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## Telemedicine in the Arctic zone of Russia

**Abstract.** Russia is simultaneously carrying out two breakthrough projects: transition to digital health and the development of the Arctic zone. An unrestricted solution to these problems is the integrated use of telemedicine system solutions, technologies, stationary and mobile equipment. The relevant decisions are adapted to the specific living conditions of different groups of the population in the Arctic zone.

**Key words:** digital healthcare, telemedicine system solutions, stationary and mobile telemedicine equipment, population groups in the Arctic zone, economic efficiency

**JEL codes:** I11, I15, I18

### Introduction

Over the past year and a half or two years, the state policy has undergone drastic changes aimed at creating a modern healthcare system in the Arctic zone of Russia. One of the main tools for implementing this program is the use of information technologies and, first of all, telemedicine systems, technologies, stationary and mobile equipment.

This is connected with the adoption of strategic decisions on the development of the “digital economy” and its most important component of “digital health” [Andreeva, Natenson, 2017], the adoption of the Federal Law of July 29, 2017 No. 242-FL “On Amending Certain Legislative Acts of the Russian Federation on the Application of Information Technologies in the Area of Health Protection” (“telemedicine law”) [Federal Law..., 2017; Order of the Ministry of Health..., 2017], the development of the “Strategy for the Development of Healthcare of the Russian Federation for the period until 2025”, the inclusion of the “Development of Healthcare” section in the first place in the “List of State Programs of the

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Russian Federation, including pilot programs, which form sections and/or provide summary information on the priority development of priority territories” in the Decree of the Government of the Russian Federation of November 25, 2017 No. 2620-r [Strategies for the development ..., 2017].

To further unambiguously unified understanding of the matters under discussion, it is necessary to cite the definition of telemedicine that is used in this article. Given the complex nature of telemedicine and its transboundary nature, we will use the definition of telemedicine given in the “Memorandum on Cooperation of CIS Member States in the field of creating compatible national telemedicine consulting and diagnostic systems” signed by the Heads of Government of the CIS Member States on November 14, 2008 in Chisinau (Republic of Moldova). This is the first document in world practice in the field of telemedicine signed by the Heads of Government of an entire region, which allows harmonizing the legislation of the CIS countries and ensuring the legitimacy of cross-border telemedicine consultations between the CIS countries.

Telemedicine is a complex of organizational, financial and technological measures that ensure the activity of a remote consulting and diagnostic medical service system in which a patient or a doctor directly examining or treating a patient receives remote advice from another specialist using modern information and communication technologies.

### **Analysis of the demographic situation in the Arctic zone and methods of creating a modern healthcare system in the region**

Russia and other countries of the Arctic zone certainly belong to countries with developed, constantly modernized healthcare systems, and yet these countries face similar problems in providing medical care and social services in the polar and circumpolar territories for local and migrant workers.

The features characterizing the Arctic zone are a huge territory, severe climatic conditions, extremely low population density в certain (mainly non-urban) territories, the presence of nomadic population, shift work organization in industrial enterprises and enterprises of the oil & gas complex. Lack of transport infrastructure makes it practically impossible to use traditional methods of providing medical and social services to the population built on the hierarchical structure of inpatient health facilities.

Living in extreme conditions of the Far North negatively affects the health of the resident population and the population working on a rotational basis, as evidenced by numerous studies [Kvashnina,2001; Khamnagadayev, 2008; Alekseev, 1984; Alekseev et al., 1989; Panin et al., 1986; Astakhova, 1981; Ivanov, 2006] on the increase in the incidence of the cardiovascular system, gastrointestinal tract, nervous system, endocrine system, frequency of avitaminosis, immunodeficiency states, infectious diseases among the population in this region. For the “shift”

population, an additional load is the periodic change in climatic conditions and the need for the organism to adapt to these conditions.

The creation of modern industrial enterprises, high-technology complexes of the oil & gas complex, infrastructure of the Northern Sea Route requires the involvement of specialists from other regions of Russia and foreign specialists. This is typical for all countries of the Arctic region.

The deterioration of the health of non-indigenous peoples is observed practically in all countries of the Arctic basin [Kvashnina, 2001]. In a number of the most northern districts of the region, 50% of the labor-age population get diagnosed with pathological deviations of health. Thus, arterial hypertension affects up to 47% of the adult European population living in the regions of the Far North, while the prevalence of this pathology in the mid-latitudes is 20% [Khamnagadayev, 2008].

There exists direct correlation between the state of health of non-indigenous people and the duration of their stay in the regions of the Far North was confirmed. Among the newcomers living in the extreme North for 10 years or more, the number of “conditionally healthy” people does not exceed 25%. Among the others, 31.6% have a disorder of cholesterol metabolism, 38.5% have stable arterial hypertension and profound changes in the heart muscle. Due to work in extreme conditions, pathology of respiratory organs and the gastrointestinal tract is growing, and the phenomena of asthenia occur more frequently [Khamnagadayev, 2008; Alekseev, 1984; Alekseev et al., 1989].

At the same time there is a deterioration in the health status of the indigenous population. However, the nature and causes of pathological changes are different for aboriginal and migrant populations.

It is possible to adequately assess the influence of different factors on the health of the population of the North and in the Arctic only by a comprehensive analysis and systematization of the available experience and knowledge. Simultaneously, for successful implementation of practical recommendations, it is necessary to conduct demonstration and pilot projects with a subsequent synthesis of their results for use by the countries of the Arctic region, since the problem of preserving the health of indigenous population and newcomers in the Far North is common to all countries in the circumpolar region. The problems of providing high-quality medical assistance is similar for the nomadic Sami people living in northern Sweden, Norway and Finland, the Eskimos of Alaska and northern regions of Canada.

Taking into account all of the above mentioned, four important areas should be identified in the organization of medical and social services for residents of the North, Siberia and the Far East:

1. small indigenous peoples,
2. population of rural, remote and hard-to-reach areas,
3. personnel of industrial and infrastructural facilities,

4. temporary communities of builders creating new industrial and infrastructure facilities, especially in the zone of the Northern Sea Route.

The solution of the formulated tasks is the “Integrated telemedicine system for protecting health and social services for the population living and working in the Far North and the Arctic regions” project [Natenzon, Tarnopolskiy, 2006; 2008; Natenzon, 2012; 2014] (Picture 1).

### **Description of the proposed innovative model of medical services for the population**

To economically ensure the social development of the Arctic regions of the Russian Federation, including medical care for the Northern Sea Route, it seems reasonable to create an integrated telemedicine system (hereinafter referred to as ITS) in these areas.

The proposed ITS consists of two parts: a network of stationary telemedicine consultation and diagnostic centers installed in medical institutions of port cities and large settlements in the Arctic coast areas, and an infocommunication-related system of mobile telemedicine laboratory and diagnostic complexes (MTCs) for various purposes. MTCs are intended for the decision of a wide spectrum of medical problems and rendering of social services to the population in remote and hardly accessible areas, including crews and service personnel of the Northern sea way. Built on international standards, the ITS integrates with similar systems in other regions of Russia, interacting with telemedicine systems of other countries.

The main goal of the ITS is to solve four socially important tasks:

- ensuring the availability of medical and social services to the personnel of the Northern Sea Route and the population in the Arctic regions of Russia;
- ensuring an equally high quality of medical and social services to people regardless of their location and social status;
- optimization of expenditure on healthcare, while improving its quality and coverage;
- creation of permanent jobs for highly qualified technical and medical personnel, ensuring the creation and operation of the ITS.

The key element of the ITS is mobile telemedicine laboratory-diagnostic complexes designed to provide medical examinations, diagnostics and treatment of basic nosologies in rural, remote and hard-to-reach areas, as well as to transmit medical information to inpatient facilities via satellite communication (Picture 2 and 3).

The technological basis of MTC is the infocommunication system of three mobile telemedicine laboratory-diagnostic complexes of various specializations, a stationary telemedicine consulting and diagnostic complex (STC) and a vehicle used to service and change the crews of MTCs and other auxiliary tasks to ensure the functioning of MTCs.



Equipment of MTCs with medical equipment and software fully complies with the requirements of Order No. 869n of October 26, 2017 of The Ministry of Health of the Russian Federation “On approval of the procedure for clinical examination of certain groups of adults”;. The medical and management data of the patients served at MTCs, in accordance with the requirement of order No. 869n of the Ministry of Health of the Russian Federation, are transmitted directly on-line to doctors in on-line hospitals at inpatient medical institutions of various levels, to which the MTC is assigned.

Taking into account the huge length of the sea coasts of the Arctic zone and the location of the settlements along the banks of the rivers flowing into the Arctic Ocean, advance designs of families of sea and river ice class hospital ships have been developed. An ice class hospital is designed for a one-time hospitalization of up to 400 patients with the provision of all necessary medical services in the polar zones, and is a unique project in the world.

The vessel is equipped with laboratories, surgery departments, independent air conditioning and air purification systems, a quarantine department (Picture 4).

The cargo deck of the ship is intended for the transport of several mobile telemedicine complexes, transport and trucks, an air cushion ship for transporting telemedicine complexes to hard-to-reach mainland regions of the Arctic region, helicopters and/or seaplanes.

The vessel provides all conditions for residing and resting of the personnel of the hospital and crew of the vessel.

The presence of 3-4 vessels of this class in the Arctic zone of Russia and distributed along the Northern Sea Route can play a significant role in creating a modern infrastructure for servicing the functioning of the Northern Sea Route and the industry for developing the natural resources of the Arctic zone.

This family of ice-class medical vessels with telemedical functions will enable providing high-quality medical care to the teams of infrastructure builders and industrial enterprises in the Arctic economically, and after the construction is over, when the construction team is radically reduced and replaced by a much less numerous team of maintenance personnel, the ships can be relocated to a new construction site. The same medical services will be provided by inpatient medical institutions, with a capacity corresponding to the size of the settlement with the enterprise.

A similar socially and economically effective solution is proposed for the local population and employees of enterprises living and working along river banks. For year-round quality medical care, it is proposed to use a family of river hospital ships and coasting vessels with telemedicine functions. These specially designed vessels are equipped with all necessary medical equipment and provide high-quality working and living conditions for medical and technical personnel. They are also umbrella ships for mobile telemedicine laboratory and diagnostic complexes, primarily for mass medical examination and primary medical care for the population in remote and hard-to-reach areas. In summer, vessels

serve residents of settlements along river banks, and MTCs serve people living away from the coast. In winter, hospital ships are based in the wrecks of large settlements, and MTCs continue to provide medical assistance on winter roads.

### **Rationale for the economic efficiency of integrated telemedicine systems**

An example of the economic effectiveness of telemedicine technologies can be the use of mobile telemedicine complexes for early diagnosis of breast cancer, the most common cancer among the rural population of the Tver region [Rumyantseva et al., 2006].

The mobile telemedicine complex, which operated in the Tver Region on the basis of the regional oncological dispensary, provided the following opportunities:

- The possibility of a one-stage complex examination of women (mammology, gynecology, laboratory research, ultrasound, functional diagnostics),
- The general availability of preventive examinations by conducting surveys directly at the place of residence and work of patients,
- A high level of diagnostics due to special software and telemedicine consultations with hospital specialists,
- Planned arrival of patients in medical institutions,
- Early diagnosis of the disease and optimization of treatment costs.

The last point requires a special explanation. Medical statistics show that the cost of treatment of an oncological patient in the early stages of the disease is much cheaper than in the later stages, and the likelihood of avoiding death is much higher. It is clear that as MTCs are regularly used, the proportion of detection of oncological patients with advanced stages will decrease and, in the long term, we will detect oncology only at early stages, which, at such volumes of clinical examination, will save tens of millions of rubles per year on treatment only according to the results of the work of one MTC, which provides medical care to 20,000 women per year, which, in terms of the entire female population of Russia, means almost half a million of rescued women and tens of billions of rubles in savings for their treatment.

The combination of mobility, telemedicine technologies and equipment, the complexity of the survey is the tool that enables solving these problems.

### **The model in the context of the state policy of creating a modern model of healthcare**

The basis for the phased implementation of the project are the following documents of the Administration of the President of Russia, the Government of Russia and intergovernmental documents of Russia:

1. “Agreement on the cooperation of the CIS member states in the creation of compatible national telemedicine systems and their further development and use”, signed on November 19, 2010 in St. Petersburg by the Heads of Government of the CIS countries (behalf the Russian Federation, Chairman of the Government of the Russian Federation V. V. Putin);
2. The project of a compatible integrated national telemedicine system of the Russian Federation is included in the Action Plan for the implementation of the second stage (2012–2015) of the Strategy for Economic Development of the Commonwealth of Independent States for the period until 2020 (paragraph 2.5.1.2.), Approved by the Decision of the Council of Heads of Government of the Commonwealth of Independent States of October 18, 2011 in St. Petersburg;
3. Order of the Government of the Russian Federation ISh-P2-7852 of November 9, 2011 to federal executive bodies and organizations to ensure the implementation of the Plan;
4. Order of the Government of the Russian Federation No. 1906-r of 12.10.2012 on approval of the Action Plan for the implementation in 2012–2015 of the Concept of Sustainable Development of Indigenous Peoples of the North, Siberia and the Far East of the Russian Federation. Paragraph 9 and item 10 of section III “Creating conditions for improving the demographic indicators of indigenous peoples of the North, Siberia and the Far East of Russia” of the Action Plan provides for the establishment of a network of telemedicine centers in inpatient facilities and the use of mobile medical and social complexes for serving the population, with indication of the sources of finance;
5. The “Strategy of social and economic development of the Far East and the Baikal region for the period until 2025”, “Strategy of social and economic development of Siberia until 2020” and “Transport strategy until 2030” programs. The main instrument for implementing the strategy are federal targeted programs — “Economic and social development of the Far East and Transbaikalia until 2013”, as well as “Development of the transport system of Russia until 2015”;
6. Programs “Social and Economic Development of the Kuril Islands”; and “Economic and Social Development of the Far East and the Baikal Region until 2018”;
7. Items 2, 3, 4 of the President’s instructions on the implementation of the President’s Address to the Federal Assembly of May 12, 2016;
8. Federal Law of July 29, 2017 No. 242-FL “On Amending Certain Legislative Acts of the Russian Federation on the Application of Information Technologies in the Area of Health Protection”;
9. Order of the Ministry of Health of Russia of November 30, 2017 No. 965n “On approval of the order of organization and provision of medical assistance using telemedicine technologies”;

10. Plan of measures for the implementation of the Strategy for the socio-economic development of the Volga Federal District for the period until 2020, approved by the Government of the Russian Federation on February 7, 2011, No. 165-r;
11. Order of the Government of the Russian Federation No. 1906-r of 12.10.2012 on approval of the Action Plan for the implementation in 2012-2015 of the Concept of Sustainable Development of Indigenous Peoples of the North, Siberia and the Far East of the Russian Federation;
12. Documents of the G-8 meetings. The project of the Russian SPO “National Telemedicine Agency” of the telemedicine system SCAESNET (Satellite Communication AntiEpidemic Screening NETwork) formed the basis for the joint initiative of the President of the Russian Federation V. V. Putin and Prime minister of Italy S. Berlusconi on the use of information technology in healthcare in the developing countries of Africa, supported by the G8 summits in Evian in 2003 (G8 Health Action Plan) and in St. Petersburg in 2006;
13. The “e-Health” Resolution, adopted at the 58th session of the World Health Organization on May 25, 2005 (WHA 58.28), which calls on all countries to develop information and communication technologies in the field of medicine and expand e-health services for human health;
14. UN document “Goals for the Millennium”. Recommendations for the United Nations from the International Telecommunication Union, developed by the Working Group on Telemedicine, on the application of digital healthcare technologies for the implementation of the “Goals of the Millennium”.

Considerable attention is paid to social and medical services for the population in numerous documents of the Subcommittee on Affairs of the North and Small Peoples of the Council of Federation Committee on the Federal Structure, Regional Policy, Local Self-Government and the Affairs of the North.

The gradual implementation of such a global infrastructure and system-forming innovative project [Natenzon, Melersanov, 2017] for ensuring livelihood and production is determined by the very essence of the Arctic doctrine, which will involve a huge amount of human resources, possibly a serious migration of population to the Northern regions. The complex telemedicine system is specifically oriented to autonomous year-round work in remote and hard-to-reach areas with low population density, in complex geographic and climatic conditions.

## Expected results

The proposed system solutions, technologies and equipment based on the use of infocommunication technologies, mobility and inpatient substitution ensure

the creation of an economically optimal, effective healthcare infrastructure and social services for the working and non-working population, including children.

The Integrated Telemedicine System should play a special role in protecting Russia's national interests in the Arctic, ensuring the development of unique deposits on the Arctic Ocean shelf. It is not without reason that the first telemedicine systems were developed and applied to ensure the effective work of offshore drilling personnel in the North Sea.

Ensuring the safety and health of the population, increasing the social security of the indigenous population in such a vast territory with the harshest climatic conditions, on which millions of Russian citizens still live, the traditional methods of building and maintaining inpatient medical centers require enormous financial costs and unacceptably long time for construction.

## Conclusion

The proposed medical and social infrastructure system is of particular importance in ensuring the interests of the Russian Federation in the resource-rich Arctic region, the rights to which many countries now claim. Success in this economic and political competition of different countries will be determined by facts, including who will be the first to build a system of effective infrastructure support for the development of the region with severe climatic and geographical conditions.

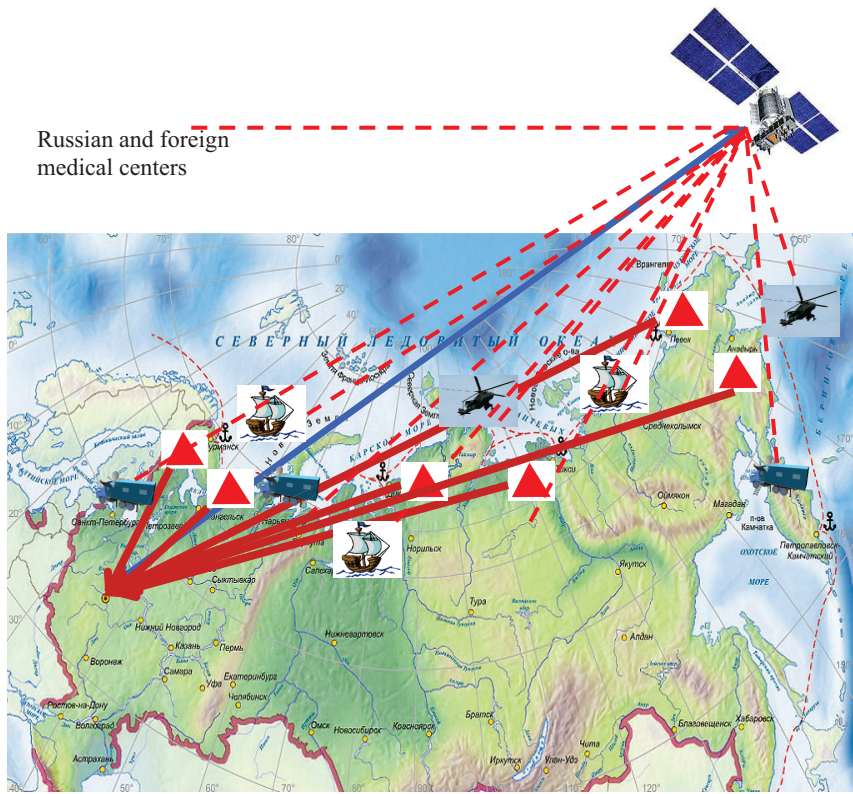
The system has no analogues in the world, as evidenced by eight patents and recognition of the international community, including the documents of the G8 Summits, the CIS Executive Committee, NATO, the International Telecommunication Union, the World Health Organization, etc.

The system has a high export potential and can be successfully disseminated in Canada and the US, as well as in Scandinavian countries through the mechanisms of international organizations of northern countries.




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Acronyms:

-  Stationary telemedicine centers
-   Mobile Telemedicine Complexes

**Figure 1.** Scheme of the pilot segment of the Integrated telemedicine system for medical support of the Northern Sea Route and the Arctic regions of the Russian Federation



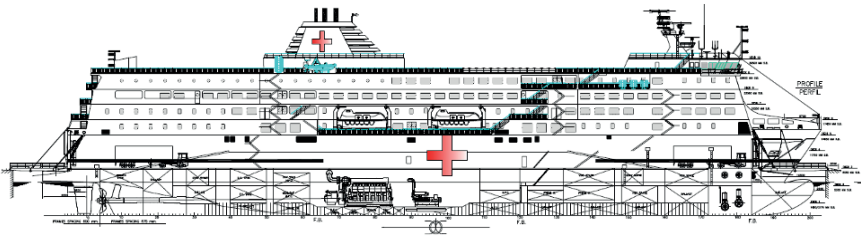


**Picture 2.** Appearance of mobile telemedicine laboratory and diagnostic complex



**Picture 3.** Digital diagnostic equipment for a mobile telemedicine complex





**Picture 4.** Telemedicine hospital sea-craft for rendering of medical services to the population