Chapter I: The Anti-plague System of Armenia

1. History of Armenia's Anti-plague System

The Armenian AP system was established in 1942, when the Soviet MOH transformed a tularemia station, which had existed under the auspices of the municipal disinfection station in Armenia's capital Yerevan, into the Armenian AP station. At the time the main impetus for opening an AP station in Armenia was the proximity of natural plague foci on the territories of neighboring Azerbaijan, Iran, and Turkey (as is noted below, natural plague foci were first discovered in Armenia in 1958). With a staff of only 14 employees, the Armenian AP station was unable to carry out the sanitary and prophylactic anti-epidemiological measures against especially dangerous infectious diseases over the entire territory of the republic. Consequently, in 1944 the Soviet MOH established the first field AP station in Leninakan (now Gyumri). In 1953, the Soviet MOH opened a second field AP station in Kapan to monitor the regions adjacent to the border with Azerbaijan, due to the existence of natural plague foci in Azerbaijan (near Mehmed-Beyliy, Akara, and Gadrut).[4] And in 1972, the Soviet MOH opened its third field AP station in the settlement of Martuni on the southern coast of Lake Sevan for the purpose of full-scale epizootiologic monitoring and implementation of necessary prophylactic anti-epidemiological measures on the territories of the districts contiguous to the Lake Sevan.[5]

As with other Soviet AP stations, the Armenian AP station was subordinate to the Main Directorate of Quarantine Infections of the Soviet MOH. Throughout the Soviet period the Stavropol Scientific-Research AP Institute of the Caucasus and Transcaucasus (now Stavropol Scientific-Research AP Institute) oversaw the activities of the Armenian AP station, conducted research on its premises, and provided consultative-methodological guidance to its personnel and administration. After the Soviet Union's dissolution in December 1991, the Armenian AP station came under the jurisdiction of the Armenian Ministry of Health (MOH) and in 1993 it was renamed the Center of Prophylaxis of Especially Dangerous Infections (CPEDI).

2. Current Organizational Structure of the Armenian Anti-plague System

As of March 2004, the Armenian AP system was comprised of the CPEDI, three field AP stations in Gyumri, Kapan, and Martuni, and seven seasonal AP laboratories in Aparan, Ararat, Jermuk, Sevan, Sisian, Stepanavan, and T'alin.[6] Figure 1 shows the organizational chart of the Armenian AP system. The Armenian AP system had 240 employees, including 26 physicians, 10 zoologists, and the balance comprised of auxiliary personnel (laboratory technicians, disinfectors, sanitary workers, drivers, guards, etc.).[7] Figure 2 shows the changes in personnel and funding of the Armenian AP system for the period from 1995 to 2002.

Figure 1. Organizational Structure of Armenia's AP System

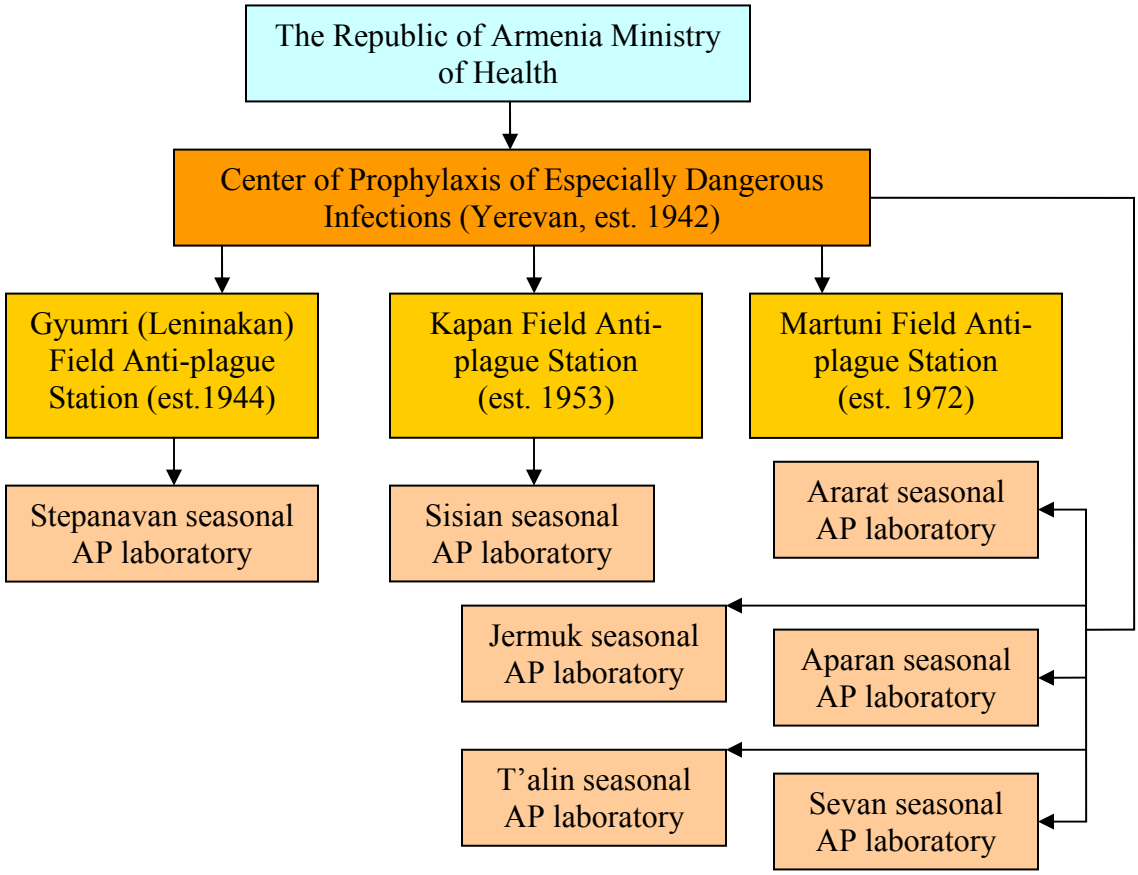

Figure 2: Personnel and Funding of Armenia's AP System (1995-2002)[8]

Year	**1995**	**2000**	**2002**
Total personnel	297	253	240
Doctors	42	36	35
Zoologists	33	26	25
Laboratory technicians	53	46	45
Disinfectors	50	40	34
Total funds allocated in millions of Armenian Drams or AMD ($ equivalent)[9]	27 AMD ($66,502)	69.2 AMD ($128,259)	69.7 AMD ($121,566)

3. Public Health Activities of the Armenian Anti-plague System

The overall public health functions carried out by the Armenian AP system since 1992 have remained the same as during the Soviet period. Thus, its main objective is to protect the population of Armenia from group I-II infectious diseases[10] (plague, anthrax, tularemia, cholera and brucellosis), by monitoring epizootic activities in the natural foci of especially dangerous infectious diseases and implementing appropriate anti-epidemiological measures. Plague surveillance and control include the following activities:

- The epizootic monitoring of the territory with the purpose of timely identification of epizootics of plague (as well as other naturally occurring infectious diseases) and the prevention of its spread to the population;
- The epidemiological monitoring of regions endemic for plague;
- Prophylactic measures (extermination, disinfection, vaccination, and educational outreach addressing sanitary and hygienic issues in the population);
- The training of the medical personnel in public health organizations for clinical monitoring, diagnostics, and prophylaxis of plague (and other especially dangerous infectious diseases); and
- The examination of patterns of natural occurrence of plague (and other infectious diseases).[11]

Other public health activities performed by the Armenian AP system include:

- Prophylaxis of other especially dangerous (tularemia, anthrax, and brucellosis) and naturally occurring infectious diseases (yersiniosis, leptospirosis, and erysipeloid);
- Vaccination of the population against especially dangerous infectious diseases—particularly in the areas frequently affected by outbreaks of such diseases and people who might be exposed to them due to their professional occupations;
- Sanitary protection of the Armenian territory from imported diseases;
- Implementation of quarantine measures as necessary to stop the spread of quarantined diseases;
- Epidemiological readiness of public health institutions with regard to the especially dangerous infections;[12]
- Implementation of laboratory and field experiments for scientific purposes.

The most important Armenian AP facility, CPEDI, is comprised of a laboratory for diagnostics of prionic diseases, a bacteriological laboratory, and a zooparasitological laboratory. The CPEDI's public health mandate also incorporates monitoring and control of cholera, including the following related activities:

- The bacteriological study of water samples (open water sources, sewage, tap water) to identify and isolate strains of *Vibrio cholerae* in order to prevent their spread to the population;
- The monitoring of patients exhibiting symptoms of acute intestinal diseases;

- The training of SES personnel stations and public health organizations in laboratory diagnostics of cholera;
- The training of medical personnel in clinical monitoring, diagnostics, treatment, and prophylaxis of cholera; and
- The identification and verification of strains of *V. cholerae* recovered by SES stations and public health organizations.[13]

The CPEDI also has a specialized anti-epidemiological brigade responsible for rapidly responding to epidemiological emergencies. However, in March 2004, it was not fully equipped, casting doubts about its readiness level.

CPEDI's 2004 budget was equivalent to approximately $270,000, of which $158,000 was earmarked for employee salaries, while the rest was supposed to cover all other expenditures, including implementation of sanitary-prophylactic measures, acquisition of diagnostic materials, laboratory equipment, and other necessary items and activities.[14]

Epizootic and Epidemiological Monitoring of Natural Foci of Plague

Armenia's territory hosts natural foci of plague, tularemia, anthrax, yersiniosis, leptospirosis, and erysipeloid. There are two natural plague foci in Armenia—the Transcaucasus Mountainous and Trans-Arax foci. The Transcaucasus Mountainous focus was discovered by Armenian AP specialists in 1958, when they isolated the first culture of *Yersinia pestis* from the flea species *Ctenophthalmus teres* collected from the burrows of common voles in the vicinity of Zugaykhpyur village (close to Gyumri city, Gukasyan district, northwestern part of Armenia) at the foot of the Kechut (Javakheti) Mountain Ridge.[15] The Transcaucasus Mountainous plague focus is located in the mountains of the Armenian Plateau and Lesser Caucasus at elevations of 1,600 to 3,200 meters above the sea level. It is further divided into three plague meso-foci—Gyumri, Zangezur-Karabakh, and Trans-Sevan. Armenian AP specialists discovered the natural plague foci in the Zangezur-Karabakh and Trans-Sevan regions in 1962. The main host in these foci for *Y. pestis* is the common vole, while the vectors are particular varieties of fleas that reside on voles— *Callopsylla caspia* and *Nosopsyllus consimilis*. The Trans-Arax natural plague focus was identified and mapped in 1972. The main host here is Vinogradov's jird (*Meriones vinogradovi*), a gerbil-like animal whose ectoparasites *Nosopsyllus iranus* and *Xenopsylla conformis* are vectors. The fauna of plague vectors responsible for transmission of this deadly disease in Armenia is very diverse—comprised of 63 species of fleas, 31 species of gamasid ticks, and 40 species of argas and ixod ticks.[16]

According to CPEDI, approximately 24,000 sq. km of Armenia's territory (29,800 sq. km), or 80 percent of the country, is endemic for plague.[17] The fact that Armenia is a very mountainous country with more than 90 percent of its territory located at over 1,000 meters above sea level further complicates epidemiological monitoring.

Each of the main structural units of the Armenian AP system is responsible for the epidemiological health of a particular part of the country.[18] Thus, the Gyumri field AP station monitors the epidemiological situation in the provinces of Shirak and Lorri, which encompass ten former districts of northwestern Armenia—Akhuryan, Ani, Artik, Amasiy, Ashots, Gugar, Tashir, Stepanavan, Spitak, and Alaverdi. The Kapan field AP station services the territory of Syunik province (formerly the Sisian, Goris, Kapan, and

Megrin districts). The Martuni field AP station is responsible for the epidemiological health of residents of the Gegharkunik province (formerly four regions near Lake Sevan—Gavar, Martuni, Vardenis, and Krasnoselsk). The territory of the remaining six provinces (Aragatsotn, Ararat, Armavir, Kotayk, Tavush, and Vayots' Dzor) and the federal municipality of the capital Yerevan are monitored by the CPEDI.[19]

Armenia's natural plague foci are characterized by relatively high levels of epizootic activity. From 1968 to 1991, plague epizootics of varying intensity were recorded annually in Armenia, although the highest levels were recorded in 1973-1974, 1977-1978, 1980-1981, and 1987.[20] Starting in 1976, Armenian AP specialists began using serological methods for plague diagnostics in the natural foci. From 1992 to 2002, localized plague epizootics were recorded in the Zangezur-Karabakh region and during 1995-1996 and 2001-2002 in the Gyumri region. The CPEDI established that the *Y. pestis* strains that circulate in the natural plague foci in Armenia are characterized by selective virulence when tested on laboratory animals (for instance, cultures are virulent for white mice, but less virulent for guinea pigs). It must be also noted that the *Y. pestis* strains isolated from the Persian jirds (*Meriones persicus*) in the Trans-Arax focus are characterized by higher virulence than those that are isolated from voles in the Transcaucasus Mountainous focus.[21] The CPEDI regularly notifies the AP Center of the Russian MOH about any discovered epizootics of plague and quantities of isolated *Y. pestis* and *V. cholerae* strains. In exchange it receives information on the epidemiological situation in the rest of the Commonwealth of Independent States (CIS).

Monitoring of Other Especially Dangerous Infectious Diseases

Tularemia: Armenian AP specialists first reported a tularemia epizootic in the fall of 1949 when they isolated the *Francisella tularensis* strains from a wood mouse, a black rat, and ticks. However, the main host is the common vole, and sometimes the water vole, while the main vectors are ixod and gamasid ticks. In the 1950s, tularemia outbreaks of varying intensity were reported along the 230 km-long border with Turkey both among people and rodents. In 1954, a tularemia outbreak was recorded among workers of the meat packing plant in Gyumri. Reportedly, 165 workers were infected by contaminated mutton meat that had been imported from Turkey. Tularemia occurs naturally throughout nearly the entire territory of Armenia.[22]

Anthrax: Anthrax is endemic throughout Armenia. During 1990-2002, with the exception of 1994, 1996, and 1997, sporadic cases of anthrax were recorded. In 1999 and 2001 the Armavir and Artik districts suffered outbreaks of the disease. CPEDI's records indicate that anthrax is contracted in Armenia on a seasonal basis—from June to October—which corresponds to the period when cattle are sent to the fields for annual grazing. In fact, more than 80 percent of recorded anthrax cases occur during this period. Anthrax is a profession-specific disease in Armenia as it is prevalent among cattle breeders (usually age 30 and over). Anthrax epizootics among cattle occur annually.

Cholera: One of the main measures of epidemiological monitoring for cholera is the bacteriological control over open-water sources, as well as timely identification of patients exhibiting symptoms of acute intestinal diseases. For decades Armenian AP personnel have been collecting water samples from special control points located along

main waterways, including the Arax River, Lake Sevan, irrigation canals, ponds, and public pools. The *V. cholerae* El Tor strain was first isolated in Armenia in 1971 from the Arax River. In 1988, a cholera outbreak occurred in the village of Zartonk, Amavir district, in the southwestern part of Armenia. About 200 patients were affected; of them, 42 were carriers of *V. cholerae*.[23] The diagnosis was confirmed by the laboratory of the Armenian AP station in Yerevan. After the outbreak's etiology was established by the Armenian AP station, subsequent examinations of patients took place at the bacteriological laboratories of SES stations and infectious disease hospitals under the direct supervision of AP specialists.[24] The prompt anti-epidemiological measures carried out by the AP specialists contained the outbreak. However, during 1999-2002, the CPEDI and its branches continued to isolate *V. cholerae* strains from open-water sources.

Leptospirosis and Erysipeloid: Gyumri field AP station workers discovered the first natural occurrence of erysipeloid in Armenia in 1957 in the Gukasyan district. At various times since, people infected with this disease were identified among the workers of the Gyumri meatpacking plant and the population of the Gyumri district in general.

Natural leptospirosis foci have been found among rodent populations in 29 districts of Armenia. Nine species of rodents are considered carriers of its causative pathogen, *Leptospira* species, in Armenia. The highest percentage of infections is observed among the grey rat, Asia Minor ground squirrels, and common voles. Among people, leptospirosis was first recorded in the Aykadzor village in 1948. Subsequent sporadic and group outbreaks were recorded in Armavir district in 1963, 1971, and 1974 in the Shamshadin district. During 1986-2002, 95 persons were diagnosed with leptospirosis in Armenia.

Decline in Epizootic Surveillance and Epidemiological Monitoring of Natural Plague Foci

After Armenia's independence, the financial situation of the AP system deteriorated dramatically. Fund allocations from the state budget were reduced substantially and as a result, epizootiologic monitoring and other sanitary and prophylactic activities were reduced by 60 to 90 percent. As of March 2004, the CPEDI and its subordinate field AP stations could monitor only about 30 to 40 percent of the territory endemic for plague.[25] Compared to the Soviet period, epidemiological monitoring is carried out on a much smaller scale and for shorter periods of time, which does not allow the CPEDI to discern the complete picture of the epizootiologic and epidemiological situation in Armenia. As depicted in Map 1, both Gyumri and Kapan field AP stations have their own seasonal laboratories in Stepanavan and Sisian, while CPEDI uses the rest of the seasonal laboratories for its epidemiological monitoring. The CPEDI and its subordinate field AP stations dispatched epidemiological and zoological teams for a total of only 50 days during June – September 2004. During this period, the zoological teams deliver collected field material (rodents) to the seasonal laboratories on a daily basis. Due to the shortage of funds and vaccines, the CPEDI can no longer vaccinate residents of areas frequently affected by epizootics of plague and tularemia, which could create significant epidemiological complications in case of outbreak.

In addition some areas, such as the Nagorny-Karabakh enclave, are virtually unmonitored. Prior to the war between Azerbaijan and Armenia over the Armenian-

populated enclave of Nagorny-Karabakh, the Azerbaijani AP system controlled the field AP station in the settlement of Gadrut located in the enclave. After the end of the war in 1994, CPEDI formally assumed epidemiological control of the unrecognized Nagorny-Karabakh Republic, where plague is endemic to the entire territory. However, in practice, neither the Armenian nor the Azerbaijani AP systems have performed any epidemiological monitoring in the Nagorny-Karabakh enclave since 1993. The CPEDI receives no information on the epizootic or epidemiological situation from the Nagorny-Karabakh Republic, while the Gadrut field AP station seems to have been lost in a no-man's land, being part of neither the Armenian nor the Azerbaijani AP systems. As of October 2005, the Gadrut field AP station was still open, although its operation remains doubtful: it was not staffed with qualified specialists and the chief doctor of the local SES station served as its director.[26]

The lack of funding and appropriate personnel also affects the monitoring of other dangerous diseases. For instance, in Soviet times, beginning in 1965, the population in areas affected by tularemia was vaccinated en masse with live tularemia vaccine every five years.[27] However, the cutoff of state funding following the Soviet Union's dissolution ended this practice and as a result the residents of those regions have not been vaccinated against tularemia for more than 15 years. Similarly, cattle breeders in regions endemic for anthrax are no longer vaccinated against the disease due to the lack of funds. The absence of special burial sites in villages for animals that died from anthrax complicates the epidemiological situation further. All of this, according to CPEDI's specialists, makes Armenia's current epizootic and epidemiological situation dangerously unpredictable.

The deterioration of the overall epidemiological situation in the country is further evidenced by the fact that other zoonotic infections, which previously had not been recorded in Armenia, have been reported as of late. According to the medical statistics released by the Armenian MOH in January-October 2006, there were five cases of leptospirosis, one case of intestinal typhoid, two cases of paratyphoid fever, and twelve cases of tularemia. Also in the aforementioned period there was a growth in the number of acute infectious diseases such as brucellosis, syphilis, and sarcoptic mange. The cases of acute intestinal disease increased by 660 in 2006 compared to 2005. The number of patients with intestinal problems was 4,698, including 876 with bacterial dysentery.[28] In 2004, according to the information submitted by Armenia to the Coordinating Council on Problems of Sanitary Defense of Territories of the CIS Member-States of the Council on Cooperation in the Field of Public Health of the CIS Member-States, in the third and fourth quarters there were 107 cases of brucellosis, 23 cases of malaria, 402 cases of tuberculosis (TB), and 8 cases of meningococcal infection.[29] In addition, the Russian AP Center received information that in 2004 plague epizootics were recorded in the natural plague foci located in Gyumri (Ani and Ashtarak districts) and the Zangezur-Karabakh region (Kapan and Sishan districts).[30]

Map 1: Locations of Armenian Anti-plague Facilities

4. International Activities Involving the Armenian Anti-plague System

When CNS staff visited Armenia in 2004, no significant international activities involving AP facilities were underway and none was in the planning stage.

5. Analysis of the Armenian Anti-plague System's Weaknesses and Proliferation Potential

Before the Soviet Union's dissolution, the Armenian AP system performed another important function in the public health area; it offered training sessions on pathogen identification to workers employed by hospitals, clinics, SES, and other public health institutions. As of March 2004, the CPEDI was no longer able to offer such courses due to the absence of diagnostic materials such as reagents for immunofluorescence assays and enzyme-linked immunosorbent assays (ELISA). The CPEDI staff was able to perform pathogen identifications only by the classical methods of gram staining, culturing, and antibody titre analysis, which are not suitable for instructional purposes at this level as they are basic microbiology and are time-consuming.

Armenian MOH officials appear to pay very little attention to the problems accumulated in the AP system, possibly because they do not understand the importance of the AP system.[31] This leads to a combination of factors that cause a steady decline of cadres at the CPEDI. First among these factors is the low level of salaries offered by the CPEDI. According to the CPEDI director, the Armenian AP system experiences acute shortages of specialists because it cannot offer competitive salaries. As of March 2004, the average monthly salary of an experienced AP specialist was the equivalent of $90; the starting salary of a physician with no experience was $60; while the average salary for auxiliary personnel was estimated to be $40.[32] As a result, the majority of CPEDI specialists are forced to seek supplemental income by working at local hospitals or teaching at medical schools in order to support their families.

Many of the CPEDI's personnel have not received proper professional training since the breakup of the USSR. Prior to 1992, staff physicians, zoologists, and laboratory technicians had to attend specialization training in especially dangerous infectious diseases at Soviet AP institutes in Stavropol, Saratov, Rostov, Irkutsk, or Almaty. As of 2003, about 80 percent of Armenia's AP physicians had not received proper specialized training, while those who had received such training in Soviet times, had not had the opportunity to refresh their skills since the Armenian National Institute of Health does not offer courses on especially dangerous infectious diseases.[33] The fact that qualified old cadres are retiring also contributes to the overall decrease in professionalism in the Armenian AP system. Already there are no employees with higher scientific degrees at the CPEDI.

Armenian AP specialists work under very difficult conditions. All laboratory equipment at the CPEDI and its branches was manufactured in the 1960s or 1970s and is therefore obsolete and in dire need of replacement or upgrading. The antiquated equipment increases the risk of laboratory accidents involving pathogens of dangerous infectious diseases occurring, which poses a major health hazard to not only employees of the AP system but also to the population living near the laboratory facilities, especially in the event of an accidental release of pathogens. The likelihood of the aforementioned accident occurring is increased at the CPEDI since there is no ventilation system in the

laboratory building. Furthermore, the CPEDI and its branches are not heated in winter when temperatures sometimes drop to below minus 20 degrees Centigrade. In 2004, AP facilities had no hot water in the AP facilities and they experienced frequent power outages. In addition, some of the AP facilities, (including the seasonal AP laboratories in Stepanavan, Sisian, and the field AP station in Martuni) have been occupied by Armenian refugees from Nagorny-Karabakh. In March 2004, there were still refugees in these facilities. At the Kapan field AP station the situation was different. The Armenian police department and the local branch of the Ministry of National Security occupied most of the building, forcing AP personnel to work on the top or fourth floor.[34] While on the one hand, the presence of law enforcement authorities in AP buildings may prevent potential security breaches, on the other hand, working with dangerous pathogens requires strict adherence to biosafety rules, which implies that the premises should not be shared with other organizations.

In our view, the implementation of the following recommendations would significantly improve the effectiveness of disease surveillance by the Armenian AP system and considerably reduce the proliferation threat:

- Improve the physical protection of CPEDI's pathogen collection (the range of measures can vary from the most expensive, such as setting up a CCTV surveillance system, to the least costly, such as installing iron doors and combination locks);
- Institute a background check procedure for newly hired employees at the CPEDI and throughout the Armenian AP system;
- Computerize the CPEDI and field AP stations and link them into an integrated information exchange system;
- Sponsor biosafety/biosecurity training of select CPEDI personnel at Russian and/or Kazakh AP institutes;
- Install modern laboratory equipment at the CPEDI and field AP stations in phases to gradually replace old equipment; and
- Establish a nucleic acid-based laboratory for the diagnosis of plague, tularemia, cholera, and other especially dangerous infectious diseases.

Even partial implementation of the aforementioned recommendations would lead to an increased level of biosecurity. Further, it is likely that the focusing of international attention on the CPEDI and its affiliated branches would prompt the Armenian government to give a higher priority to this indispensable public health service.