S.A.Portenko, S.A.Shcherbakova, E.S.Kazakova, I.N.Sharova, I.G.Karnaukhov, A.V.Toporkov, V.V.Kutyrev

Key Stages in the Development of SAET Laboratory Facilities

Russian Research Anti-Plague Institute "Microbe", Saratov, Russian Federation

Considered are the stages of the SAET laboratory facilities development. Initially main area of activities was assumed to be specific indication of bacterial threats and laboratory control over the ambient environment objects for the presence of particularly dangerous infectious disease agents. Significant increment in the workload occurred during the period of localization and elimination of epidemic cholera manifestations in the 1970s, when primary tasks of bacteriological unit consisted in carrying out mass bacteriological investigations of samples from humans, environment objects, and food items. Assignment of new functions to the laboratory facilities, such as performance of sanitary-microbiological investigations, monitoring over ambient environment objects for the presence of vibrio-flora and natural-focal infectious disease agents, clinical material assays – is associated with SAETs participation in liquidation of medical-sanitary consequences of natural disasters and human cost relief as aftermaths of military conflicts, as well as participation in management of mass events with international representation.

Most important issues in the development of SAET laboratory facilities are implementation of advanced diagnostic technologies, automatization of various stages in the process of analysis performing, standardization of diagnostic investigations, and ensuring compliance of the facilities with national and international requirements.

Key words: SAET, SAET laboratory facilities, SAET bacteriological unit.

Improving the organization of the SAET laboratory facilities was determined by the evolution of the SAET concept. The tasks that were put before SAET and the level of development of laboratory diagnostics determined the state of the laboratory facilities [19].

The formation of SAET in 1963 was due to the threat of the use of biological weapons, therefore the main activity of SAET was to conduct specific indication of bacterial agents of destruction and laboratory monitoring of environmental objects for contamination with particularly dangerous pathogens (Order of the Ministry of Health of the USSR of 30.09.1963 No. 466).

Soon after the creation of the SAET, the need arose for their participation in localization and elimination of the epidemic manifestations of cholera in the 1970s, to assist the territorial structures of health care. According to the archive materials of RusRAPI "Microbe", the main task of the bacteriological department was to conduct mass analyses of the material from people, objects of the environment and food products. During this period, due to the lack of laboratory facilities in the institutions of the State Sanitary and Epidemiological Surveillance, the adapted facilities of schools, clubs, institutes, etc. were used to deploy the SAET laboratory facilities. The main diagnostic method was bacteriological analysis.

Subsequently, the efficiency of using SAET in eliminating the epidemic foci of cholera was confirmed during the cholera epidemic in the Republic of Dagestan in 1994. To eliminate the cholera outbreak (for the periods of the most intensive increase in the incidence), 6 SAETs were involved in their entirety: Rostov RAPI – 2, Stavropol RAPI – 1, RusRAPI "Microbe" – 2, Volgograd RAPI – 1. This allowed us to strengthen the laboratory facilities of the largest cities of the Republic of Dagestan, increasing the daily number of tests to 1000 or more. SAET has conducted more than 100 thousand studies on cholera of material from people and from environmental objects [9].

One of the forms of use of specialized teams in the foci of cholera was the involvement of individual operational teams of specialists (in 55 % of cases) – in case of insignificant intensity of the epidemic process and the availability of laboratory facilities capable of deciphering the genesis of the outbreak. As an example, we can cite the work of the operative epidemiological and diagnostic group of specialists of the SAET of RusRAPI "Microb" who participated in the elimination of cholera outbreak in the Republic of Tatarstan in 2001 [18].

The turning point in the change in the concept of the SAET functioning, and,

accordingly, on the organization of laboratory and diagnostic work, was the involvement of the SAET in the elimination of medical and sanitary consequences in the disaster zone (earthquake in Armenia in 1988–1989), when the SAET carried out the functions of the institutions of the territorial sanitary-epidemiological service in conditions of destroyed infrastructure. The main focus of the work of the laboratory department of SAET at that time was the implementation of current sanitary control of preserved and restored epidemiologically significant objects, sanitary and bacteriological control of the quality of drinking water, food products, bacteriological analysis on the presence of pathogenic intestinal microflora of the material from patients, contacts, decreed population groups, conducting research in the framework of the monitoring of natural focal infectious diseases. Such a wide range of tasks solved by specialists of the SAET bacteriological department required not only serious training in sanitary microbiology, but also a significant modernization of the entire SAET material and technical base [7].

Further improvement of the laboratory-diagnostic activities of the SAET was associated with their participation in ensuring the sanitary and epidemiological well-being of the population in areas of armed conflict with humanitarian consequences – local Ossetia-Ingushetia conflict (1992–1993), the armed conflict in the Chechen Republic (1995), the anti-terrorist operation on the territory of the Chechen Republic (2000), in the Republic of Ingushetia, where the influx of refugees from the Chechen Republic took place (1995, 1999–2000 .) Georgia-South Ossetia armed conflict (2008). In this situation, the tasks of the SAET laboratory were in many ways similar to those when working in the earthquake zone in Armenia, as well as in other natural emergency situations (ES) [12] and were associated with the temporary performance of the functions of sanitary and epidemiological institutions. SAET specialists conducted sanitary and microbiological studies of drinking water, food products, environmental objects, and also epizootiological survey of natural foci of especially dangerous infectious diseases (plague, tularemia). At the same time, additional readiness was provided for the diagnostics of diseases of unclear etiology and indication of infectious disease pathogens of bacterial etiology in environmental objects. In order to strengthen the territorial institutions of state sanitary and epidemiological surveillance in the areas less affected by the social conflict where the refugees were stationed, the epidemiological teams were formed, consisting of SAET specialists (at least one epidemiologist and one bacteriologist). It should be noted that in the Chechen Republic, during the work of SAET, laboratories were used on the basis of an automobile chassis: an autolaboratory for bacteriological diagnosis of acute intestinal and droplet infections and an indoor car GAZ-66 for preparing nutrient media [1, 2, 3, 5, 10, 11, 16, 22].

A landmark event in the further improvement of the laboratory component of the SAET was their participation in ensuring sanitary and epidemiological well-being during mass events with international participation (APEC-2012 Summit in Vladivostok, 2013 Universiade in Kazan, the G-20 Summit in St. Petersburg Olympic and Paralympic Winter Games in 2014 in Sochi). The organization of laboratory research based on the SAET during the preparation and conduct of the above activities clearly demonstrates the various tactics of laboratory support for the activities of the SAET, depending on the tasks. For the first time, the most comprehensive capabilities of the SAET laboratory facilities (at such events) were disclosed when organizing work during the 2013 Universiade in Kazan. The main activities of the SAET laboratory department were:

- ensuring readiness for laboratory diagnostics of especially dangerous infectious diseases;
- carrying out laboratory diagnostics of infectious diseases in accredited persons;
- monitoring of surface water bodies for vibrioflora;
- monitoring of the water of the hot water supply system for the houses of the Universiade Village for the presence of legionella;
- sanitary-microbiological studies of food products [17].

At the same time, the organization of work during the G-20 summit demonstrated the unique capabilities of the SAET for conducting mass laboratory screening of environmental and food samples using modern methods of rapid and express diagnostics. Analysis of the expe-

rience of organizing laboratory support during two different mass events (Universiade 2013 and the Summit) showed that the duration of the event, as well as the conditions for holding it, affect the timing of a response from the laboratory service, which is decisive when choosing priority methods and algorithm of analysis. Taking into account the significant amount of work attributable to the laboratory base in ensuring the sanitary and epidemiological well-being of mass events, among the main principles of the organization of laboratory research are the following:

- selection of priority research indicators;
- logistics of sampling and delivery systems;
- priority use of methods of rapid and express diagnostics (MFA, ELISA, PCR);
- automation of all stages of the study (sample preparation, microbiological studies, etc.) [14, 15].

Along with expanding the range of tasks to be performed, another direction for improving the laboratory support of the SAET activity is the introduction of modern diagnostic technologies into the work of the SAET. The turning point in this regard was the use of PCR – a method that allows an indication (and now identification) of infectious disease pathogens as soon as possible. The successful use of PCR in conducting epidemiological investigation of the anthrax outbreak in the Republic of Mordovia in 1999 further determined the place and role of molecular genetic analysis as the most demanded in the organization of laboratory studies based on SAET.

Currently, PCR laboratories most widely used PCR based on the results in real time. A significant part of the used test systems allows for multi-factor analysis, i.e. identify several pathogens in one sample (for example, a complex of causative agents of acute intestinal infections), or determine several characteristics of one pathogen (systematic position, epidemic significance, etc.). In addition, in accordance with the Regulation of the functioning of SAET, in the SAET laboratories, it is necessary to detect pathogens of 54 nosologies, most of which are viruses, and in this case PCR is the method of choice, since the implementation of virological studies in the SAET is not practical. Prospects for the further introduction of molecular genetic methods in the work of SAET are associated with the use of sequencing. So, during the 2013 Universiade, in order to determine the type of pathogen sequencing of the isolated culture was carried out in the on-line mode and its homology with the *Salmonella enterica* strain was confirmed [8].

Along with PCR, other methods of express and accelerated diagnostics are very demanded – MFA, ELISA, immunochromatography. Research using these methods is provided for in the indication laboratory of the MC SAET, however, given the small overall dimensions of the equipment, it is possible to place it in any laboratory unit of the mobile complex.

Traditionally significant role in the organization of laboratory research in SAET is assigned to bacteriological analysis. At present, the SAET equipment sheet includes microbiological analyzers, and the range of their use is quite wide – from conducting sanitary-microbiological studies to determining the pathogen antibiogram.

It is necessary to note the presence of equipment in the modernized MK SAET, which allows to automate the process of preparing nutrient media. The introduction of automatic environments, bottling modules, etc., has significantly reduced the staff of technical personnel involved in providing bacteriological research (preparation and bottling of nutrient media, preparation of laboratory glassware).

The priority issue in the organization of laboratory diagnostcis of especially dangerous infectious diseases is compliance with the requirements of biological safety. The development of this direction in the work of laboratory divisions was carried out simultaneously with the evolution of the concept of the SAET functioning and was fully implemented during its modernization [6]. However, it should be emphasized that the compliance with the biological safety requirements of the work performed was always carried out, regardless of the conditions of placement of the laboratory base (premises of the sanitary epidemiological service laboratories, adapted premises of schools, clubs, tents, pneumoframe modules, etc.). In modern modernized laboratories of the MC SAET, engineering and technical means make it possible to provide BSL-3 (isolated laboratory) in biologi-

cal indication laboratories in accordance with WHO criteria, and BSL-2 in bacteriological and sanitary hygienic laboratories (basic laboratory of level 2) [4, 20].

Another key issue that needs to be addressed when considering evolutionary changes and the current state of the organization of laboratory diagnostics at SAET is compliance with the requirements of the international standard in force in the Russian Federation (GOST ISO/IEC 17025 "General requirements for the competence of testing and calibration laboratories").

When many countries of the world took part in the implementation of the IHR (2005), they thereby expressed their commitment to building national capacities to detect public health events of international importance and to respond to such events. The results of laboratory diagnostics, which in emergency situations of international concern will be trusted by the international community, it is possible to get only in the laboratories of national health systems, where reliable quality management is carried out [21]. The main components of the quality management system (QMS) for laboratories, including those carrying out research in the framework of ensuring sanitary and epidemiological surveillance, are defined in GOST ISO/IEC 17025. SAET specialists do not carry out surveillance activities, but carry out research in the framework of sanitary protection of the territory and epidemiological surveillance. The organization of such studies in the SAET laboratories acquires particular relevance when working in the emergency zone with full or partial replacement of local Rospotebnadzor institutions, or when organizing and conducting mass events, when SAET activities are carried out in close cooperation with the bodies and institutions of Rospotrebnadzor. In addition, compliance with the requirements of international standards in the field of the organization of diagnostic studies (confirmed by appropriate accreditation) gives legitimacy to the results obtained in the event that the SAET is involved abroad. Modern SAET laboratories are part of testing laboratory centers operating on the basis of anti-plague institutions and accredited in the prescribed manner for technical competence in conducting research.

The introduction of the QMS has ensured the standardization of diagnostic studies carried out in all SAETs. This was achieved, inter alia, through the use of high-tech analytical equipment, conducting research in accordance with a single nomenclature, which is reflected in the Regulation of the functioning of the SAET [27] and the introduction of SOPs into the work of the SAET laboratories of all the anti-plague institutes. In this regard, it is necessary to note the work on the optimization of regulatory and methodological support, which regulates the organization and conduct of laboratory diagnostics in the MC SAET, and determines, along with other components, the functioning of the QMS in the MC SAET laboratories.

Thus, the analysis of changes that have occurred in the organization of laboratory diagnostics for the period from the creation of the SAET to the present time has shown that they fully correspond to the evolution of the SAET functioning concept. The development of the laboratory and diagnostic spectrum in the activities of SAET has ensured the creation of unique laboratory complexes equipped with modern equipment, on the basis of which it is possible to conduct a wide range of studies (from indication of causative agents of especially dangerous infectious diseases of bacterial and viral nature, toxins, to sanitary and microbiological analysis of food products and objects environment) as part of measures for sanitary protection of the territory and ensuring sanitary and epidemiological well-being.

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Authors:

Portenko S.A., Shcherbakova S.A., Kazakova E.S., Sharova I.N., Karnaukhov I.G., Toporkov A.V., Kutyrev V.V. Russian Research Anti-Plague Institute "Microbe". 46, Universitetskaya St., Saratov, 410005, Russian Federation. E-mail: rusrapi@microbe.ru

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