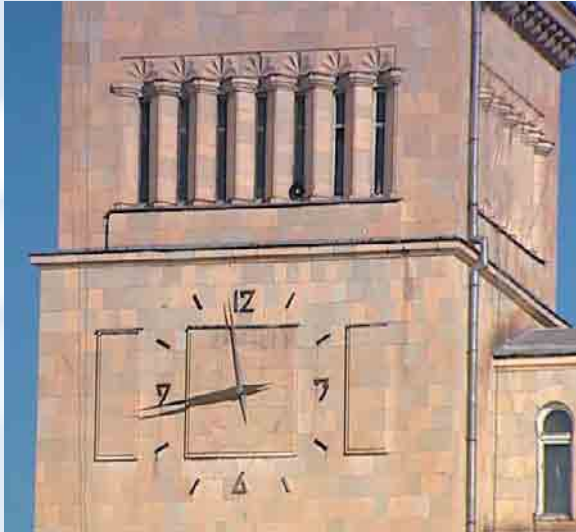




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NEW APPROACHES TO PREVENTION OF EPIDEMIC OUTBURST RISKS IN EMERGENCY SITUATIONS (LESSONS LEARNT FROM THE EARTHQUAKE: ARMENIA, 1988)

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Abstract

It is known that natural disasters, including the earthquakes, are fraught with the potential destructive properties bringing forth the most complex ecological, socio-hygienic, and epidemiological situations. These factors, in their turn, condition the outbursts of infectious diseases (the extremely dangerous infections amongst them), mass poisonings, etc. Epidemic outbreaks almost always accompanied the natural disasters.

To factors capable to influence the emergence and spread of infectious diseases under extreme situations belong the following ones: mass (total) character of injuries of non-infectious nature, prevalence of combined injuries, psychic stress, disorganization of social structures, intense migration processes, disintegration of ecological systems.

In the zone of Armenian earthquake (1988) the most favourable conditions existed for epidemic complications: huge mass of people cumulated at not so large, unadjusted areas without any sanitary hygienic conditions; disintegration or total failure of the water supply system, food sector and catering, trade, municipal services, as well as insanitation of the environment.

In Armenia like nowhere else in the world the calamity resulting from the earthquake was inter-related with other powerful factors, amongst which were the war, communications, energy and economy blockades of the country, which worsened and aggravated the complicated state of affairs.

Despite the high risks of epidemic outbreaks in a period of Armenian earthquake (1988), neither epidemic outbursts, nor group infectious diseases and food poisonings were registered. This was possible due to correct tactics and distinctly implemented preventive and anti-epidemiological actions.

The study on the experience of activity performed in the Armenian earthquake zone (1988) during liquidation of the disaster after-effects has a great scientific and practical significance for development of a system ensuring anti-epidemiological safety of population, taking into account that such research and development is lacking in the world practice

Keywords: natural disaster, ecology, hygiene, epidemic, organization, water-supply system, infections, prevention, disease prevalence

Introduction

December 7, 1988: in the northern part of Armenia there was a huge devastating earthquake with the epicenter between the town of Spitak and Leninakan city (nowadays Gyumri). About 40 % (11.3 km) of country territory, embracing 24 cities, 16 administrative districts,

344 settlements with the population of 596.9 thousand persons, had strongly suffered. The most severe blow had fallen to Spitak, Leninakan, Kirovakan (nowadays Vanadzor), Stepanavan; 58 settlements had been razed to ground.

As a result there was a destruction of all industrial and agricultural entities and facilities on this territory, destruction of the water supply and power-supply systems. In consequence of this awful natural disaster according to official

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data 25 000 persons deceased, 32 000 were wounded, 40 thousand persons were rescued from under the tumbledown, thousands became invalids and orphans. Material loss from the earthquake even by the most approximate calculations made 13 milliard rubles (in 1988 prices).

It is known that natural calamities, including the earthquakes, are fraught with the potential destructive properties bringing forth the most complex ecological, socio-hygienic and epidemiological situations. These latter, in their turn, condition the outbursts of infectious diseases (the extremely dangerous infections amongst them), mass poisonings, etc. [Dunsmore D. 1986, Belyakov V., Zhuk E., 1988; Mayrapetyan A. 1997; 1998a; 2005]. As a rule, the natural disasters were almost always accompanied by the epidemical outbursts.

To factors capable to influence the emergence and spread of infection diseases under extreme situations belong the following ones: mass (total) character of injuries bearing non-infectious features, prevalence of combined injuries, psychic stress, disorganization of social structures, intense migration processes, endless streams of people forced to leave the affected zone; partial or complete destruction of health care logistics, disorder of treatment-and-prevention services, as well as that of state sanitary surveillance, disintegration of ecological systems [Barker D., Bennet F., 1982; Becker W., 1990; Keller A. et al., 1990; Noji E. et al., 1990; Struve S. 1990; Bold B. 1991; Noji E., 1993; 1994; Noji E., Frumkin H. 1994; Shrivastava P. 1995; Shultz C. et al., 1996].

In the zone of disaster a grave situation emerged and was fraught with the danger of epidemic outbreaks of a number of infectious diseases in general population and in the cohorts of new-comers: life-savers and builders who arrived to perform construction/reconstruction works. The most favourable conditions were created for epidemic complications: huge mass of people cumulated at not so large, unadjusted areas without any sanitary hygienic conditions

(frequently they found shelter in tents, motor-garages, basements of residential houses, etc.); disintegration or total failure of the water supply system, food sector and catering, trade, municipal services, as well as insanitation of the environment. This is the incomplete list of negative factors, which in the aggregate predefined the hazard of emerging epidemic outbursts. On the background of activated stress-inducing factors there was a threat of wide prevalence of a number of diseases caused by conditionally pathogenic and pathogenic microorganisms [Belyakov V., Zhuk E., 1988; Aznaurian A. et al., 1990]. The situation was worsened by the fact that the material and technical basis of medical establishments, in particular, sanitary-epidemiological services were damaged and the rhythm of activity of these institutions was entirely interrupted.

At the same time the situation that arose in Armenia after the devastating earthquake by its numerous manifestations differed from other cases of earthquakes and calamities in general. The cause was conditioned by the fact that in Armenia like nowhere else in the whole world the calamity resulting from the earthquake was interrelated with other powerful factors, amongst which were the war, communications, energy and economy blockades of the country, which worsened and aggravated the complicated state of affairs [Mayrapetyan A. 1997; 1998 a,b,c].

In addition, it should be emphasized that till present the earthquake consequences are not liquidated in full: either in the sphere of housing problems solution or in concern of recovering the industrial capacity, facilities of culture, education, public health. In such a major city as Gyumri (former Leninakan) about 3700 families still continue to dwell in temporary constructions under severe conditions, which frequently exclude even elementary hygienic conveniences. Thus, one can state that in practice from the sanitary hygienic point of view the state of calamity in the earthquake zone and the associated epidemiological risks still exist and constant endeavors are required in order to ensure control over the

situation and its development; in order to prevent hygienic and epidemiological complications constant endeavors are required.

Despite the complex character of the situation and the high risks of epidemic outbreaks in a period of Armenian earthquake (in 1988, neither epidemic outbursts, nor group infection diseases and food poisonings were registered) immediately after the disaster or later on. In our opinion [Mayrapetyan A. 1990; 1998a,b,c] and according to judgment of a number of specialists [Korolkov V. et al. 1990; Onishchenko G. et al. 1990], who took part in liquidation of the earthquake consequences, this became possible only due to correctly selected tactics and distinctly implemented preventive and anti-epidemiological actions in the zone of calamity.

Materials and Methods

In order to prevent severe after-effects or at least to limit their scales in case of disasters the necessity is becoming highly urgent to carry out comprehensive study and thorough analysis on the experience gained due to activity performed in the zone of earthquake (Armenia, 1988), taking into consideration the abovementioned peculiarities ever more worsening the situation that arose in the country as a result of the earthquake, moreover that as shows the history of mankind till present no country of the world has done everything required for minimizing the consequences of major catastrophes [Hayryan A., 1984]. At present, there is a considerable increase in significance of studies aimed at summarizing, scientific substantiation and comprehension of the experience gained in different countries especially taking into consideration the activation of international terrorism, the events of September 11, 2001 in USA and further occurrences in other parts of the world. Hence the study on our experience in the Armenian (1988) earthquake zone has a great scientific and practical significance for the development of a general concept, taking into consideration that, as shown by the analysis of literature data, such R& D is lacking in the world practice. The

initial material for a study on the problem was the complex situation that arose in the zone of disaster as a result of the destructive earthquake. The situation was conditioned by the collapse of the entire infrastructure of entities ensuring services to general population: water supply system, sewerage, trade, catering, food industry, services, etc., as well as by the total anti-sanitary, numerous tumble-downs, huge amounts of cumulated building/constructional wastes, mass accumulation of people without any shelter and elementary hygienic conditions. All the above mentioned was prone with the high risk for emergence and spread of epidemic outbreaks of numerous infectious diseases.

While performing this research we studied and summarized numerous documents dealing with the activity of the public health bodies on liquidation of the after-effects of the earthquake; in particular, the activity of the sanitary service, including our own work was studied, as well as the activity of other Agencies and civil engineering organizations from all USSR republics, the representatives of which arrived to the earthquake zone. Different reports, on-line data on prevalence of infectious diseases, etc. were also studied.

For research all known methods and approaches were used: epidemiological, hygienic, statistical, laboratory, etc.

One of the most important issues for ensuring the hygienic and epidemiological wellbeing in the zone of calamity is decreasing the risks and prevention of epidemiological outbursts of intestinal infections (cholera, typhoid fever, paratyphoid, dysentery, common intestinal group of hepatitis, etc.), in particular: water-borne infections. The real threat of this risk was first of all associated with the sanitary and technical state of the water-supply system. Ensuring the sanitary-epidemiological wellbeing in the zone of disaster, working out the tactics and principles for organization and carrying out preventive and anti-epidemiological measures the initial information on natural, socioeconomic

and medical geographical peculiarities of the region of a disaster acquired high significance [*Hairiyan A. 1984; Keller A. et al.; 1990; Korolkov V. et al. 1990*]. Special part was devoted to knowledge on nosogeography of anthroponose and zoonotic infections, as well as characteristics of epidemiological and epizootic processes for revealing the risks of epidemic complications emergence, prognosis of situations, and decision making.

Upon obtaining the information about the Armenia earthquake of December 7, 1988 the Ministry of Health of the Republic of Armenia directed 3 brigades to the zone of disaster; each team was comprised of specialists in epidemiology, communal hygiene, and hygiene of nutrition. Then the next day 5 more brigades were assigned, including also specialists on radiology and bacteriology. In compliance with the decision of the USSR Ministry of Health 5 specialized anti-epidemiological brigades from Rostov, Stavropol, Saratov and Volgograd anti-plague institutes were also sent to the zone of calamity.

Since the very first days after the natural disaster it became obvious that in the extreme situation for stabilization of the state and prevention of epidemiological complications the commonly applied principles and approaches to organization of anti-epidemiological activity could not ensure the desired effect. A challenge arose before the sanitary epidemiological services to work out and apply new non-standard, more efficient methods and principles for implementation under the extreme conditions, as in case of clear-cut tactics and precise arrangement of the activity it could secure the required results [*Onishchenko G. et al., 1990*].

In order to ensure complete control on disaster area a decision was made to divide the settlements into sectors depending on area and population size. For each sector brigades of specialists were assigned responsible for control and preventive anti-epidemic measures in the sector. In the city of Leninakan 12 brigades were functioning, in Spitak town and Spitak region 8, and in Stepanavan town and rural

area there were 7 brigades. The brigades involved medical doctors: epidemiologists, hygienists, disinfectionists, pediatricians, etc. Each brigade was provided with the special sanitary vehicles. During the daily rounds on the area the staff of these brigades allowed to identify sick persons and those “suspected” for infectious diseases, children, pregnant women, as well as to carry out preventive actions, etc. [*Mayrapetyan A. 1990; 1998 a; b; c*]. The complete information about the identified patients was transferred by portable radio transmitters to the Emergency Service for their further observation and hospitalization in a specially arranged infectious hospital. Brigade-based arrangement of activity was highly appropriate and had an invaluable part not only in the aspect of sanitary and epidemiology, but also in concern of treatment and prevention in general population, especially in the initial period, when the local/district medical network was not functioning in practice. The brigades executed control on sanitary-hygienic state of the water supply system through sampling water for bacteriological and sanitary-chemical laboratory analyses, arrangement of public catering, as well as total supervision of the state of sectors.

Jointly with the governing bodies of Sanitary Epidemiological Service, the representatives of which were in the zone of disaster, the structure, membership and functions of specialized anti-epidemic teams were changed and specified. Besides the specialized functions for epidemiological surveillance on extremely dangerous infections these teams had to solve also more general tasks: prevention of intestinal infections, grippe, laboratory diagnoses of intestinal infections, control on the quality and state of drinking water.

In addition to anti-epidemiological brigades of general indication the special hygienic brigades were also arranged to control water-supply entities and system, and entities of catering. Specialized brigades were formed to perform disinfection in the foci of infection, in places from where corpses were removed and buried, etc.

In order to ensure the hygienic and epidemio-

logical wellbeing in the zone of calamity the “Cross-cutting integrated Programme for ensuring sanitary-epidemiological wellbeing in towns and regions of the republic that suffered the earthquake” was developed by Ministry of Health of Armenia and approved by the Government of Armenia and the USSR Ministry of Health. Identical plans were also developed for every town and region. Mentioned plans presupposed actions, responsible bodies, such as a number of republican ministries and agencies (the agricultural production sector, Ministry of housing community management, Ministry of domestic services, Ministry of trade, Ministry of internal affairs, etc.), city and regional councils. The sanitary epidemiological service constantly controlled implementation of the Programme, focusing on the situation at the sites of disaster, especially in places, where the aftereffects of the earthquake were grave, and timely responded to situations which caused concerns.

Results and Discussion

One of the most important challenges for carrying activity in the zone of calamity is the prevention of outburst of intestinal infections, in particular water-borne ones. In this respect great significance was acquired by the initial information about this problem prior to the earthquake. According to data available the level of disease prevalence in regions and towns of the zone of disaster before the earthquake, in particular the spread of typhoid fever, paratyphoids, etc., salmonellosis, bacterial dysentery, and a group of acute intestinal diseases, was characterized by intense indices at the level equal to or below the average republican values, while these latter were below the average all-union indices. However, we took into consideration the fact that in certain years before the earthquake in some areas of disaster zone there were group cases of intestinal infections associated with pollution of tap water and it should be emphasized that these cases were mainly registered in major towns of the region. In the city of Leninakan with population above 200,000 persons the last

case of such infections occurred in 1980, when the number of patients made 60. The intense index of disease prevalence made 30.0 compared to 6.6 of an average republican level and 4.8 of the all-union level for the same year. In the city of Kirovakan the last such outburst took place in 1976 with the number of sick people making 36 and the index of disease prevalence 27 compared to average republican (8.0) and all-union (5.7) levels for the same year. This initial information was of great significance for assessment/valuation of the situation, as well as for planning and implementation of anti-epidemic actions.

In this respect the situation caused concerns. It is sufficient to mention that only in towns and urban-type communities of the zone of calamity 304 km of water pipes were out of order, thus making 20% of all water supply network. Out of 1420 km of the water net 513 km or 41.8 % were entirely ruined, while 594 km (41.8%) were in accidental state. Thus, the specific gravity of entirely ruined and accidental water supplies made 78% of the total. Only in Leninakan 140 km (40%) of the 343 km water supply net was out of order.

As a result of these breakdowns there occurred unchecked pollution of a significant portion of drinking water. The fact of intense drinking water pollution by the sewerage water was confirmed by the laboratory analyses according to which the hygienic indices of drinking water worsened hundredfold: nitrates and nitrites were present in water samples, while there was absolutely no residual chlorine. For example, in Spitak *coli* index of drinking water was worsened 150-200 times, the content of ammonia made 1-5 mg/L, chlorides 20-60 mg/L, sulfates - 130-200 mg/L, dry residue 350-400 mg/L.

In order to avert the threats of water-borne outbreaks of intestinal infections, first of all as an emergency measure the damaged and ruined water supplies were disconnected. Sanitary epidemiological teams (brigades) visited the inhabited area, the camps of emergency and building workers, etc. and warned the population about

the existing threat of transmission of the infections with water. The practice to render information by means of megaphones proved to be efficient. Later on, when the radio broadcasting system worked anew, the information campaign continued via the local radio. A great number of precautionary leaflets was disseminated among the population and emergency workers, informing about the threat to use unboiled drinking water. Recommendations were given to prevent the spread of diseases. In particular, general population and emergency workers were insistently recommended to use even the tested water only after boiling. The decision was made to use bottled mineral water for general water use, as it was entirely substantiated from the hygienic and epidemiological point of view. Mineral water was brought to the zone of disaster from other towns and regions and distributed immediately in the streets, at temporary dwellings, etc. For the first days this action was an appropriate and even life-saving one. However, it was impossible to solve the problem only by means of mineral water, especially for a long time. Therefore, new additional measures were taken, in particular, to use earlier abandoned low-efficacy water supply sources, for which there was no necessity before the disaster and due to the presence of powerful centralized water supply system. From these small wells the water was taken for use only after the thorough laboratory examination and upon issuing an appropriate permission of the State sanitary inspection bodies.

The deficiency of good-quality drinking water was also overcome by water brought in cisterns from the problem-free areas outside the earthquake zone. To ensure entire guarantee laboratory checks were done and chlorination of water at special control sites guarded by military troops. Cisterns with water were allowed to enter the zone of disaster only after these measures. Examination and chlorination of water was performed by the personnel of the State Sanitary Epidemiological Supervision (5 g dry matter per 1 m³ water; exposure time= 30 min.). All the

auto-cisterns involved in drinking water supply were passportized; the drivers were exposed to obligatory medical examination and got appropriate instructions [Mayrapetyan A., 2006b].

Epidemiological services performed activity to identify and remove the accidental sites of water and sewerage networks issuing official permissions to resume exploitation in each specific case after the appropriate preventive measures (disinfection of water-supply and water network, control laboratory checks, etc.).

In order to ensure overall guarantee of water intended for use by the general population we worked out and implemented new strict regimen for drinking water chlorination was developed in order to achieve overall guarantee. High levels of chlorine were used: 1.5 – 2 mg/L so that at the end-point the residual chlorine made no less 0.5-0.7 mg/L.

The constant laboratory control on the quality of drinking water was exercised at numerous points and in quantities ensuring actual control of all the sites of the water-supply system. Only by the Sanitary epidemiological services in Lenakan about 100 bacteriological analyses of water were performed daily. During January 1989, the number of such analyses achieved 7151, of which deviations made no more than 1.5%. In different settlements of Spitak region it was 2.5% - 10% (number of analyses = 2300), in Stepanavan 830 analyses were performed, in Kirovakan – 345, etc.

All in all, beginning with the second and third weeks almost everywhere on the main affected area, including such major city as Lenakan, water was supplied in 97-98% accordance with the GOST [State Standard] and the task to prevent the outbreak of intestinal infections through the drinking water was completed.

Another important problem of prophylaxis of intestinal infections and food poisonings was that of foodstuffs. Implementation of this task was hindered by the fact that in order to arrange meals, including hot foods there were functioning numerous temporary facilities, while the

non-professional personnel was frequently hired without the previous experience in this sphere, even without the medical checks and medical permissions on the part of bodies of Sanitary epidemiological services.

In Leninakan, there functioned 143 such entities, including 70 catering facilities, 64 trade entities, 9 - of food industry. Under the complex conditions the bodies of Sanitary epidemiological services performed enormous activity to arrange the work at these entities, passportization thereof followed by issuing recommendations for ensuring the hygienic order. First of all the requirement was dictated and implemented to deliver hot food only in expandable (single-use) table-ware.

The requirements were imposed to secure the functioning entities with the temporary cold and hot water facilities, refrigerators. Under the severe extreme conditions the personnel of the State sanitary surveillance daily reported at the Headquarters meeting about the situation and got the tasks to act more strict and rigorously despite the opinion of numerous local party leaders, Soviet and economical leaders/authorities, who considered such severe approach inappropriate. In particular, to this testified the fact that during the first months after the earthquake 65 entities were closed and 41 employees were dismissed. In Leninakan fines were imposed on 39 persons for the unsatisfactory state of the entities; 30 such entities/facilities were temporarily stopped, and 12 persons dismissed. To ensure legal/legislative basis, Temporarily Sanitary Rules were extraordinarily developed and implemented for the entities of catering, trade and food industry. The requirement was implemented to perform at least once a month medical examinations of individuals engaged in this sphere. The laboratory bacteriological control was strengthened as well as the control for *Escherichia coli*. During the period of activity, totally 9050 samples were taken from these entities; the number of positive ones made 1805 (20%). In Spitak the analyses revealed that positive cases of wash-off liquid from the tableware, equipment made 10.6%; as

to wash-offs from the tables, the positive cases achieved 44%, while wash-offs from hands of the personnel were positive in 5% of all cases, thus confirming once again the strict position of the bodies of State Sanitary Supervision.

In order to prevent the intestinal infections and food poisonings the strict control was exercised at the entities of food industry, catering and trade, temporary dwellings of construction workers. With this aim Temporary Sanitary Rules were developed and implemented and the laboratory control strengthened. Only in January 1989, 65 entities ceased functioning until the revealed violations were eliminated; 41 dysentery carriers were dismissed.

The phage-prevention, as well as mass prophylaxis of grippe by means by Remantadin application was for the first time widely implemented within the entire complex of preventive and anti-epidemic measures in the zone of the Armenian disaster [Mayrapetyan A., 1998]. Such decision was dictated by the high risk of emergence and spread of intestinal infections and grippe, as well as by desire to achieve express effects in a situation when no alternative measures exist in practice.

The phage-prevention among the population of the zone of calamity and builders who came to recover the zone, was performed using the bacteriophages for typhoid fever, dysentery, and salmonellosis. Totally 400, 000 individuals were phaged. Mass prophylaxis of grippe with the use of Remantadin was done in a cohort of 183,000 individuals. Children and elderly persons were given interferon (about 70,000 individuals) in combination with the multivitamins.

These complex measures turned to be sufficiently effective in a period immediately after the earthquake and further on, in 1989 – 1990, in the zone of disaster no outbreaks of infectious diseases or group morbidity were registered. The spread of typhoid fever, paratyphoid, salmonellosis and other intestinal infections was below the level of previous years or at the same level.

In the earthquake zone no epidemic increases

of grippe spread was registered; on the contrary, in 1989, this morbidity in the zone of calamity was 1.5-3 times lower compared to the previous year and compared to other regions of the republic, which were not affected by the earthquake. For characterization of the general epidemiological situation in the zone of the Armenian earthquake (1988) we consider necessary to mention that it was evaluated as stable in concern of a number of manageable infections (diphtheria, poliomyelitis, tetanus, etc.) in the years before the quake. Alongside with the registration of a number of diphtheria outbreaks in certain countries of the European region, in particular in Former USSR republics, the epidemiological situation for diphtheria remained to be problem-free in Armenia for a long time.

As to main infections of this group: diphtheria, poliomyelitis, tetanus, whooping cough, measles during a decade prior to the earthquake in Armenia, including the region that afterwards became a zone of calamity, the epidemiological situation was mainly favourable; to this latter signified data on disease prevalence for both the republic and the earthquake zone. According to mentioned data no cases of diphtheria were registered in Armenia for 7 of the preceding 10 years, while for the rest 3 years it was registered as instances with the intense indices 3, 6, 17 times below the average USSR indices for the same years: 0.06 and 0.34 in 1982; 0.03 and 0.51 in 1983; 0.09 and 0.3 in 1988, appropriately).

During the period of 1985-88, in some towns and regions of the earthquake zone the cases of diphtheria and tetanus were either single or no cases were registered. No cases of poliomyelitis were registered. As a rule, whooping cough and measles morbidity in mentioned regions and towns before the quake was low compared to average all-union indices. The following data signified to the satisfactory state with the inoculative immunity. Before the earthquake the coverage of children below the age of 3 years in concern of diphtheria and tetanus made 75-82%, while for poliomyelitis it was 84-96%.

This was also confirmed by data of serological studies, according to which prior to the earthquake in cities of Leninakan and Kirovakan, Gugark, Spitak and some other regions the specific gravity of children seronegative to tetanus and diphtheria never exceeded 10%, thus signifying to the satisfactory protection of children. In the area of Leninakan, Kirovakan, Gugark, Stepanavan the specific gravity of children seronegative to poliomyelitis type I, II, and III made accordingly 9.2%, 6.5% and 14.3%, also signifying to satisfactory protection and immunity of children.

The above-mentioned implies that prior to the earthquake in towns and districts of this region the epidemiological situation on children's manageable infections was stable and, on the main, gave no reasons for special concerns. However, with the emergence of new powerful factors the resulting situation was subject to extreme changes.

Such factors capable to activate the epidemic process were mass accumulation of people, in particular children, in the zone of calamity under strained conditions of temporary dwellings without any hygienic conveniences, the factor that undoubtedly stimulated amongst others the quick spread of droplet infection, if infection carriers and patients were present and this latter could not be excluded. The next factor negatively affecting the epidemiological situation was the influx of life-savers and builders from different regions of USSR and foreign countries, including those unfavourable from the point of view of diphtheria, poliomyelitis and other infections.

The threat of worsening the epidemiological situation on different infections was aggravated by migration processes of population from the zone of disaster to other regions of the country and mass accumulation of people in different places: hotels, boarding houses or any premises adjusted for living purposes, as well as by contralows of refugees from Azerbaijan immediately before the earthquake and their concentration in different settlements of Armenia, including the earthquake zone.

All the above-mentioned created a highly explosive situation for emergence and spread of infectious diseases, including children's manageable infections. The available scientific publications on a decrease of immunity for manageable infections as a result of stressful conditions also provided information on possibility to decrease the immunity in children earlier inoculated against diphtheria, poliomyelitis, tetanus, and other infections. Thus, there were a number of powerful negative factors, which in aggregate created favourable conditions for a "break-through" of immunity to manageable infections and occurrence of epidemic complications not only in the earthquake zone, but in the republic as a whole.

While planning and carrying out preventive measures the administration and specialists of the Sanitary Epidemiological Service thoroughly studied and considered all the mentioned circumstances. The republican Ministry of Health developed a programme of preventive actions on raising the protection of general population in concern of mentioned infections. To our conviction, application of mass vaccine prophylaxis amongst the population of the calamity zone and other regions of Armenia might have become such an action. Random serological studies confirmed the fact of a decrease of inoculation-connected immunity. For example, in Spitak region random serological study demonstrated that the specific gravity of children seronegative to poliomyelitis made 38% for type I, 35% for type II and 50% for type III. The entire mass of information was taken into consideration upon planning and implementation of anti-epidemic measures.

Mass vaccine-based prevention of children was arranged and held in 2 rounds: the 1st round in 1989 and the 2nd in 1990.

In the zone of calamity and places of children's concentration 137 392 children aged 0 to 14 were registered (the coverage by the inoculations made 91.8%). During the 2nd round 130727 children or 95% of the total number of

those registered were inoculated.

Children at the age from 3 months to 4 years were additionally vaccinated with combined vaccine against whooping cough, diphtheria and tetanus while children aged 4-14 years got single combined vaccine against diphtheria and tetanus. Immunization against poliomyelitis was done twice with the time interval between the inoculations in children from 3 months to 5 years made 1.5 month. The number of refugee children of all age groups vaccinated against diphtheria, tetanus and poliomyelitis made 24 218.

Data of serological studies performed after the second round confirmed the presence of a reliable immunological barrier amongst the children against diphtheria, tetanus and poliomyelitis. In particular, for diphtheria the specific gravity of seronegative children in Leninakan made 5.6%, in Artik region - 2 %, in Kalinin region 8.2%. For tetanus the values were as follows: in Leninakan: 2.8%, in Stepavan region 1.8%, in Kalinin region 4.9%.

For poliomyelitis in Leninakan according to types I, II and III -11.1%, 8.2%, 25%, in Akhuryan region 8%, 6%, 14%, in Stepanavan region 4%, 10%, 30%, appropriately.

To the effectiveness of the performed mass vaccination against diphtheria, tetanus and poliomyelitis signified absence of disease cases of these infections in towns and regions of the earthquake zone round the year 1989 and in subsequent years.

For assessment/evaluation of the situation and prognosis of its development an important part was devoted to a number of problems dealing with the extremely dangerous infections in connection with the high degree of risks for epidemiological complications. It was conditioned by the fact that 1 of 3 meso-foci of plague and tularemia existing on the territory of Armenia particularly the Leninakan meso-focus of Trans-Caucasian highland focus covered exactly the territory of the earthquake (Leninakan, Spitak, and the adjacent rural regions). Prior to the earthquake in all the 3 meso-foci epizooties of plague

and tularemia were registered [*Onishchenko G. et al. 1990; Mayrapetyan A., 2006a*]. Single cases of plague in humans were registered in Armenia in 1958 and 1975. Cases of tularemia in the republic were registered in different years; there were even outbreaks of the disease in 1954, 1964, 1965, and 1974. To the real threat of epidemic complications signified the fact that immediately before the earthquake in Bogdanovski region of Georgia bordering with Shirak region of Armenia (Leninakan and adjacent districts) a water-borne outburst of tularemia in humans occurred. The number of patients was above 200.

The epizootological and epidemiological situation on other extremely dangerous zoonotic infections was also unfavourable: in the majority of rural regions in concern of brucellosis and in some of them in concern of anthrax as well. The last circumstance acquired great significance as during the recovery and ground work, excavation in the zone of calamity the spores of anthrax agent might have been propagated into the environment.

For evaluation of the created situation and forecast of its further development an important part was devoted to a number of questions referring to extremely dangerous infections, as in the region covering the zone of calamity there were serious problems of high risks for epidemic complications. It was conditioned by the fact that out of 3 foci of plague and tularemia at the territory of Armenia within the Trans-Caucasian highland (Zangezur-Karabakh, Leninakan, Sevan area) Leninakan meso-focus covered the earthquake zone as such: Leninakan city, town of Spitak and the adjacent rural districts. Earlier in all the 3 meso-foci epizooties of plague and tularemia were registered, as well as cases of diseases in humans. Single cases of plague in humans were registered in Armenia in 1958 (Artagyugh village of Spitak region – 1 case) and in 1975 (cattle-breeding farm in Agudi village of Sisian region). The cases of tularemia in humans were registered in Armenia in different years, however

there were outbreaks of this disease at Leninakan meat-processing plant in 1954 (168 cases), water-borne outbreaks in 1964 (Tokhluja village of Krasnoselsk region 12 cases), in 1965 (Tsovinar village of Martuni region 12 cases), in 1974 Sevan psychiatric facility - 70 cases.

To the real threat of epidemic complications due to plague and tularemia signified the fact that prior to the earthquake in Bogdanovski region of Georgia near the boundaries with the Shirak region of Armenia (Leninakan and adjacent regions) there was a water-borne outbreak of tularemia in humans (number of patients was above 200 persons).

The risk of extremely dangerous infections emergence, in particular that of plague and tularemia occurrence was real enough if the following circumstances were taken into consideration: (1) natural foci of plague and tularemia in the region covering the calamity zone and in the vicinity of settlements and places where the teams of builders were dislocated; (2) constantly occurring epizooties in rodents on the territory of the mentioned natural foci, to which signified isolated culture of plague and tularemia agents (768 during the decade before the earthquake); (3) cases of plague occurring as single occurrence and tularemia as group water-borne diseases in different years. In order to prevent the epidemic after-effects in the zone of calamity the bodies of Sanitary epidemiological services arranged and carried out emergency targeted actions. For prevention of plague and tularemia the anti-plague service (Armenian anti-plague station and specialized anti-epidemic teams of the USSR anti-plague institutions) jointly with the local bodies of Sanitary epidemiological service implemented a number of large-scale complex measures. In order to inhibit the activity of epizooties in rodents the actions were arranged and performed to exterminate rodents on the territory of natural foci and settlements making about 20 mln m^2 . The resulting rodents-free zones and the fight against sanantotropic rodents in inhibited places and builders' camps on the total area of 251 000

m^2 were also positive.

Alongside with these measures were taken for identification of suspicious sick persons and their hospitalization by means of daily medical rounds and examinations in general population, as well as in order to raise the level of protection by preventive vaccination in cohorts of high risk (against plague) and mass inoculation in rural population (against tularemia). Totally 6 000 individuals were inoculated against plague and 126 000 against tularemia. As a result of performed complex targeted preventive and anti-epidemic measures it became possible to control the epidemiological situation and to avoid the emergence of epidemic outbursts of extremely dangerous infections. Moreover, in the zone of disaster and in the republic as a whole no cases of plague or tularemia were registered during the years after the earthquake. Due to these actions it became possible to liquidate epizootics of the mentioned infections.

It should be mentioned that the epizootic and epidemiological situation on other extremely dangerous zoonotic infections was also unfavourable. The majority of rural regions of Armenia were not safe for brucellosis and some for the anthrax as well. The last circumstance acquired greater significance in concern of the fact that under conditions of recovery and ground works in the zone of the earthquake there might have been dissemination of spores of anthrax and this point required special attention.

The general management on carrying out anti-epidemiological measures against the extremely dangerous infections was performed by the sanitary Epidemiological service of the Ministry of Health of Armenia, while the practical realization was done by the regional, urban sanitary-epidemiological stations with the direct participation of the Armenian anti-plague station and the Research anti-plague institute of Caucasus and Trans-Caucasus.

The entire complex of alternative measures on extremely dangerous infections became a significantly stable "shield" for the prophylaxis:

- Mass vaccination against tularemia in Leninakan (in high risks groups), in Amassia, Spitak, Ghukasyan and other regions;

- Homesteads rounds performed by medical doctors in order to identify patients with extremely dangerous diseases;

- Thorough epidemiological surveillance on the sites of plague, tularemia epizootics (epizootologic examination, sanitary awareness-raising activity, etc.)

Actions on rodents' extermination at the territory of Spitak region and the suburbs of Leninakan, where in 1989 single strains of plague and tularemia agents were identified, were of high importance as well.

One of the important challenges for ensuring sanitary epidemiological welfare in the zone of disaster was to implement the sanitary hygienic control on the temporary builders' camps. For this purpose the Ministry of Health of Armenia worked out and circulated Temporary Sanitary rules on the maintenance of builders' camps. During the first months 35 recovery-and-constructing teams embracing 4775 specialists, including 284 females, from 29 ministries and agencies of the Former USSR worked in Leninakan. To ensure normal conditions of life in the builder's camps 910 wash-hand-stands (1 per 5 individuals), bathes, showers, (up to 5 for 11 teams), 77 removed toilets (1 per 10 individuals) were arranged, while the clothes were washed in a bath-and-laundry train (further on it was done in town laundries). It should be mentioned that alongside with the arrival of new cohorts and teams, the number of builders' camps increased, new problems arose and the bodies of sanitary epidemiological service timely informed about them the team managers, coordinators from the ministries and agencies in accordance with their belonging and the problems were solved.

In the zone of the earthquake huge work was performed to ensure sanitary hygienic welfare of the territory. In towns with the destroyed sewerage system after the coordination with the

sanitary epidemiological service removed toilets were arranged at the places of temporary dwellings, near to the salvage works; measures were taken to remove the wastes in timely mode, to disinfect toilets, wastes, tumble-downs. In Lenakan there were arranged 325 such toilets. Total disinfection of the area was performed with the help of special auto-disinfection facilities.

An important part of sanitary-hygienic and anti-epidemic activity in case of emergency situation is the information and awareness-raising, the aim of which was considered the “traditional” ensuring the hygienic and epidemiological welfare of the population.

The awareness-raising talks involving discussion with the use of printed materials turned to be the most effective type of activity in such a situation. Compared to other traditional methods of information-instructive activity awareness-raising talks became the integral part of patronage (regular prophylactic and medical attendance) of the general population, teams of builders and military brigades.

To our mind, the principles for organization of the awareness-raising activity in extreme sit-

uations should be delivered at the lectures within the “Sanitary-epidemiological service in extreme situations occurring under natural calamities and catastrophes” post-grad cycle for medical doctors, as well as in the frames of other training other specialists.

Due to targeted implementation of preventive measures against the extremely dangerous infections, which was done by specialized anti-epidemiological brigades from leading anti-plague institutes from Russia, Armenian anti-plague station and the sanitary epidemiological service of Armenia after December 1988 and further on, no cases of plague, tularemia, anthrax, epidemic [louse-borne] typhus, etc. were registered.

Thus, due to appropriate planning, targeted implementation of complex anti-epidemic measures, arrangement of activity performed by bodies and establishments of sanitary epidemiological service according to new, non-standard principles and approaches it was possible to avoid outbursts of infectious diseases and to ensure sanitary-epidemiological welfare in the zone of disaster.

REFERENCES

1. *Aznaurian A., Khachatrian S., Zilfian A. et al.* New Scientific and Methodological Approaches in Implementation of Curative and Preventive Measures in the Disaster Area. In: Medical aspects of earthquake consequences in Armenia. Yerevan, 1990; 190.
2. *Barker D., Bennett F.* Practical Epidemiology, Edinburgh, Churchill Livingstone, 1982.
3. *Becker W.* Military Medical Response to Civilian Catastrophes. In: Materials of International Conference “Disaster Medicine”, Moscow, 1990; 423
4. *Belyakov V., Zhuk E.* Military [Hygiene and Epidemiology], [published in Russian]. Moscow, 1988.
5. *Bold B.* Balance of Risks and Benefits in Preparation for Earthquakes. Science, 1991; 251: 169-174
6. *Dunsmore D.* Safety Measures for Use in Outbreaks of Communicable Diseases. Geneva, WHO, 1986.
7. *Hairiyan A.* To the Socio-ecological [Prevalence of Human Diseases] [published in Russian], Yerevan, 1984. .
8. *Keller A., Korolkov V., Furgal S.* Medicogeographical Aspects of Disaster Epidemiology. In: Medical Aspects of Earthquake Consequences in Armenia. Yerevan 1990; 19-20.
9. *Korolkov V., Keller A., Furgal S.* Problems of Disaster Epidemiological Consequences. In: Medical Aspects of Earthquake Consequences in Armenia. Yerevan 1990; 181.
10. *Mayrapetyan A.* Attainment of Favourable Hygienic and Epidemiological Situation in the Zone of the Earthquake in Armeni. In:

- Medical Aspects of Earthquake Consequences in Armenia. Yerevan 1990; 183 - 184.
11. *Mayrapetyan A.* [New Approaches to Ensure the Effectiveness of Anti-epidemiological Measures in Case of Natural Calamities (from our experience in a period of Armenian Earthquake, 1988)] [published in Russian] In: Proceedings of the Yerevan State Medical University 1997; 1: 90 - 92. .
 12. *Mayrapetyan A.* [Organization and Tactics of Anti-epidemiological Measures under Conditions of Natural Calamities (based on our experience of arranging activity in the zone of 1988 Armenia earthquake)] [published in Russian]. J. of Microbiology, Epidemiology and Immunology, 1998a; 6: 87-90.
 13. *Mayrapetyan A.* Infection Diseases after Spitak Earthquake (Report 1) Armenian Monthly Public Health Report, 1998b, vol. 6, No. 6: 3-5
 14. *Mayrapetyan A.* Infection Diseases after Spitak Earthquake (Report 2) Armenian Monthly Public Health Report, 1998c, vol.6, No. 7: 3-6
 15. *Mayrapetyan A.* [Certain Scientific and Organizational aspects for Planning and Implementation of Anti-epidemiological Actions under Extreme Conditions] [published in Russian] Bulletin IAELS, St. Petersburg, 2005; V.10, No. 6: 24-28. .
 16. *Mayrapetyan A.* [To Main Problems for the Maintenance of Anti-epidemiological Safety of Population in Extreme Situations (in case of natural disasters and mass catastrophes)]. [published in Russian], Scientific Medical Journal of the National Institute of Health (Armenia), Yerevan, 2006a; No. 1: 7-17
 17. *Mayrapetyan A.* Natural Disasters: Water Supply Problems in Case of Earthquake and their Solution. The 6th General Assembly ASC 2006 and Symposium on Earthquake and Tsunami Disaster Preparedness and Mitigation, 7-10 November 2006b; Bangkok, Thailand.
 18. *Noji E., Armenian A., Oganesyanyan A.* Earthquake Injury Epidemiology. Materials of International Conference "Disaster Medicine", Moscow, 1990; 467
 19. *Noji E.* Issues of Rescue and Medical Care Following the 1988 Armenian Earthquake. International Journal of Epidemiology, 199; Vol. 22, No. 6: 1070-1075.
 20. *Noji E.* Progress in Disaster Management. Lancet, 1994; Vol. 343; 1239-1240
 21. *Noji E., Frumkin H.* More on Disaster Preparation by Schools of Public Health. Am. J. Public Health, 1994, vol. 84; 1341-1342
 22. *Onishchenko G., Fedorov Yu., Mayrapetyan A. et al.* [Resolving Complex Tasks: the Experience of Activity Performed by the Sanitary and Epidemiological Service for Liquidation of the Earthquake Consequences in Armenia] [published in Russian], J. USSR Civil Defense. 1990; 62 - 65.
 23. *Shultz C., Koening K., Noji E.* Medical Disaster Response to Reduce Immediate Mortality after an Earthquake. New In. J. Medicine, 1996, vol. 334; 438-444
 24. *Shrivastava P.* Quake Score: Nature 1, Technology. J. Philadelphia Inquirer, January 30, 1995, A 7
 25. *Struve S.* Medical Aspects of the 1989 San Francisco Earthquake. Materials of International Conference "Disaster Medicine". Moscow, 1990; 451.