St. Petersburg : Olma-Press. – 2002. – 313 p.

58. Novikov, D. A. Statistical methods in a biomedical experiment (typical cases) (in Russ.) / D. A. Novikov, V. V. Novochadov; Volgograd : VolGMU. – 2005. – 84 p.

59. Nuclear tests of the USSR (in Russ.) / I. A. Andryushin [et al.]; Sarov : RFNC-VNIIEF. – 1997. – Vol. 1. – P. 14.

60. Oleshko, V. A. Medical and psychological correction of psychosomatic disorders in veterans of special risk units in the long-term period : dis. ... doctor of Medical Sciences (in Russ.) / V. A. Oleshko; St. Petersburg : Federal State Institution «All-Russian Center for Emergency and Radiation Medicine». – 2007. – 74 p.

61. Onishchenko, G. G. Radiological consequences and lessons of radiation accidents at the Chernobyl and Fukushima-1 nuclear power plants (in Russ.) / G. G. Onishchenko, A. Y. Popova, I. K. Romanovich // Radiation hygiene. – 2021. – Vol. 14, No. 1. – P. 6-16.

62. Pathology of the long-term period in liquidators of the consequences of the Chernobyl accident : All-Russian Center for Emergency and Radiation Medicine of the Ministry of Emergency Situations of Russia (in Russ.) / ed. A.M. Nikiforov; St. Petersburg. – 2004. – 400 p.

63. Pegov, A. A. Characteristics of some clinical features of the state of health of veterans of special risk units (in Russ.) / A. A. Pegov, S. P. Uspensky, N. A. Nikolaeva // In the collection: Medical and social aspects of the problems of nuclear veterans and

ways to solve them: Abstracts of the Scientific and Practical Conference of St. Petersburg. – 1997. – P. 94-95.

64. **Pershina, E. I.** Assessment of the quality of medical care for veterans of special risk units (in Russ.) / **E. I. Pershina**, K. G. Dobretsov // Kremlin medicine. Clinical Bulletin. – 2020. – No. 4. – P. 52-58. – DOI 10.26269/8f94-3978.

65. **Pershina, E. I.** Legislative aspects of compensation for harm caused to the health of workers with harmful working conditions (in Russ.) / **E. I. Pershina**, V. M. Vasilets, A.V. Korobova // Clinical Hospital. – 2016. – № 1(15). – P. 12-16.

66. **Pershina, E. I.** Organization of medical care for veterans of special risk units (in Russ.) / **E. I. Pershina**, S. S. Moskaleva // Jubilee international scientific and practical conference « FSBI SSC FMBC named after A. I. Burnazyan FMBA of Russia: 75 years on guard of human health» : Abstracts of the anniversary international scientific and practical conference, Moscow, November 16-17, 2021. – Moscow: State Scientific Center of the Russian Federation – A.I. Burnazyan Federal Medical Biophysical Center, 2021. – P. 220-223.

67. **Pershina, E. I.** Organization of medical care for veterans of special risk units of the Russian Federation (in Russ.) / **E. I. Pershina** // Bulletin of the Ivanovo Medical Academy. – 2020. – Vol. 25, No. 2. – P. 18-22.

68. **Pershina, E. I.** Providing medical care to veterans of the era who have been exposed to ionizing radiation of nuclear technologies. The International scientific and practical forum of young scientists and specialists «Ilyinsky readings 2024» on February 28, 2024. Electronic resource. URL: https://ilyinforum.ru/prezentaczii (date of application: 05/16/2024). Access mode: free.

69. Piliptsevich, N. N. Malignant neoplasms in the cohort of liquidators: morbidity, disability, mortality (in Russ.) / N. N. Piliptsevich, I. V. Suvorova // International. Journal of Radio Science. medicine. – 2001. – Vol. 3, No. 1. – P. 269-280.

70. Povarov, Yu. V. Violation of the immune status in case of damage to the upper respiratory tract in participants in the liquidation of the consequences of the Chernobyl accident (in Russ.) / Yu. V. Povarov, A. D. Kasyanov // Materials of the All-

Russian Symposium «Problems of immunology in otorhinolaryngology». – 1994. – P. 72-73.

71. Pyatkin, E. K. Assessment of the absorbed dose based on the results of cytogenetic studies of lymphocyte cultures in victims of the Chernobyl accident (in Russ.) / E. K. Pyatkin, V. Yu. Nugis, A. A. Chirkov // Med. radiol. – 1989. – Vol. 34, No. 6. – P. 52-57.

72. Radiation accidents (in Russ.) / N. M. Oganesyan, K. V. Oganesyan, M. I. Asryan, N. M. Mirijanyan [et al.]; Yerevan : Naapet. – 2004. – 127 p.

73. Radiation effects on the population of the Altai Territory of nuclear tests at the Semipalatinsk test site (in Russ.) / Ya. N. Shoikhet [et al.]; Barnaul. – 1999. – 346 p.

74. Radiation psychosomatic illness among the liquidators of the consequences of the Chernobyl accident (in Russ.) / V. K. Shamrey [et al.] // Med.-biol. and social psychology. The security problem is in the future. situations. – 2016. – No. 1. – P. 21-33.

75. Radiation-hazardous objects. The main damaging factors in radiation accidents. Medical and tactical characteristics of accidents at radiation-hazardous facilities. Electronic resource. URL: https://studfile.net/preview/9141507/page : 2/ (date of access: 08/27/2023). Access mode: free.

76. Refugee, V. F. The state of the immune system of women exposed to the complex of factors of the Chernobyl accident (in Russ.) / V. F. Refugee, A. E. Antushevich, A. N. Grebenyuk // Obstetrics and gynecology. – 1999. – No. 2. – P. 56-59.

77. Registration of morbidity of participants in the liquidation of the consequences of the Chernobyl accident in various dose groups (in Russ.) / A. P. Biryukov, M. L. Bolokhonenkova, E. V. Kochergina [et al.] // Almanac of clinical Medicine. – 2006. – No. 10. – P. 9-15.

78. Results of cytogenetic examination of persons who took part in the liquidation of the Chernobyl accident (in Russ.) / V. G. Zainullin, P. A. Borodkin, S. I. Chernyak [et al.] // Radiobiology. – 1992. – Vol. 32, No. 5. – P. 668-672.

79. Russian Federation. Certificate of state registration of the database No. 2021621045. Survey data for veterans of special risk units using the author's questionnaire : No. 2021620883 : application 04.05.2021 : publ. 21.05.2021 / **E. I. Pershina,** K. G. Dobretsov, S. S. Moskaleva ; applicant Federal state budgetary institution «North-Western district scientific and clinical center named after L.G. Sokolov federal medical and biological agency».

80. Russian Federation. Laws. About the Committee of Veterans of Special Risk Units of the Russian Federation: Decree of the Government of the Russian Federation No. 806: [adopted by the Government of the Russian Federation on October 21, 1992] – Guarantor. Information and legal support. Electronic resource. URL: https://base.garant.ru/180576/ (access date: 08/27/2023). Access mode: free.

81. Russian Federation. Laws. On measures to ensure social protection of citizens from special risk units: Decree of the Government of the Russian Federation No. 958: [adopted by the Government of the Russian Federation on December 11, 1992] – Consultant plus. Electronic resource. URL: http://www. consultant.ru/ document/cons_doc_LAW_23248 (date of access: 08/27/2023). Access mode: free.

82. Russian Federation. Laws. On the extension of the RSFSR Law “On the social protection of citizens exposed to radiation as a result of the disaster at the Chernobyl Nuclear Power Plant” to citizens from special risk units”: Resolution of the Supreme Council of the Russian Federation No. 2123-1: text with amendments and additions as of August 15, 2023: [adopted by the Supreme Council of the Russian Federation on December 27, 1991] – Consultant plus. Electronic resource. URL: http://www.consultant. ru/ document/ cons_ doc_ LAW_4713 (date of access: 08.27.2023). Access mode: free.

83. Russian Federation. Laws. On the social protection of citizens exposed to solar radiation leading to the disaster at the Chernobyl nuclear power plant: Text of the Law of the Russian Federation of July 10, 2020 No. 1244-1 with amendments and additions: [approved by the Supreme Council of the Russian Federation on May 15, 1991] – Consultant plus. Electronic resource. URL: https://www. consultant. ru/ document/ cons_doc_LAW_5323/ (date of access: 08/27/2023). Access mode: free.

84. Rybnikov, V. Yu. Health status and medical and psychological correction of psychosomatic disorders in veterans of special risk units (in Russ.) / V. Yu. Rybnikov, V. A. Oleshko // Biomedical and socio-psychological problems of safety in emergency situations – St. Petersburg: 1st Naval Clinical Hospital, Federal State Institution «All-Russian Center for Emergency and Radiation Medicine». – 2007 – P. 11-18.

85. Shevchenko, V. A. The significance of cytogenetic examination for assessing the consequences of the Chernobyl disaster (in Russ.) / V. A. Shevchenko, G. P. Snigireva // Radiats. biology. Radioecology. – 2006. – Vol. 46, No. 2. – P. 133-139.

86. Shipitsina, E. MSCh No. 144: golden conditions for veterans of special risk (in Russ.) / E. Shipitsina // Who's who in medicine – 2010. – № 1(44) – P. 62-63.

87. Shubik, V. M. Radiation accidents and health : a monograph (in Russ.) / V. M. Shubik; St. Petersburg. – 2003. – 336 p.

88. Somatic effects of chronic gamma radiation. (in Russ.) / Yu. T. Grigoriev [et al.]; M. : Energoatomizdat. – 1986. – 195 p.

89. Specialized and high-tech medical assistance to victims of the Chernobyl accident as part of the activities of the Union State (in Russ.) / S. S. Aleksanin, V. Y. Rybnikov, K. K. Rogalev [et al.] // Radiats. hygiene. – 2018. – Vol. 11, No. 4. – P. 89-97.

90. Specialized medical care in a round-the-clock hospital for citizens exposed to radiation as a result of the Chernobyl disaster (in Russ.) / S. S. Aleksanin, V. Y. Rybnikov, K. K. Rogalev, V. A. Tarita // Biomedical and socio-psychological problems of safety in emergency situations. – 2019. – No. 4. – P. 5-11.

91. The nature of changes in immunity in women liquidators of the consequences of the Chernobyl accident and evacuees from the radioactively contaminated territory (in Russ.) / Yu. V. Tsvelev [et al.] // Military-med. Journal. – 1997. – Vol. 317, No. 1. – P. 38-42.

92. The results of dynamic cytogenetic monitoring of children and adolescents living in radioactively contaminated areas after the Chernobyl accident (in Russ.) / A.V. Sevankaev, G. F. Mikhailova, O. I. Potetnya [et al.] // Radiats. biology. Radioecology. – 2005. – Vol. 45, No. 1. – P. 5-15.

93. The results of the cytogenetic examination of the liquidators of the consequences of the Chernobyl accident, conducted in different years (in Russ.) / I. E. Vorobtsova, V. M. Mikhelson, M. V. Vorobyova [et al.] // Radiats. biology. Radioecology. – 1994. – Vol. 34, No. 6. – P. 798-803.

94. The role of cytogenetic examination to assess the effects of uncontrolled radiation exposure on humans (in Russ.) / I. K. Khvostunov, A.V. Sevankaev, G. F. Mikhailova [et al.] // In the collection: «Medical radiological consequences of Chernobyl: prognosis and evidence after 30 years. – 2015. – P. 93-119.

95. The state and current issues of ensuring radiation protection of personnel of the Navy (in Russ.) / G. Yu. Sharaevsky, M. B. Murin, A.D. Belikov [et al.] // Military Medical Journal – 1999. – No. 7. – P. 62-65.

96. The use of the FISH method for the reconstruction of absorbed doses received by participants in the liquidation of the Chernobyl accident (in Russ.) / G. P. Snigireva, V. A. Shevchenko, N. N. Novitskaya // Radiats. biology. Radioecology. – 1995. – Vol. 35, No. 5. – P. 654-661.

97. The USSR Atomic Project : Documents and materials. (in Russ.) – Moscow : Publishing company «Physico-mathematical literature». – 2008. – 736 p.

98. Vashkevich, A. A. Features of the clinic and treatment of dermatomycosis in veterans of special risk units : diss. ... candidate of Medical Sciences (in Russ.) / A. A. Vashkevich; St. Petersburg : VMedA. – 2008. – 157 p.

99. Vasilenko, Yu. S. On protective-adaptive functions of the nasal mucosa in old age and old age (in Russ.) / Yu. S. Vasilenko // Bulletin of otorhinolaryngology. – 1963. – No. 4. – P. 31-37.

100. Veselkova, A.V. Clinical assessment of the state of ENT organs in veterans of special risk units : abstract. diss. ... candidate of Medical Sciences (in Russ.) / A.V. Veselkova; St. Petersburg : VMedA. – 2004. – 144 p.

101. Vorobtsova, I. E. Stable chromosomal aberrations in peripheral blood lymphocytes of persons affected by the Chernobyl accident (in Russ.) / I. E. Vorobtsova, A. N. Bogomazova // Radiats. biology. Radioecology. – 1995. – Vol. 35, No. 5. – P. 636-640.

102. Yarmonenko, S. P. Low radiation levels and health: radiobiological aspects. Analytical review (in Russ.) / S. P. Yarmonenko // Medical radiology and radiation safety. – 2000. – Vol. 45, No. 3. – P. 5-32.

103. Yarmonenko, S. P. Small doses – big trouble (in Russ.) / S. P. Yarmonenko // Med. radiology. – 1996. – Vol. 41, No. 2. – P. 32-39.

104. Zakharenko, M. The role of the submarine fleet in ensuring the security of Russia (in Russ.) / M. Zakharenko // Marine collection. – 2006. – No. 4. – P. 20-30.

105. Anderson, R. E. Ionizing radiation and the immune response / R. E. Anderson, N. L. Warner // Adv. Immunol. – 1976. – Vol. 24. – P. 215-335.

106. Campbell M.J. Medical statistics: a textbook for the health sciences. / M.J. Campbell, D. Machin, S.J. Walters. // John Wiley & Sons. – 2007. – 331 p.

107. Chromosome painting in highly irradiated Chernobyl victims: a follow-up study to evaluate the stability of symmetrical translocations and the influence of clonal aberrations for retrospective dose estimation / K. Salassidis, V. Georgiadou-Schumacher, H. Braselmann [et al.] // Int. J. Radiat. Biol. – 1995. – Vol. 68, No. 3. – P. 257-262.

108. Cytogenetic Dosimetry: Applications in Preparedness for and Response to Radiation Emergencies; Vienna : IAEA. – 2011. – 245 p.

109. DNA content and DNA-based centromeric index of 24 human chromosomes / M. L. Mendelsohn, B. H. Mayall, E. Bogart [et al]. // Science. – 1973. – Vol. 179, No. 78. – P. 1126-1129

110. Francoeur, A. M., Autoantibodies: terms and concepts / A. M. Francoeur, J. G. Heitzman // Clin. Immunol. Immunopathol. – 1988. – Vol. 47. No. 3. – P. 245-252.

111. French, J.R.P., Jr. S. Adjustment as person-environment fit. / J.R.P. French, Jr., W. Rodgers, S. Cobb // J. Soc. Issues. – 1974. – No. 18. – P. 316-333.

112. Immunosupressive factors: Role in cancer development and progression / C. Botti, E. Seregni, L. Ferrari [et al.] // Int. J. Biol. Markers. – 1998. – Vol. 13, No. 2. – P. 51-69.

113. International study of factors affecting human chromosome translocations / A. J. Sigurdson, M. Ha, M. Hauptmann [et al.] // Mutat. Res. – 2008. – Vol. 652, No. 2. – P. 112-121.

114. Jaworowski, Z. Observations on the Chernobyl disaster and LNT / Z. Jaworowski // Dose-Response. – 2010. – Vol. 8, No. 2. – P. 148-171.

115. Legeza, V. I. Medical protection in radiation accidents: some results and lessons of the Chernobyl accident / V. I. Legeza, A. N. Grebenyuk, V. V. Zatsepin // New York: Nova Science Publishers Inc. – 2012. – P. 47-54.

116. Matthews, D.E. Using and understanding medical statistics / D.E. Matthews, T.V. Farewell // S. Karger AG. – 2007. – 322 p.

117. McCartny, M. No increase in radiated-related death seen in US «atomic veterans» / M. McCartny // Lancet. – 1996. – Vol. 9037. – P. 1300.

118. Meineke, V. The role of damage to the cutaneous system in radiation-induced multi-organ failure / V. Meineke // Br. J. Radiol. – 2005. – Vol. 27, Suppl. – P. 85-99.

119. Peacock, J. L. Oxford Handbook of Medical Statistics / J. L. Peacock, P. J. Peacock / Oxford University Press. – 2011. – 517 p.

120. Petrie, A. Medical statistics at a glance / A. Petrie, C. Sabin. // Wiley Blackwell. – 2009. – 181 p.

121. Rapid translocation frequency analysis in human decades after exposure to ionizing radiation / J.N. Lucas, A. Awa, T. Straume [et al.] // Int. J. Radiat. Biol. – 1992. Vol. 62, No. 1. – P. 53-63.

122. Review of translocations detected by FISH for retrospective biological dosimetry application / A. A. Edwards, C. Lindholm, F. Darroudi [et al.] // Radiat. Protect. Dosim. – 2005. – Vol. 113, No. 4. – P. 396–402.

123. Savage, J. K. Classification and relationships of induced chromosomal structural changes / J. K. Savage // J. Medical Genetic. – 1976. – Vol. 13, No. 2. – P. 103-122.

124. Studies of the mortality of atomic bomb survivors. Report 12, Part I, Cancer: 1950–1990 / D. Pierce [et al.] // Radiat. Res. – 1996. – Vol. 146, No. 1. – P. 1-27.

125. The outcome of local radiation injuries: 14 years of follow-up after the Chernobyl accident / P. Gottlöber [et al.] // Radiat. Res. – 2001. – Vol. 155, No. 3. – P. 409–416.

126. Translocation yields in peripheral blood lymphocytes from control populations / C. A. Whitehouse, A. A. Edwards, E. J. Tawn [et al.] // Int. J. Radiat. Biol. – 2005. – Vol. 81, No. 2. – P. 139-145.

127. Walford, R. L. The immunologic theory of aging. Copenhagen / R. L. Walford // Munksgeard. – 1969. – P. 1-27.

128. Weetman, A. P. Autoimmune thyroiditis: Predisposition and pathogenesis / A. P. Weetman // Clin. Endocr. – 1992. – Vol. 36, No. 4. – P. 307-323.

129. Werfel, T. Immunologische Befunde bei atopisher Dermatits / T. Werfel, A. Kapp // Allergologie. – 1998. – No. 6. – P. 251–258.

APPENDIX A

Questionnaire for assessing the organization of medical care for veterans of special risk units

(There are probably several answers)

1. Date of filling in: «_____» _____20_____ г.
2. FIO: _____
3. Gender:
    1) male;
    2) female.
4. Age: _____
5. Diagnosis(s): _____

_____

6. What year was the emergency? _____
7. Emergency location _____
8. Position during an emergency _____
9. After what time was the veteran's of SRU certificate received? _____
10. Do you have a disability
    1) yes;
    2) no.
11. The diagnosis was made:
    1) when contacting the city polyclinic;
    2) upon hospitalization in a hospital;
    3) when contacting the LSC;
    4) Other: _____.
12. Who was diagnosed:
    1) a therapist;
    2) by another specialist: _____.

13. Specify the year when you first felt the symptoms that you associate with the emergency: _____.

14. After what time did you contact the medical institution with these complaints?

1) immediately;

2) in a month;

3) in six months;

4) in a year;

5) more than a year.

15. If you have had to contact a medical institution about your illness since the diagnosis, please fill out the table.

Place of address	How many times have you applied since the onset of the disease	Including for the last year	Were there any difficulties in obtaining this type of assistance: 1- with the receipt of a referral 2- the absence of a specialist 3- other 4- there was no difficulty	Satisfaction with the quality of medical care (scores from 1 to 5) 5- fully satisfied 4- satisfied, but it could have been better 3- not completely satisfied 2- partially unsuccessful. 1- completely dissatisfied
Polyclinic:	-	-	-	-
Therapist				
Pulmonologist				
Cardiologist				
Surgeon				
Oncologist				
Hospital				
LNC				
Examination by an ambulance doctor				

16. Have you received any doctor's recommendations?

1) yes;

2) no.

17. If you have received a doctor's recommendation, please fill in this table.

Appointment	What recommendations were given to you by your doctor?	Do you follow them 1- Yes, always 2- On a case-by-case basis 3- I don't do it	The reason why you do not follow a doctor's appointment			
			Financial difficulties	I don't think it's necessary	I forget	Another
Non-drug therapy (physiotherapy)						
Drug therapy						
Spa treatment						
Physical activity						
Other						

18. Do you use any other methods besides the main prescriptions?

1) traditional medicine;

2) recommendations read on the Internet, magazines;

3) other: _____.

19. How much do you think your illness leads to a restriction of activity?

Type of activity	does not affect	it has little effect	It has a strong effect
a) employment			
b) family relationships			
c) physical activity			
d) the psychological climate is disturbed			
e) other			

20. What information do you lack about your disease?

1) is there enough information;

2) about the treatment;

3) about benefits;

4) other: _____.

21. Do you have enough information about the benefits of a veteran of SRU?

1) there is enough information;

2) there is information, but I would like more;

3) there is no information:

4) other: _____.

22. If you are dissatisfied with the quality of medical or household services, please indicate the possible reasons:

1) insufficient attention of the staff of the institution;

2) insufficient awareness of patients about planned therapeutic measures;

3) dissatisfaction with the quantity and quality of food;

4) dissatisfaction with the conditions of accommodation and stay;

5) another reason: _____.

APPENDIX B

Questionnaire for assessing satisfaction with the quality of medical care

(There are probably several answers)

1. Date of filling in: «_____» _____20_____ г.

2. FIO: _____

3. Gender:

1) male;

2) female.

4. Age: _____

5. The period of work in the institution or department

with harmful working conditions _____

6. Type of institution or unit

with harmful working conditions _____

7. Position during the period of work in an institution or department

with harmful working conditions _____

8. What kind of education do you have?

1) Primary or secondary general;

2) secondary vocational education;

3) Unfinished higher education;

4) Higher education;

5) Academic degree.

9. Do you currently work, and if so, by whom?

1) head of the structural unit;

2) a specialist of the highest qualification level (the job requires higher education);

3) an intermediate-level specialist (the job requires secondary specialized or vocational education);

4) the worker;

5) other (what exactly?) _____

10. What kind of social package is provided to you at this job? ((Check all the appropriate ones):

1) extended vacation time;

2) shorter working hours;

3) salary allowances for harmful working conditions;

4) therapeutic and preventive nutrition;

5) other (write what exactly) _____

_____

11. Do you currently smoke? If not, please specify: have you smoked before, but quit or have you never smoked?

1) I smoke;

2) Smoked, but quit;

3) I have never smoked.

12. Do you drink alcoholic beverages (vodka, wine, beer or similar)? If so, how often?

1) less than 12 times a year;

2) 1-2 times a month;

3) 1 time per week;

4) several times a week and more often;

5) I do not use.

13.Diagnosis(s): _____

_____

14. Is there a disability?

1) yes;

2) no.

15. The diagnosis was made:

1) when contacting the city polyclinic;

2) upon hospitalization in a hospital;

3) other: _____

16. Who was diagnosed:

1) a therapist;

2) by another specialist: _____

17. When (year) did you first experience symptoms that you associate with working in an institution or department with harmful working conditions? _____

18. After what time did you contact the medical institution with these complaints?

1) immediately;

2) in a month;

3) in six months;

4) in a year;

5) more than a year.

19. If you have had to contact a medical institution about your illness since the diagnosis, please fill in the table.

Place of address	How many times have you applied since the onset of the disease	Including for the last year	Were there any difficulties in obtaining this type of assistance: 1- with the receipt of a referral 2- the absence of a specialist 3- other 4- there was no difficulty	Satisfaction with the quality of medical care (scores from 1 to 5) 5- fully satisfied 4- satisfied, but it could have been better 3- not completely satisfied 2- partially unsuccessful. 1- completely dissatisfied
Polyclinic:	-	-	-	-
Therapist				
Pulmonologist				
Cardiologist				
Surgeon				
Oncologist				
Hospital				
LNC				
Examination by an ambulance doctor				

20. What recommendations have you received from your doctor on the positive aspects of a healthy lifestyle? (please fill in the table)?

Recommendation	What recommendation was given to you by your doctor? (+/-)	Are you following the recommendation? 1- Yes, always 2- On a case-by-case basis 3- I don't do it	The reason why you do not follow the recommendation			
			Financial difficulties	I don't think it's necessary	I forget	Another
Rational nutrition						
Physical activity						

21. What appointments have you received from a doctor (please fill in the table)?

Appointment	What appointment was given to you by your doctor? (+/-)	Are you following the appointment? 1- Yes, always 2- On a case-by-case basis 3- I don't do it	The reason why you do not follow the appointment			
			Financial difficulties	I don't think it's necessary	I forget	Another
Drug therapy						
Non-drug therapy (physiotherapy)						
Spa treatment						

22. Do you use any other methods besides the main prescriptions?

1) traditional medicine;

2) recommendations read on the Internet, magazines;

3) other _____

23. Have you received recommendations from a doctor about the need to lead a healthy lifestyle?

1) yes;

2) no.

24. Do you consider it necessary to adhere to the principles of a healthy lifestyle?

1) I think it is necessary;

2) I think it's important, but not the main thing in life;

3) this problem doesn't bother me..

25. If you consider it necessary to adhere to the principles of a healthy lifestyle, what prevents this?

1) lack of time;

2) financial difficulties;

3) lack of necessary perseverance, will, perseverance;

4) absence of conditions (specify which ones): _____;

5) other reasons (specify which ones): _____.

26. In general, would you rate your health status as:

1) Excellent;

2) very good;

3) Good;

4) mediocre;

5) bad.

27. How would you rate your health now compared to what it was a year ago?

1) significantly better than a year ago;

2) slightly better than a year ago;

3) about the same as a year ago;

4) slightly worse than a year ago;

5) much worse than a year ago.

28. How much do you think your illness leads to a restriction of activity?

Type of activity	does not affect	it has little effect	It has a strong effect
a) employment			
b) family relationships			
c) physical activity			
d) the psychological climate is disturbed			
e) other			

29. Are you often stressed?

1) Yes;

2) from time to time;

3) no.

30. Note the reasons that cause you stress:

1) financial difficulties;

2) problems in the team;

3) problems in the family;

4) loneliness;

5) other: _____.

31. What information about your disease are you missing?

1) There is enough information;

2) about the treatment;

3) other: _____

32. Are you satisfied with the attitude of doctors and nurses during your stay in a medical organization? Rate it on a 5-point scale, where: 1 – extremely bad; 2 – bad; 3 – satisfactory; 4 – good; 5 – excellent. Please put any icon in the appropriate table cell.

N	The work of doctors and nurses	1	2	3	4	5
1	Courtesy and attentiveness of doctors					
2	Courtesy and attentiveness of nurses					
3	Informing patients about planned treatment activities					
4	Prompt response of staff to patient complaints					

33. Are you satisfied with the quantity and quality of food during your stay at the medical organization?

1) completely satisfied;

2) partially satisfied;

3) rather not satisfied;

4) completely dissatisfied.

34. During your stay in the hospital, how often was there silence near your room at night?

1) always;

2) as a rule;

3) sometimes;

4) never.

35. Are you satisfied with the conditions of accommodation and stay in a medical institution?

1) completely satisfied;

2) partially satisfied;

3) rather not satisfied;

4) completely dissatisfied.

36. Would you recommend this medical organization to your friends and relatives?

1) Yes;

2) no;

3) I don't know yet.

37. Are you satisfied with the quality and completeness of the information available on the official website of the medical organization?

1) yes, completely;

2) more yes than no;

3) More no than yes;

4) not satisfied.

APPENDIX C

The act of implementation

Федеральное медико-биологическое агентство
Федеральное государственное бюджетное учреждение
«СЕВЕРО-ЗАПАДНЫЙ ОКРУЖНОЙ НАУЧНО-КЛИНИЧЕСКИЙ ЦЕНТР
ИМЕНИ Л.Г. СОКОЛОВА ФЕДЕРАЛЬНОГО
МЕДИКО-БИОЛОГИЧЕСКОГО АГЕНТСТВА»
(ФГБУ СЗОНКЦ им. Л.Г. СОКОЛОВА ФМБА РОССИИ)

УТВЕРЖДАЮ
Генеральный директор
ФГБУ СЗОНКЦ им. Л.Г. Соколова
ФМБА России
_____ В.М. Колабутин
«22» апреля 2024 г.

АКТ

о внедрении результатов диссертационного исследования
«Организация системы оказания медицинской помощи лицам, испытавшим воздействие ионизирующего излучения ядерных технологий»

«22» апреля 2024г. г. Санкт-Петербург

Комиссия ФГБУ СЗОНКЦ им. Л.Г. Соколова ФМБА России в составе: председатель В.А. Ратников, члены комиссии: В.П. Горелов, С.С.Москалева, Ю.В. Суворова, В.М.Василец провела оценку внедрения в практику результатов диссертационного исследования, выполненного Е.И. Першиной по теме «Организация системы оказания медицинской помощи лицам, испытавшим воздействие ионизирующего излучения ядерных технологий».

Комиссия установила:

– результаты диссертационного исследования, выполненного Е.И. Першиной по теме «Организация системы оказания медицинской помощи лицам, испытавшим воздействие ионизирующего излучения ядерных технологий», используются в клинической деятельности ФГБУ СЗОНКЦ им. Л.Г. Соколова ФМБА России, в частности, в специализированном стационаре профпатологии, в специализированном стационаре кардиологии, в специализированном высокотехнологичном стационаре;

– выполнено определение доминирующих диагнозов лиц, испытавших воздействие ионизирующего излучения ядерных технологий, на основе данных ретроспективного исследования первичной заболеваемости пациентов. Определено наличие преемственности в отношении 80% доминирующих диагнозов, определенных авторами исследования 2002 года (по данным медицинской литературы);

– впервые разработан алгоритм применения трехуровневой системы медицинского обслуживания для диагностирования и лечения лиц, испытавших воздействие ионизирующего излучения ядерных технологий;

– впервые проведен опрос ветеранов подразделений особого риска. Получены и обобщены данные по оценке ими качества медицинского обслуживания;

– впервые проведено анкетирование представителей прикрепленного контингента СЗОНКЦ им. Л.Г. Соколова ФМБА России. Получены и обобщены данные по оценке ими качества медицинского обслуживания и данные по выполнению ими рекомендаций здорового образа жизни;

– впервые разработана модель системы оказания медицинской помощи лицам, испытавшим воздействие ионизирующего излучения ядерных технологий, учитывающая клинические и социально-психологические аспекты функционирования.

Применение результатов диссертационного исследования, выполненного Е.И. Першиной, позволяет повысить качество оказания медицинской помощи лицам, испытавшим воздействие ионизирующего излучения ядерных технологий, с учетом клинического и социально-психологического аспектов, а также способствовать повышению качества жизни пациентов путем контроля соблюдения рекомендаций здорового образа жизни.

Председатель:
заместитель генерального директора
ФГБУ СЗОНКЦ им. Соколова ФМБА России –
медицинский директор — В.А. Ратников

Члены комиссии:
Главный врач — В.П.Горелов

Начальник научно-образовательного управления,
заведующая отделением рентгенохирургических
методов диагностики и лечения — Ю.В. Суворова

Заместитель медицинского директора
по амбулаторно-поликлинической
помощи – главный врач
Центральной поликлиники — С.С.Москалева

Руководитель Центра
Профпатологии — В.М. Василец

APPENDIX D

State registration of the database

РОССИЙСКАЯ ФЕДЕРАЦИЯ

ФЕДЕРАЛЬНАЯ СЛУЖБА
ПО ИНТЕЛЛЕКТУАЛЬНОЙ СОБСТВЕННОСТИ

RU2021621045

ГОСУДАРСТВЕННАЯ РЕГИСТРАЦИЯ БАЗЫ ДАННЫХ, ОХРАНЯЕМОЙ АВТОРСКИМИ ПРАВАМИ

Номер регистрации (свидетельства):
2021621045
Дата регистрации: 21.05.2021
Номер и дата поступления заявки:
2021620883 04.05.2021
Дата публикации и номер бюллетеня:
21.05.2021 Бюл. № 6
Контактные реквизиты:
нет

Автор(ы):
Першина Елена Игоревна (RU),
Добрецов Константин Григорьевич (RU),
Москалева Светлана Сергеевна (RU)
Правообладатель(и):
ФЕДЕРАЛЬНОЕ ГОСУДАРСТВЕННОЕ БЮДЖЕТНОЕ УЧРЕЖДЕНИЕ "СЕВЕРО-ЗАПАДНЫЙ ОКРУЖНОЙ НАУЧНО-КЛИНИЧЕСКИЙ ЦЕНТР ИМЕНИ Л.Г. СОКОЛОВА ФЕДЕРАЛЬНОГО МЕДИКО-БИОЛОГИЧЕСКОГО АГЕНТСТВА" (RU)

Название базы данных:
Данные анкетирования ветеранов подразделений особого риска с помощью авторского опросника

Реферат:
База данных отражает результаты опроса ветеранов подразделений особого риска, проведённого в 2020 году. База данных предназначена для получения статистической информации по структуре заболеваемости, по распределению категорий инвалидности, по удовлетворённости качеством медицинского обслуживания и по сопутствующим параметрам, относящимся к указанной категории граждан, с целью разработки методик дальнейшего улучшения качества оказания медицинской помощи. База данных может быть использована Министерством здравоохранения, организаторами здравоохранения и другими специалистами, имеющими отношение к описанной тематике. Тип ЭВМ: персональный компьютер. ОС: MS Windows 7 или более поздняя версия.

Вид и версия системы управления базой данных:	Excel
Объем базы данных:	47,5 КБ

APPENDIX E

Gratitude

ГОСУДАРСТВЕННО-ОБЩЕСТВЕННАЯ ОРГАНИЗАЦИЯ
"КОМИТЕТ ВЕТЕРАНОВ
ПОДРАЗДЕЛЕНИЙ ОСОБОГО РИСКА
РОССИЙСКОЙ ФЕДЕРАЦИИ"
ГУМАННОСТЬ. МИЛОСЕРДИЕ. ДОБРОТА. ВЗАИМОПОМОЩЬ.

БЛАГОДАРНОСТЬ

Комитет ветеранов подразделений особого риска
Российской Федерации
выражает искреннюю благодарность и признательность
за длительное и плодотворное взаимодействие
в целях медицинского обеспечения
ветеранов подразделений особого риска
Санкт-Петербурга и Ленинградской области

Першиной Елене Игоревне

Благодарим Вас, Елена Игоревна за добросовестное, ответственное
отношение к своему делу.
Добра и удачи Вам и Вашим сотрудникам!

Председатель Комитета,
капитан 1 ранга в отставке *А. Евсеев*

"Комитет ветеранов подразделений особого риска Российской Федерации"

APPENDIX F

Certificate of honor

ФЕДЕРАЛЬНОЕ ГОСУДАРСТВЕННОЕ БЮДЖЕТНОЕ УЧРЕЖДЕНИЕ
«ПЕТЕРБУРГСКИЙ ИНСТИТУТ ЯДЕРНОЙ ФИЗИКИ им. Б. П. КОНСТАНТИНОВА
НАЦИОНАЛЬНОГО ИССЛЕДОВАТЕЛЬСКОГО ЦЕНТРА «КУРЧАТОВСКИЙ ИНСТИТУТ»

ПОЧЕТНАЯ ГРАМОТА

НАГРАЖДАЕТСЯ

ПЕРШИНА
ЕЛЕНА ИГОРЕВНА

Заведующая профпатологическим отделением стационара
Врач-профпатолог
ГБУ СЗОНКЦ им. Л.Г. Соколова ФМБА России

За значительный вклад в сохранение и восстановление здоровья сотрудников НИЦ «Курчатовский институт» - ПИЯФ и в связи с Днем медицинского работника

Директор С.Е. Горчаков

г. Гатчина
15 июня 2023 г.