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## FUNCTIONING PRINCIPLES OF THE NETWORK OF BIOLOGICAL RISK MONITORING OF THE FEDERAL MEDICAL AND BIOLOGICAL AGENCY OF RUSSIA

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**Introduction.** The activity aimed at biological risk monitoring (BRM) ensures timely response against emerging biological threats in order to prevent their negative impact on human health. The improvement and further development of the existing network of BRM of the Federal Medical and Biological Agency (FMBA) of Russia requires understanding of its functioning principles.

**Objective.** Substantiation of the functioning principles of the BRM network in the entitled territories and organizations of the FMBA.

**Materials and methods.** The study was conducted using the automated information system of the FMBA Center for BRM, which aggregates BRM data from the territories and organizations serviced by FMBA. The methods of systems analysis, reverse engineering, classical logic, analysis, synthesis, comparison, generalization, categorization, and classification were used.

**Results and discussion.** A comprehensive study of the operating BRM network of FMBA was conducted. Its aims, objectives, functions, characteristics, and activities were examined. Using the method of reverse engineering, 19 key principles of the BRM network were substantiated. These principles were classified based on stratification of classes according to the types of activities that ensure the BRM network functioning as a complex organizational system. As a result, the principles were distinguished into informational and technological, organizational and managerial, and scientific and practical classes.

**Conclusions.** The functioning principles of the MBR network in the territories and organizations serviced by the FMBA were identified, formulated, substantiated, and classified. These include the use of the systems approach, the principle of continuous monitoring and reporting, the principle of comprehensive information and analytical support, etc. The results obtained can be used as the basis for decision making when optimizing the technology of BRM monitoring by FMBA.

**Keywords:** biological safety; biological risk monitoring; network functioning principles; biological risk monitoring network; systems approach

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## ПРИНЦИПЫ ФУНКЦИОНИРОВАНИЯ СЕТИ МОНИТОРИНГА БИОЛОГИЧЕСКИХ РИСКОВ НА ТЕРРИТОРИЯХ И В ОРГАНИЗАЦИЯХ, ОБСЛУЖИВАЕМЫХ ФМБА РОССИИ

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**Введение.** Мониторинг биологических рисков (МБР) обеспечивает своевременное реагирование на возникающие биологические угрозы и предотвращение их негативного воздействия на здоровье человека. Для совершенствования и развития сети МБР ФМБА России необходимо знание и понимание принципов его функционирования.

**Цель.** Научное обоснование принципов функционирования сети МБР на территориях и в организациях, обслуживаемых ФМБА России.

**Материалы и методы.** Информационной платформой для исследования послужила автоматизированная информационная система Федерального информационно-аналитического центра мониторинга биологических рисков ФМБА России (ФИАЦ ММБР ФМБА России), агрегирующая данные МБР на территориях и в организациях, обслуживаемых ФМБА России. Исследование построено на применении научных методов системного анализа, обратного инжиниринга, классической логики, анализа, синтеза, сравнения, обобщения, категоризации и классификации.

**Результаты и их обсуждение.** Проведено всестороннее исследование действующей сети МБР ФМБА России. Рассмотрены и детально проанализированы цель, основные задачи, функции и направления деятельности созданной сети МБР, ее свойства, характеристики и особенности. На основании применения метода обратного инжиниринга обоснованы 19 ключевых принципов работы сети МБР. Разработана и представлена классификация перечисленных принципов, основанием для которой послужил признак разделения на классы по видам деятельности, обеспечивающей функционирование сети МБР как сложной организационной системы. В результате выделено 3 класса принципов: информационно-технологической, организационно-управленческой и научно-практической направленности.

**Заключение.** По результатам проведенного исследования были определены, сформулированы, обоснованы и классифицированы принципы функционирования сети МБР на территориях и в организациях, обслуживаемых ФМБА России. Среди них: системный подход, принцип непрерывности мониторинга и представления его результатов, принцип комплексности информационно-аналитического обеспечения и некоторые другие. Научное обоснование ключевых принципов, базирующееся на результатах исследования

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процессов функционирования сети мониторинга, будет способствовать выработке предложений по оптимизации и совершенствованию технологии мониторинга биологических рисков ФМБА России.

**Ключевые слова:** биологическая безопасность; мониторинг биологических рисков; принципы функционирования сети; сеть мониторинга биологических рисков; системный подход

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## INTRODUCTION

At present, the issues of biological safety are acquiring a greater importance and relevance. According to the experts of the Federal Medical and Biological Agency (FMBA) of Russia [1], the objective need to create an effective biosafety system is determined by the growing biological threats posed by various types of infections caused by pathogenic and opportunistic microorganisms (e.g., *Flavivirus*, SARS-CoV-2, MERS-CoV, and Ebola viruses), as well as ESKAPE pathogens (a group of multi-drug resistant bacteria, mostly responsible for nosocomial infections — *Enterococcus faecium*, *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Acinetobacter baumannii*, *Pseudomonas aeruginosa*, *Enterobacter spp.*). The antimicrobial resistance of these microorganisms has increased dramatically, having reached pandemic proportions [2, 3].

FMBA is responsible for the health and sanitary-epidemiological well-being of employees in more than 730 organizations with highly hazardous working conditions, including radiation, chemical, and biological risks. The FMBA provides support to more than 3.3 million people residing and working in 20 closed administrative-territorial entities, 39 satellite cities, and science cities in 59 Russian regions and on the territory of the Baikonur complex. FMBA is responsible for ensuring the biological safety and security of the personnel in the government-approved list of territories and organizations (referred to as entitled territories and organizations).

Activities in the field of biological risk monitoring (BRM) are aimed at timely response to emerging biological threats in order to prevent their negative impact on human health, including the following:

- identification, analysis, prediction, evaluation, and biological risk ranking based on unified criteria approved by the Russian government;
- accumulation of data and its implementation to assess the effectiveness of measures aimed at ensuring biological safety;
- development of measures to prevent and reduce biological risks, improve the protection of the population

and the environment from the effects of dangerous biological factors, and mitigate biological threats.

In order to address these problems, the FMBA of Russia has established a BRM network, which has been operating since January 2022 in the entitled territories and organizations.

The growing amount of biological threats and the associated health risks determine the importance of analyzing the processes and functioning principles of the FMBA BRM network with the purpose of its optimization and further development based on the evidence-based approach. There is a lack of research studies that would substantiate the functioning principles of BRM technologies in general and the BRM network operated in the entitled territories and organizations of FMBA. These circumstances determine the relevance and novelty of this study.

In this article, we set out to develop a scientific basis for the functioning principles of the network of biological risk monitoring in the entitled territories and organizations of the FMBA of Russia.

## MATERIALS AND METHODS

The study was based on Russian and foreign publications in peer-reviewed scientific journals presented in electronic bibliographic databases in the Russian (eLibrary, CyberLeninka) and English languages (Web of Science, Scopus, PubMed, Google Scholar, Cochrane Library).

The FMBA database “Regulatory Legal Acts of Radiation, Chemical and Biological Monitoring” and the regulatory legal documents of the BRM network database (FMBA) were used to analyze the content of legal documents. The automated information system of the FMBA Center for BRM, which aggregates data on biological risks monitoring in the entitled territories and organizations of FMBA, served as the information platform for the study.

The study was conducted using the methods of systems analysis and reverse engineering [4], as well as general scientific methods, including classical logic, analysis, synthesis, comparison, generalization, categorization, and classification.

## RESULTS AND DISCUSSION

The processes and operations of the FMBA BRM network were studied based on the data provided by the FMBA Information Analysis Center. The aims, objectives, functions, and activities of the established MBR network, as well as its properties, characteristics, and features, were thoroughly examined. In total, 19 key principles of the BRM network were identified, formulated, and justified. The FMBA BRM network is a complex organizational system, which functions based on operating principles.

### Principle of the network architecture of biological risk monitoring

The organizational architecture of biological risk monitoring in the entitled territories and organizations of FMBA is a geographically and functionally distributed network of governmental institutions participating in the BRM network, consisting of subordinate medical organizations (177); microbiological research organizations (56); blood supply service institutions (17); territorial authorities (63), and other institutions of the FMBA of Russia (5) (Fig. 1).

As of today, the BRM network comprises 318 FMBA organizations, including six reference centers based at leading research and medical FMBA organizations, two of which have a federal status. Since January 1, 2022, the FMBA has established the Biological Risk Monitoring Information Analysis Center, which serves as the coordinating authority (coordinator) of the BRM network.

The FMBA BRM Information Analysis Center solves the following tasks:

- activity coordination of the BRM network within the established FMBA scope;

- collection and processing of information about biological threats in the entitled territories and organizations, as part of: medical activity; federal state epidemiological surveillance (supervision); state control (oversight) over the safety of donor blood and its components;
- continuous monitoring of biological risks using the information resources of the FMBA BRM Information Analysis Center, including identification, analysis, forecasting, evaluation, and biological risk ranking in accordance with unified criteria;
- prompt reporting to the FMBA management on the identified biological threats in the entitled territories and organizations;
- resource support monitoring of the FMBA medical organizations for carrying out diagnostic, preventive, medical, and rehabilitation measures in the event of biological threats in the entitled territories and organizations.

The structure of the Center includes two administrations: data collection and analysis, forecasting and assessment of biological risks. Taking into account the specifics of their activity, the following structural units have been formed (Fig. 2). Thus, the principle of BRM network architecture is implemented.

### Principle of prioritization of compliance with the intended purpose

This principle is determined by the FMBA priority of protecting human life and health. The main purpose of establishing the network of biological risk monitoring was to create a reliable mechanism for monitoring biological risks in the entitled territories and organizations of FMBA, in accordance with Federal Law No. 492-FZ<sup>1</sup> and the relevant Decree of the Russian government.

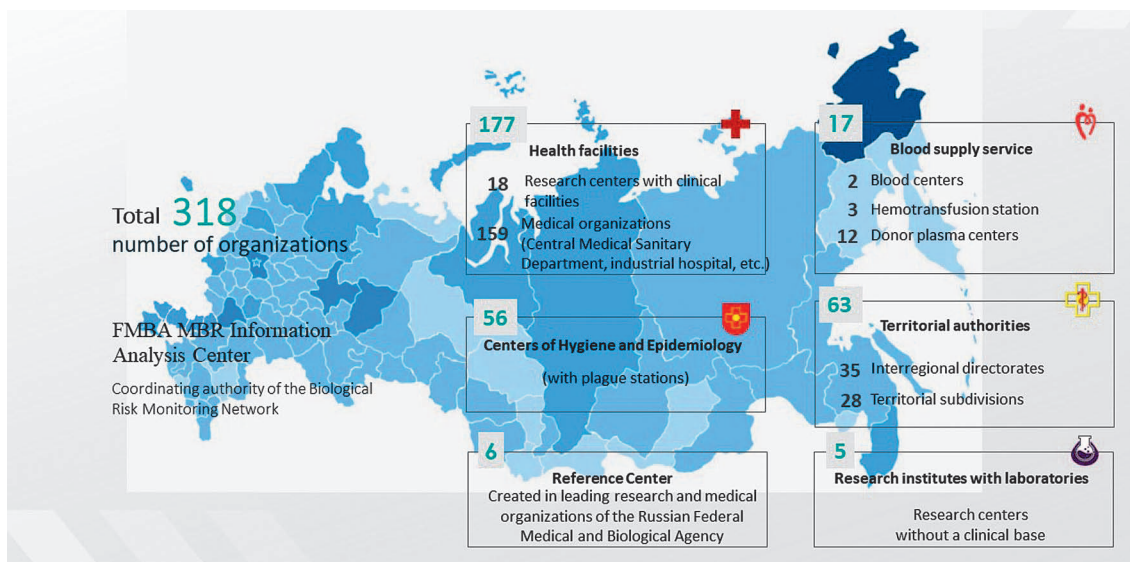


Figure prepared by the authors

**Fig. 1. FMBA Biological Risk Monitoring network**

<sup>1</sup> Federal Law No. 492-FZ dated 30.12.2020, "On Biological Safety in the Russian Federation".

Therefore, the main purpose underlying the organization of the BRM network was to ensure the biological safety of the FMBA personnel. In this regard, the principle of compliance with the intended purpose, or the target purpose principle, has been identified as one of the main functioning principles of the BRM network. All network activities are subordinated to this main purpose, which is given absolute priority: ensuring the biological safety of the FMBA work force, as well as protecting the environment from the effects of hazardous biological factors.

### Principle of relying on a regulatory framework

Currently, the FMBA have developed regulatory legal acts that govern the process of biological risk monitoring in its entitled territories and organizations. The legal basis for the creation and operation of the BRM network is the Federal Law<sup>2</sup>, Russian Federation Presidential Decree<sup>3</sup>, Decrees of the Russian Government, departmental regulatory legal acts.

At present, the database of regulatory legal documents, created in the FMBA BRM Information Analysis Center, comprises 69 documents regulating the BRM network activities. These include Federal laws of the Russian Federation, Russian Federation Presidential decrees, resolutions and executive orders of the Government of the Russian Federation, departmental orders and instructions of the FMBA, departmental orders of the Ministry of Health of Russia, Sanitary Rules and Regulations, National State Standards, orders and instructions of the Centre for Strategic Planning of the FMBA, recommendations, instructions and methods of the FMBA MBR Information Analysis Center.

The current regulatory legal framework is the legal foundation for implementing state regulation measures in the field of ensuring biological safety and countering biological threats. This foundation determines the legal regulation of relations in the field of establishing, applying, and enforcing mandatory requirements for biological safety, including BRM, in the prevention and occurrence of natural and man-made dangerous biological situations of internal and external (cross-border) origin caused by natural and anthropogenic factors, as well as bioterrorist acts [5]. Thus, another essential principle of the MBR network is that of relying on a regulatory framework, or the regulatory regulation principle.

### Principle of systems approach

This principle implies considering the BRM network as a system that combines a holistic set of interconnected elements [6]. The BRM network has the characteristics of a complex specialized organizational system, including the following:

- holism (the dependence of each element on its place within the overall network “organism”);
- primacy of the whole (subordination of the purposes of local elements to the main purpose of the entire system);
- connectivity (the presence of intra-system relationships between elements, including horizontal and vertical connections);
- structural properties (the ability to represent a system through the structure of connections and relations between elements);

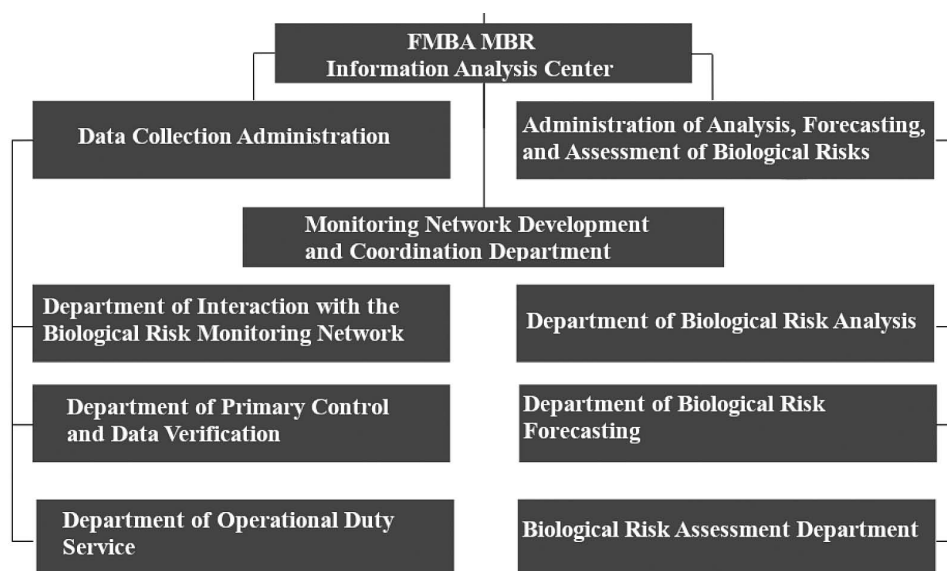


Figure prepared by the authors

**Fig. 2. Structure of the FMBA Biological Risk Monitoring Information Analysis Center**

<sup>2</sup> Federal Law No. 492-FZ dated 30.12.2020, “On Biological Safety in the Russian Federation”.

<sup>3</sup> Russian Federation Presidential Decree No. 97 dated 11.03.2019, “On the Fundamentals of the Russian Federation State Policy in the Field of Chemical and Biological Security for the Period up to 2025 and Beyond”.

- hierarchy/mono-centricity (subordination of the structural elements to a coordinator — FMBA BRM Information Analysis Center);
- synergy (functioning of interconnected elements such that generating qualitatively new properties of the system, which are not a mere sum of the properties of its elements) and some others.

The systems principle allows not only assessment of the integrity of the study object and the connections between its elements, but also determination of the sources and vectors of its development [7].

The formation of the BRM network as a system that functions both in planned and emergency modes required the determination of the object of this system's activities and the methodological approaches necessary for developing its multi-level, hierarchically subordinate structural and functional organization of elements covering the relevant functional spectrum of FMBA in the field of biological safety. A detailed analysis of the BRM network activity as a system is the subject of a separate study, which should include, among other things, the study of its properties, characteristics, and features, as well as the system's connections with the external environment.

### **Principle of continuous monitoring and its results reporting**

The purpose-oriented activity of the BRM network, regulated by relevant legal documents, determines its continuous operation to implement its main tasks and ensure the biological safety of FMBA personnel. The geographical distribution of the entitled organizations and territories of the FMBA of Russia, which covers many time zones, necessitates the provision of round-the-clock data collection and processing, including continuous monitoring, screening, indication, identification, data verification, and etiological diagnostics of the quantitative and qualitative state of dangerous biological factors and risks to human health, including taking into account long-term negative consequences for the present and future generations.

An important component is the provision of timely information, presentation to consumers of the results of analysis and forecasting of biological threats and risks, operational analytical and forecast information for the organization of work to prevent, neutralize, or eliminate threats and risks to health [8]. Information users are the departments and management staff of the Centre for Strategic Planning of the FMBA of Russia, the interested agencies, the state information system in the field of ensuring biological safety (GIS BB). The main principle in this area of work is the principle of continuous monitoring and reporting of results.

### **Principle of interconnectedness of information flow management and data aggregation**

Data aggregation is the process of combining and summarizing data from disparate sources into a single data set. The aggregation process prepares data for analysis, making it easier to understand the patterns of information flow [9].

The main tool of the FMBA BRM Information Analysis Center is its information system (IS), which is used for aggregation — collection and processing of data on biological threats and risks and formation of a single set of data. Currently, more than 3500 users are connected to the BRM IS. To date, the FMBA BRM Information Analysis Center is equipped with a modern powerful computing complex, which includes server equipment, memory blocks for data storage, high-speed communication channels. The existing computing complex allows achievement of the main tasks of BRM in the entitled territories and organizations of FMBA. It also allows for collecting and verifying any type of data.

Currently, the FMBA BRM Information Analysis Center receives data in four information streams. The first stream includes the submission of information by medical organizations based on the results of laboratory tests. The second stream includes data submitted by medical organizations based on the nosology of patients, including initial data. The third stream allows for the aggregation of data based on confirmed diagnoses through hygiene and epidemiology centers. The fourth stream includes information about identified outbreaks of infectious diseases and the respective measures taken.

The development of information technologies has led to a sharp increase in the speed and volume of data transmission. The structure of information exchange is changing significantly. The processes of data aggregation and information flow management require continuous technological monitoring, including their control and analysis, as well as the optimization of information streaming and aggregation.

### **Principle of complex automation of information processes and systems**

Automation of information and technological processes and systems is the introduction and use of advanced information technologies and technical means that perform tasks and operations without direct human intervention [10].

The automation of the BRM network aims to solve the following tasks:

- reduction of monotonous routine work through the introduction of technologies for data replication, transmission, and interconnection, as well as the ability to automate and solve simple and complex tasks;

- expansion of the information and analytical capabilities of specialists, analysts, and managers through the creation of automated workplaces, the rapid and scientific processing of large and diverse data, including the use of artificial intelligence, neural networks, and hybrid methods;
- the ability to remotely obtain and share information, and to interconnect data from different sources;
- identification of the logic behind violations of sanitary rules and regulations.

Comprehensive automation includes the standardization and unification of equipment and software, the rational integration of information technologies into the existing workflow, ensuring the flexibility of the systems being created and the optimization of information processes, as well as the scalability and extensibility of the functionality of information systems and their resistance to failures.

The automated information system (AIS) of the FMBA BRM Information Analysis Center provides for the automatic input of data through the IP-interface, which ensures direct data collection from the information systems of medical and laboratory organizations participating in the BRM network. This approach ensures the prompt collection of up-to-date and reliable information.

For automatic operation of IS in identifying biological factors influencing changes in biological threats, the average annual morbidity rates (population in the entitled of FMBA) have been established as the threshold for informing. When the specified threshold is exceeded, measures are taken to analyze, predict, and assess biological risks. To ensure the effective operation of the automatic tracking system of biological threats (hazards), reference books of threshold values are systematically updated.

One of the main prospects for the automation development is integration with artificial intelligence and machine learning. To automate the monitoring of open sources of information about possible biological threats that can lead to an emergency, a subsystem based on AI technology has been developed and implemented at the FMBA BRM Information Analysis Center. This subsystem allows for rapid and high-quality content analysis of media news and social networks in order to identify information about a possible biological threat.

### Principle of a friendly interface

The user interface is an important component of any automated, human-oriented system. A user-friendly (UF) interface refers to the intuitive means by which a user interacts with information systems, including data transmission systems. A UF interface should have a minimalist design and a high data loading speed.

In the information system of FMBA BRM Information Analysis Center, special electronic forms are used to interact with the BRM network participants. These forms are designed to meet the specific needs of medical

organizations, hygiene and epidemiology centers, district medical centers, and territorial authorities. For specific events, data “showcases” and specialized user “windows” are developed and implemented for participants in planned training sessions.

### Principle of import substitution for software products and hardware

An important technological feature of the present day is the need to switch to domestic information technologies and software and hardware tools in order to create a reliable domestic alternative to foreign analogues. Currently, the FMBA BRM Information Analysis Center carries out a transit to a domestic operating system that provides the required degree of information security and thereby reduces the vulnerability of software tools.

### Principle of effective management of network activities

Various management levels of intra-network units and structures, as well as external stakeholders and/or parties in the monitoring process, are involved in informational, functional, and organizational cooperation within the BRM network [11]. These include:

1. Internal network elements: subordinate FMBA organizations — network participants and reference centers; structural and functional divisions of the FMBA BRM Information Analysis Center, including information and analytical units for data collection, processing, control, and verification; AIS information technology support units; network coordination and development units; operational duty service; contact center; the units for ensuring the activities of the FMBA BRM Information Analysis Center and the network development; training units, etc.

2. External information users, suppliers, and sources of information: administration of the Centre for Strategic Planning of the FMBA, the Center for Operational Management of the FMBA, FMBA Operations Control Centre, FMBA executive team, authorities (Emergency Control Ministry, Ministry of Health, Russian Federal State Agency for Health and Consumer Rights, Ministry of Defense, Ministry of Industry and Trade, etc.), institutions, information and scientific centers, the State Information System for Biological Security in the Russian Federation, Internet resources, etc.

3. FMBA work force, represented by the organizations served by FMBA, and the population residing in the territories served by FMBA.

4. External management structures: the Centre for Strategic Planning of the FMBA, the FMBA, the Government and the President of the Russian Federation.

A general structural diagram of the informational, functional, and organizational interaction of the BRM network is presented in Fig. 3.

As can be seen from Fig. 3, the informational, functional, and organizational interaction of the BRM network is a complex multidisciplinary process that requires effective management. This process management and its work coordination are entrusted to the FMBA BRM Information Analysis Center, which is the BRM network coordinator. Functioning of the BRM network is provided in two modes:

1) the mode of daily activities with the implementation of procedures for identifying, analyzing, forecasting, and evaluating biological factors;

2) emergency response to biological threats that could lead to an emergency situation.

In order for the BRM network management system to function successfully, it is necessary to continuously analyze changes in the external and internal environment and adapt actions to new conditions.

### Subordination principle

The principle of subordination (co-ordination) implies management, within the framework of which the following processes are implemented: *vertical ordering*, i.e., vertical subordination of network elements, where one of the interacting elements acts as a leader, determining the activities of other participants in the relationship; *horizontal ordering* of business relations, where interaction between participants of the same level is established. Within the BRM network, the role of such a leading body belongs to the network coordinator — the FMBA BRM Information Analysis Center, which manages the activities of network participants. In turn, the FMBA BRM Information Analysis Center is part of the structure and subordinate to the Centre for Strategic Planning of

FMBA. Medical support organizations are subordinate to the district FMBA centers. At the same time, all participants and the network coordinator, together with the Centre for Strategic Planning of FMBA, are subordinate to the FMBA and are obliged to comply with all directives, orders, and instructions of its structural divisions in accordance with those appointed by the head of the functional subordination Agency.

Since June 17, 2024, in accordance with the Decree of the President of the Russian Federation<sup>4</sup>, the President of Russia is in charge of the FMBA activities.

Thus, the subordination vertical for the BRM network can be represented as follows: “President of Russia — FMBA — Center for Strategic Planning of FMBA — FMBA BRM Information Analysis Center (coordinator) — BRM network participants”.

### Principle of permanence operational and duty support

The process of continuous monitoring of biological risks and the presentation of its results, together with the principle of effective management of biological risks, is implemented in the network, including through the activities of the operational duty service established at the FMBA BRM Information Analysis Center. The shifts of this structure operate around the clock and consist of operational duty officers and specialists who take over during daytime hours. Every day, the operational duty service provides the FMBA management with a report on the epidemiological situation in the entitled territories and organizations of FMBA. This is how the principle of permanent operational support is implemented in the BRM network.

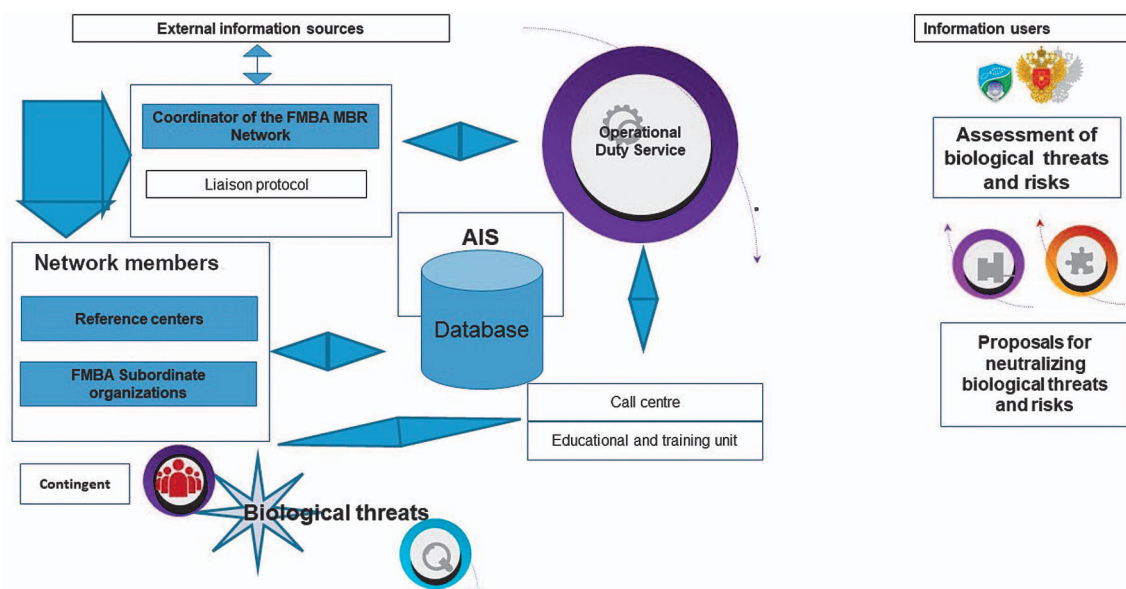


Figure prepared by the authors

**Fig. 3. Structural scheme of informational, functional, and organizational interaction of the BRM network**

<sup>4</sup> Decree of the President of the Russian Federation No. 522 dated 17.07.2024 “On the Federal Medical and Biological Agency”.

### Principle of comprehensive information and analytical support

According to the Federal Law<sup>5</sup>, biological risk monitoring includes the identification, analysis, forecasting, assessment, and ranking of biological risks based on unified criteria. This includes the information and analytical activities that are implemented in the FMBA BRM network.

Medical network organizations collect and perform initial analytical processing of medical and biological information, which is then forwarded to the FMBA BRM Information Analysis Center IS. The FMBA BRM Information Analysis Center conducts daily analysis of epidemic incidence, new, rare, recurrent, and spontaneous infections, changes in the properties and forms of pathogens, diseases associated with disruption of the normal human microbiota, infections associated with medical care (during accidents and terrorists attacks) at facilities where pathogens are used, the spread of drug resistance, and immunodeficiency conditions in humans.

The FMBA BRM Information Analysis Center conducts primary data verification and biological risk analysis, resulting in the receipt of structured information arrays on individual biological threats (hazards). It also determines methods for predicting biological risks. In accordance with the established criteria, the FMBA BRM Information Analysis Center submits information about identified biological threats (hazards) to the reference centers of the BRM network, which verify information about biological threats, including the analysis of biomaterial samples within 72 hours.

At the next stage, biological risks are predicted, i.e., the probability of dynamic changes in the biological threat indicators and their quantitative and qualitative characteristics is assessed. The outcome of biological risk prediction is the acquisition of data necessary for assessing the harm probability associated with the biological threat identified during the assessment of biological risks. If necessary, a report is prepared on the biological threat identification, which is submitted to the FMBA central office for subsequent transmission to the state information system for ensuring biological safety (SIS BS). In 2024, the FMBA Center for Strategic Planning created a database referred to as "Scientific Forecasting Methods", which includes descriptions, characteristics, and features of approximately 100 scientific methods. The presented stages of the activity of BRM experts and their collaboration in collecting, analyzing, forecasting, and evaluating specialized data related to biological threats and risks demonstrate the comprehensive nature of information and analytical support in the MBR network [12].

### Principle of ensuring the quality of information provided

The control mechanism of the BRM network ensures that specialized data on all cases of diseases registered in medical organizations is provided in a timely manner and that the data is transmitted to the FMBA BRM Information Analysis Center information system. At the same time, the quality of the information provided is monitored, including its completeness, relevance, and accuracy. In addition, the control mechanism includes automated analysis and notification of detected errors, as well as verification of operational and reporting data on key indicators.

The following types of activity are carried out daily in the FMBA BRM Information Analysis Center to ensure the information quality: checking the completeness and timeliness of filling out questionnaires by medical organizations of the BRM network in a single data collection format; deleting erroneous entries in the information resource (duplicates of infectious diseases cases and biological threat report files); detecting repeated filling of electronic forms.

The obtained quantitative indicators are verified on a weekly basis against statistical reports received from medical organizations, territorial authorities, hygiene and epidemiology centers. The reliability of incoming information is an important factor affecting the BRM network functioning quality. Reliable information refers to information (reports, data) from a reliable source about events, facts, phenomena, and processes that are authentic, truthful, and evidence-based, eliminating any doubt [13]. In this regard, particular attention is paid to the process of verifying information about biological threats, which is carried out by the reference centers of the FMBA BRM network. The assessment of biological risks is carried out based on unified criteria for the types of biological threats (hazards) to human health and the levels of biological risk.

Further forecasting, assessment, and ranking of biological risks are carried out by the Center's analysts only for biological threats that have been verified by reference centers. To calculate the biological risk level, the severity of harm to human health caused by dangerous biological factors and the causing harm likelihood are used. The result of biological risk assessment is the determination of its level: acceptable, significant, or critical, which is reflected in the relevant information and analytical documents and reports.

### Principle of professional competence development

One of the important areas in ensuring the BRM network quality is the appropriate professional training and retraining of senior officials and all employees of the BRM network organizations as a whole, as well as their

<sup>5</sup> Federal Law No. 492-FZ dated 30.12.2020, "On Biological Safety in the Russian Federation".



coordinated interaction [14]. As part of specialized professional training, the network coordinator, the FMBA BRM Information Analysis Center, holds monthly seminars, training sessions, and classes with the participation of employees from medical organizations, territorial authorities, hygiene and epidemiology centers, blood centers, reference centers, district medical centers, and scientific institutions.

The coordinator organized the work of the FMBA BRM Information Analysis Center contact center for interaction with organizations participating in the BRM network. The contact center processes phone calls, messages received through the VKontakte widget, and e-mail requests, and conducts sessions with members of the BRM network in the order of sending and reviewing requests.

**Principle of effective communication**

The activities of the BRM network involve a wide range of specialists with different professional backgrounds and qualifications from various fields of scientific knowledge and practical industries, including medical professionals, biologists, hygienists, analysts, engineers, and programmers in the IT and telecommunications industries, dispatchers and operators of operational services, consultants, training instructors, methodologists, inspectors, etc. They must clearly and unambiguously understand each other, using the same terms and concepts, which ensures smooth functioning of the BRM network as a unified, well-coordinated, and effectively developing system.

In order to improve the quality of internal corporate communications, it was decided to develop the terminological apparatus of the FMBA BRM network and create a departmental thematic glossary of terms and definitions of the network. To that end, a special algorithm for creating a thesaurus-type glossary was developed, and the subject area and terminology of the BRM network were researched and categorized. The typology of the subject area is presented in Fig. 4.

Currently, work is underway to develop the terminology system of the BRM network [15], form dictionary definitions, and create a glossary project.

**Principle of integrated scientific support**

Scientific support includes a range of scientific, scientific-technical, scientific-methodological, and other activities aimed at obtaining and effectively implementing new knowledge, techniques, and technologies related to the BRM network functioning in the fields of medicine (including hygiene, sanitation, epidemiology, etc.), biology, management, analysis, and forecasting of biological threats and risks, information technologies, professional training, and social and biological emergencies.

Currently, as part of the scientific support for the BRM network activities, research is being carried out with the participation of specialists and researchers from the Sysin Research Institute of Human Ecology and Environmental Hygiene, the State Research Center — Burnasyan Federal Medical Biophysical Center of Federal Medical Biological Agency, etc.

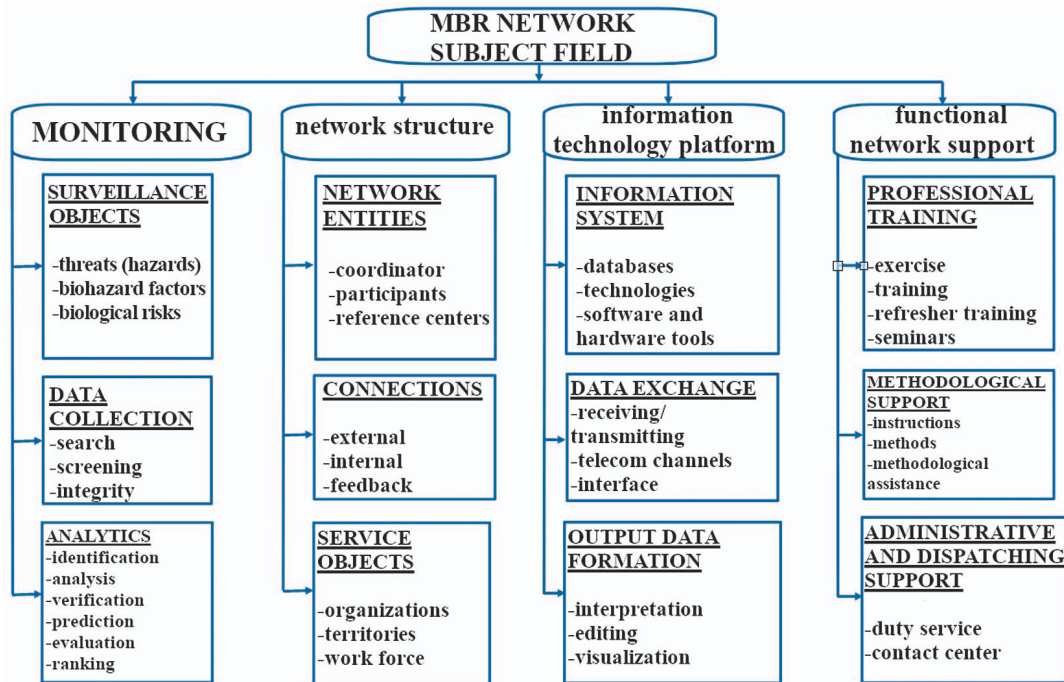


Figure prepared by the authors

**Fig. 4. Typology of the subject area of the BRM network**

### Principle of targeted methodological support

Scientific support for biological risk monitoring includes providing targeted assistance to the BRM network participants in implementing functions that fall within their professional competencies and are related to the activity of the BRM network.

In order to improve cooperation and solve the problems of identifying and neutralizing biological threats and risks, the network coordinator develops methodological manuals, recommendations, instructions, booklets, and memos. Methodological assistance is provided to responsible specialists of the organizations participating in the BRM network on the issues of collecting and presenting information on biological threats (hazards). In accordance with the methodological recommendations, interdepartmental, regional, and facility-based exercises (trainings), classes, and gatherings are held, where qualified specialists from the FMBA BRM Information Analysis Center participate as instructors, methodologists, and intermediaries.

With the purpose of raising the professional competencies of the BRM network members working in the entitled territories and organizations of FMBA, the coordinator sends special teams (brigades) to provide targeted methodological assistance.

As part of the BRM network activity, a contact center has been established to provide daily advisory and methodological assistance to the network participants. To ensure its targeted nature, specific organizations have been assigned to each contact center employee. In 2024, the FMBA BRM Information Analysis Center contact center received 2549 requests from the FMBA organizations: 1388 incoming calls, 1078 incoming emails, and 83 messages via the VKontakte widget; 34% of requests were completed with responses during the conversation, while the remaining 65% were completed within one working day.

### Principle of sustainable development

Sustainable development is a controlled process aimed at developing society and nature, as well as production and other types of organizational systems. This also includes the network of biological risk monitoring, which, as noted above, refers to organizational systems. In a broad sense, sustainable development is aimed at preserving and ensuring favorable conditions for the life of current and future generations of people [16]. The concept of sustainable development is based on the following principles: ensuring an upward trend in development, ensuring a long-term character of development, and meeting the functional needs of the organizational

system in both short- and long-term periods. These objectives are directly related to the network of biological risk monitoring.

When developing a concept for the sustainable development of the BRM network, it is advisable to implement standards and methodologies that can be used to monitor the functioning of the network itself and its subsystems (structural elements), as well as to qualitatively and quantitatively assess the target indicators [17].

### Classification of the functioning principles of the BRM network

Following determination of the key functioning principles of the MBR network, they were subjected to classification. The classification feature was the type of activities that ensure functioning of the MBR network as a complex organizational system. Such a classification basis allows the overall set of fundamental principles established above to be divided into classes (groups) neither overlapping nor mutually excluding each other.

As a result, the following three classes of MBR network functioning principles were identified: (1) principles of information and technological orientation; (2) organizational and managerial principles; (3) principles of scientific and practical orientation. The distribution of principles by classes is presented in Fig. 5. When combined, the resulting classes form the initial set of principles.

### CONCLUSION

As a result of the conducted research, the basic functioning principles of the MBR network in the entitled territories and organizations serviced of FMBA were identified, formulated, justified, and classified. The formed list of principles includes: a systems approach; the principle of compliance prioritization with the intended purpose; continuity of monitoring and presentation of its results; the principle of sustainable development; the complexity of information and analytical support, and some others. The reliance on these principles is one of the key factors that enable the biological risk monitoring network to function successfully, thus providing for the availability of the necessary resources and capabilities to identify and neutralize biological threats and to ensure biological safety.

The evidence-based substantiation of the key principles, based on the research of BRM network functioning, lays the foundation for the development of proposals for optimizing and improving the technology of biological risk monitoring by the FMBA of Russia, as well as for the development of a conceptual model for the functioning of the biological risk monitoring system.

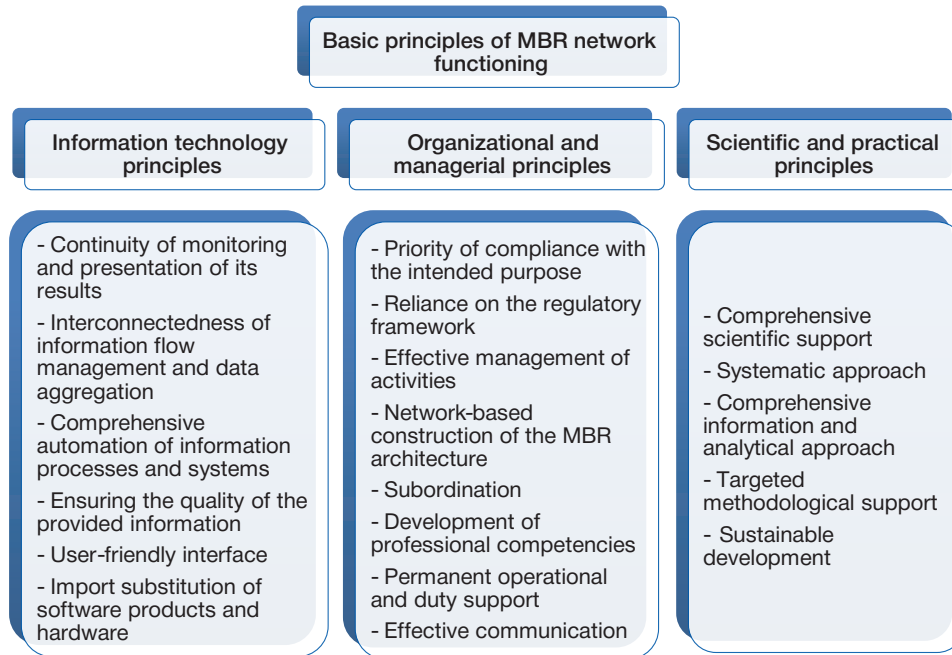


Figure prepared by the authors

**Fig. 5. Classification of the basic functioning principles of the BRM network**

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