

## MAIN DRAWBACKS AND UNRESOLVED ISSUES OF ELIMINATION OF MEDICAL AND SANITARY CONSEQUENCES OF CHEMICAL EMERGENCIES

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**Abstract.** *The purpose of the study is to analyze the main shortcomings and unresolved issues of elimination of the health consequences of chemical emergencies.*

*Materials and methods of research.* The experience of specialists of the All-Russian centre for disaster medicine Zashchita (ARCDM Zashchita) in eliminating the medical and sanitary consequences of chemical emergencies is studied.

*Research results and their analysis.* The article presents and analyzes the experience of participation of specialists of ARCDM Zashchita in the elimination of medical and sanitary consequences of a number of chemical emergencies. A wide variety of such emergencies and the need for targeted measures to eliminate their health consequences are shown. The shortcomings and unresolved issues of elimination of medical and sanitary consequences of chemical emergencies related to the imperfection of methodological support, insufficient technical and material support, and problems of special training of medical specialists are identified.

**Key words:** All-Russian Centre for Disaster Medicine Zashchita, antidotes, chemical emergencies, complex of medical measures, dangerous chemicals, disaster medicine, emergency medical care, medical and sanitary consequences, methodological support, special training of medical personnel, technical and material support, victims

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## ОСНОВНЫЕ НЕДОСТАТКИ И НЕРЕШЁННЫЕ ВОПРОСЫ ЛИКВИДАЦИИ МЕДИКО-САНИТАРНЫХ ПОСЛЕДСТВИЙ ХИМИЧЕСКИХ ЧРЕЗВЫЧАЙНЫХ СИТУАЦИЙ

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**Резюме.** *Цель исследования – проанализировать основные недостатки и нерешённые вопросы ликвидации медико-санитарных последствий химических чрезвычайных ситуаций (ЧС).*

*Материалы и методы исследования.* Исследован опыт работы специалистов Всероссийского центра медицины катастроф «Защита» (ВЦМК «Защита») по ликвидации медико-санитарных последствий химических ЧС.

*Результаты исследования и их анализ.* Представлен и проанализирован опыт участия специалистов ВЦМК «Защита» в ликвидации медико-санитарных последствий ряда химических ЧС. Показано большое разнообразие таких ЧС и необходимость целенаправленного проведения мероприятий по ликвидации их медико-санитарных последствий. Выявлены недостатки и нерешённые вопросы ликвидации медико-санитарных последствий химических ЧС, связанные с несовершенством методического сопровождения, недостаточным техническим и материальным обеспечением и проблемами специальной подготовки медицинских специалистов.

**Ключевые слова:** *антидоты, Всероссийский центр медицины катастроф «Защита», комплекс медицинских мероприятий, медико-санитарные последствия, медицина катастроф, методическое сопровождение, опасные химические вещества, пострадавшие, специальная подготовка медицинского персонала, техническое и материальное обеспечение, химические чрезвычайные ситуации, экстренная медицинская помощь*

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**The purpose of the study** is to analyze the main shortcomings and unresolved issues related to the elimination of the health consequences of chemical emergencies (ChS).

**Materials and research methods.** The experience of the specialists of the All-Russian Center for Disaster Medicine "Zashchita" (VCMK "Zashchita") in the elimination of medical and sanitary consequences of chemical emergencies has been studied.

**Research results and their analysis.** The specialists of the All-Russian Center for Disaster Medicine "Zashchita" have repeatedly participated in the elimination of medical and sanitary consequences of emergencies with many victims (Table).

Let's take a closer look at the process of elimination of health consequences of some accidents and incidents.

*Example 1. An accident at Dalkhimprom plant in Khabarovsk [1].*

Because of burning of 40 kg of an unknown powder, substances were formed that caused a sharp irritation of respiratory system. Almost all workers suffered. The medical man-

agement of the city and of the region within a short period of time managed to gather all the victims in one hospital, in which the maximum amount of medical forces and means was concentrated - which was very important for providing the victims of the accident with specialized medical care.

*Shortcomings:*

- it was not possible to identify the substance that caused the lesion. Clinically, the lesion was similar to chlorine poisoning. The experiments carried out later showed that cyanogen chlorine was formed, and if this could be determined immediately, then the only deceased worker of the enterprise could be saved;

- the doctor of the first ambulance car (SMP), instead of organizing "assistance for all", drove two randomly selected victims to the nearest hospital;

- the headquarters of the management of the elimination of the accident was not created immediately after the occurrence of the emergency.

*Example 2. Elimination of the terrorist attack at "Nord-Ost".* In the course of elimination of the consequences of the terror-

Таблица/Table

**Медико-санитарные последствия некоторых химических ЧС**

Health consequences of certain chemical emergencies

Место события Place of event	Год Year	Токсикант Toxicant	Число пораженных, чел. The number of victims, people				
			легкая степень light	средняя степень medium	тяжелая степень severe	погибли lost	итого total
Чувашская Республика, пос.Шумерля – ж/д авария Chuvash Republic, settlement Shumerlya – railway accident	1996	Фенол Phenol	144	46	–	–	190
г. Хабаровск /Khabarovsk	1997	Хлорциан Chlorocian	197	35	5	1	238
г. Верхняя Салда, Свердловская область Verkhnyaya Salda, Sverdlovsk Region	1999	Окислы азота Nitrogen oxides	73	17	2	–	92
г. Москва, «Норд-Ост» – теракт Moscow, «Nord-Ost» – terrorist attack	2002	Неизвестное вещество Unknown substance	119	202	300	129	750
г. Новокуйбышевск, Самарская область Novokuybyshevsk, Samara Region	2003	Монооксид углерода Carbon monoxide	51	14	5	1	71
Московская область, пос. Заветы Ильича Moscow Region, Settlement Zavety Ilyicha	2004	Монооксид углерода Carbon monoxide	4	20	13	5	42
Чеченская Республика Chechen Republic	2005	Неизвестное вещество* Unknown substance*	99	3	–	–	102
Республика Ингушетия Republic of Ingushetia	2006	Неизвестное вещество* Unknown substance*	22	4	–	–	26
г. Пермь, клуб «Хромая лошадь» Perm, Club «Khromaya Loshad'»	2009	Токсичные продукты горения Toxic combustion products	51	70	131	156	408
г. Старый Оскол, Белгородская область Staryy Oskol, Belgorod Region	2013	Хлор Chlorine	–	–	29	–	29
Кабардино-Балкарская Республика Kabardino-Balkar Republic	2014	Неизвестное вещество* Unknown substance*	80	2	–	–	82
<b>Всего / Total</b>						<b>292</b>	<b>2030</b>

\* В данном случае не была идентифицирована связь с токсическим поражением, хотя ситуация и потребовала серьезных усилий со стороны специалистов-токсикологов

\* In this case, the association with toxic lesion was not identified, although the situation required serious efforts on the part of toxicologists

ist attack, a special means was used, which caused a deep sleep of hostages and terrorists. Maximum efforts and resources were involved in providing medical assistance to the victims. Leading experts and specialists provided advice.

*Shortcomings:*

- the substance used remains unknown. There were difficulties in assessing the severity of the lesion. Symptomatic therapy was carried out;
- impossibility of medical triage of the affected;
- hospitalization was carried out through the unified dispatch service of SMP in Moscow. Those affected were distributed among 18 medical institutions, which made it difficult to imply a unified tactics of providing medical care. None of the affected were taken to specialized clinics outside Moscow.

*Example 3. Mass "poisoning" of schoolchildren in Chechen region, Ingushetia, Kabardino-Balkarian Republic.* Schoolchildren, mostly 11-14 years old girls, complained of nausea, vomiting, dizziness, and headache. In several children, these symptoms were accompanied by episodes of short-term loss of consciousness, convulsions [2, 3].

*Shortcomings:*

- erroneous diagnosis of lesions. Mass dissociative disorders (mass hysteria) were mistaken for poisoning with an unknown substance.
- incorrect assessment of the severity of the lesion. Hospitalization of some "affected" in the intensive care unit.

*Example 4. The control panel of the unified dispatching service in Stary Oskol, Belgorod region, received a message that a persistent pungent smell of gas of unknown origin was felt in polyclinic No. 2 [4].*

An emergency warning system was turned on in the polyclinic and within 10 minutes the patients and staff left the premises. None of the evacuees sought medical help.

The reason behind gas spread was the sawing of a cylinder of unknown origin for the purpose of selling it as a scrap metal.

Within 1 hour, the ambulance station began to receive calls from polyclinic staff and patients with complaints of sore throat, shortness of breath, cough, flushing of the facial skin. Seven ambulance teams were allocated. In the hospital, 35 hospital and 5 intensive care beds were prepared. A total of 32 victims were hospitalized, who were tentatively diagnosed with "inhalation damage by chlorine vapor" (5 cases of severe, 23 - of moderate, 4 cases of mild poisoning). On the next day, all patients were discharged from the hospital in a satisfactory condition. The final diagnosis is "acute mild chlorine poisoning." Initial overdiagnosis allowed not only to provide inpatient monitoring of patients, but also to make an informed decision about the severity of their condition.

*General shortcomings of work on elimination of medical and sanitary consequences of chemical emergencies.*

Medical organizations (LMO) and non-staff medical organizations are not always ready for a timely and complete implementation of medical and sanitary measures. Their readiness to act is affected by a number of shortcomings and unsolved problems, which can be divided into national (intersectoral) and private (departmental).

The use of departmental terms and criteria in assessing health consequences of emergencies and the implementation of the necessary measures to eliminate them should be attributed to national (intersectoral) shortcomings. Unification of

terms and criteria will contribute to the unification of understanding of goals and tasks within the process of elimination of emergency situations' consequences [5].

The whole process of preparation for liquidation of consequences can turn to be ineffective if there is no information about a potential emergency hazard and about what kind of accident may occur and what health consequences it can imply [6-8].

In addition, the accounting system for hazardous objects (AOO) and for the amount of highly toxic substances stored on them requires further development. Adequate information on emergency risks, assessment of the accident's scale, as well as information on a possible severity of medical and sanitary consequences are the basis for the readiness of medical and non-staff medical units to eliminate medical and sanitary consequences of emergencies. These data are necessary to ensure the readiness of medical forces and means to eliminate medical and sanitary consequences of acute chemical trauma. In addition, it is necessary to create an all-Russian register of hazardous chemical substances (OXO) and of the amount of such toxic substances. Regular monitoring of all-Russian data should serve as a basis for filling up the register.

Preparedness for elimination of the consequences of chemical emergencies is largely undermined due to the actual lack of methodological support for predicting health consequences of probable chemical accidents and incidents, which cannot be prepared within one industry framework.

The existing methods for predicting medical and sanitary consequences of chemical accidents have significant drawbacks, leading to a distortion of real consequences, which makes it difficult to objectively calculate necessary forces and means [9].

One of the most important cross-sectoral problems is the rapid determination and quantification of toxic substances both in environmental objects and in biomaterials [8, 10, 11]. To solve this problem, Rosпотребнадзор should be involved. This problem is associated with the development of methodological support, which must clearly stipulate the tasks of LMO and medical units, time of their functioning and volumes of their tasks, as well as their equipping with modern equipment, knowing the methods of sanitary-chemical reconnaissance and a competent assessment of the results obtained.

For the analysis of the majority of hazardous chemicals - AOKhV (chlorine, ammonia, carbon oxides, sulfur, nitrogen, etc.) - it is advisable to use portable devices, for example, the multifunctional gas analyzers "Dräger X-am 7000", "Golan" used at VCMK "Zashchita" - 1P", gas analyzer "Elan", as well as indicator means, for example, the express laboratory "Pchelka-R". Almost half of the AOKhV list is made up of ionic compounds: inorganic acids (hydrochloric, sulfuric, hydrofluoric, nitric and hydrocyanic acids), hydrogen sulfide, ammonia and amino compounds (dimethylamine, trimethylamine, ethylenediamine, hydrazine and its derivatives), which can be determined by portable gas analyzers and indicator means, and - after sampling and sample preparation - by ion chromatographs, for example, tests at the All-Russian Center of Disaster Medicine "Zashchita" stationary devices "Dionex ICS 2000" and "Dionex ICS 2500".

Indicators are used to determine organophosphorus compounds and hydrazine derivatives, but they are insensitive and, at best, provide a qualitative assessment. To determine these compounds, as well as dioxins, it is advisable to use gas

chromatography-mass spectrometric equipment.

To determine mixtures of unknown toxic chemicals after sampling onto sorption tubes, it is optimal to use gas chromatography-mass spectrometers with a thermal desorber, for example, the Focus DSQ device available at the VCMK "Zashchita".

Regarding the second group of tasks, it should be noted that up to now despite the adoption of a number of official administrative and regulatory documents and a fairly large number of publications, many issues of organizing and providing emergency medical care to those affected by chemical accidents have not yet been fully resolved [7, 8]. This is due to the fact that lesions in chemical accidents have a pronounced specificity associated with a variety of chemicals. There are difficulties in rendering assistance to the affected, caused by the structural disunity of the institutions and units involved in the provision of medical care to the affected, and their insufficient functional connection. Often, especially at the regional level, there is an incomplete equipping of institutions with means and medicaments as well as an insufficient readiness of personnel to provide medical care.

The issues of providing emergency medical care in the pre-hospital period are the competence of the Disaster Medicine Service (SMK) of the Ministry of Health of Russia, especially at the present stage, when a decision has been made to merge SMP and SMK [7]. The complex of organizational activities is applied to prehospital and hospital periods of the provision of SMP. When organizing the transportation of victims to LMOs an optimal routing should be carried out taking into account both the severity of the patient's condition and the capabilities of LMO. A quick assessment of the condition of the affected allows to detect those who are most in need of urgent stabilization of vital functions and to determine their priority and need for medical evacuation, which means its role is becoming more important.

In the prehospital period, a special role in the elimination of medical and sanitary consequences of chemical accidents is played by the teams of specialized medical care of a toxic-therapeutic profile (BSMP-TT), which are designed to provide emergency specialized medical care to the affected by AOKhV. Of the 565 BSMP-TTs available in the Russian Federation, only 16 are full-time. This results in serious difficulties while working in emergencies: brigade personnel do not always arrive at the scene of an event on time; the team includes non-core specialists, most often - resuscitation doctors [7].

In the hospital period, emergency specialized medical care is provided in departments for treatment of acute poisoning, toxicological centers, and clinical hospitals [8].

There are only 43 toxicological centers in the Russian Federation located in 34 constituent entities of the Russian Federation. These centers have different status – from independent high-profile institutions to departments in city hospitals. In half of the regions of the country, those affected with chemical trauma receive medical care in non-core institutions. Moreover, in a number of regions there are no clinical toxicologists at all [8].

Conducting triage with mandatory standardization of urgent medical measures, rational use of existing forces and means and attracting additional forces and means, adherence to the principle of reasonable sufficiency in the material and technical equipment of emergency medical units and reduction, if

necessary, of the volume of medical care provided – all this makes it possible to promptly provide the care to all those in need [12].

The existing regulatory and methodological documents on the organization of the elimination of the medical and sanitary consequences of acute chemical trauma present modern views on the provision of medical care in emergency situations of chemical nature and determine the requirements for antidote therapy of toxic lesions [8, 13, 14].

With a relatively narrow range of antidote drugs approved for use in the Russian Federation, the possibility of their targeted use in prehospital and hospital periods is especially significant.

Given the urgency of the use of antidotes, the greatest importance is their provision within a limited time span after the lesion. This directly depends on their availability for LMOs and medical units.

In the regions, there are difficulties of determining the range and volume of created reserves of antidotes. There are no methodological guidelines on the use of antidotes at the stages of medical evacuation.

In accordance with the order of the Ministry of Health of Russia No. 298 (2017), a decision was made to significantly reduce the range and volume of antidotes to three names, one of which – Intesti bacteriophage – is, in fact, not an antidote, since it is used for the prevention and treatment of bacterial diseases.

In this regard, in our opinion, it is necessary to provide antidotes of these groups, first of all, to the regions, and to leave antidotes that are applicable at later stages in the Federal Reserve. The reserve of recommended antidotes is to be kept in the amounts provided by the order of the Ministry of Health of Russia No. 1037 (2011).

Given the current shortage of clinical toxicologists in the country, the main emergency medical care for those affected by chemical emergencies is provided by therapists, resuscitators-anesthesiologists, pediatricians, doctors and paramedics of the emergency medical service, clinical pharmacologists, occupational pathologists, etc. Thus, many patients with acute poisoning get medical care in non-specialized medical institutions, which affects its quality and outcomes of acute chemical injury.

The pre- and postgraduate training of medical specialists (therapists, doctors and paramedics of the emergency medical service, resuscitation specialists-anesthesiologists, etc.) on the issues of clinical toxicology needs further improvement. It should also be noted that when providing EMP, the preparedness of each medical specialist to work with urgent patients plays a very important role.

The educational standard for undergraduate training in general medicine does not allocate hours for training in clinical toxicology.

Emergency and therapeutic doctors are not adequately trained in disaster medicine and emergency toxicology, and training programs require further improvement.

#### **Conclusion**

This article has been prepared on the basis of the experience of the specialists of the All-Russian Center for Disaster Medicine "Zashchita" in the elimination of the medical and sanitary consequences of a chemical emergency. During the first years since the establishment of the Disaster Medicine Service, emergency situations mostly occurred at industrial facilities. Later, for

various reasons, they began to arise in other places – educational and medical institutions, nightclubs, etc. It should be noted that in recent years the frequency of occurrence and the scale of chemical emergencies have significantly decreased. This contributed to the weakening of the alertness of the medical community, to the reduction of medical forces and means necessary to eliminate their medical and sanitary consequences.

In such emergencies the lesions occur due to the inhalation of polluted air, which significantly increases the role of Rospotrebnadzor institutions in eliminating their medical and sanitary consequences, in developing methodological support, in defining the tasks of institutions and formations as well as the time and volume of their functioning, in their equipping with modern equipment and in providing methods for sanitary chemical intelligence and for competent assessment of the results.

The data presented in the article show a variety of emergencies that require targeted implementation of appropriate health measures. It is advisable to improve their

methodological support, to carry out organizational measures to structure and increase the number of institutions and formations, to improve their technical and material support, and to increase the instruction level of medical personnel. It is necessary to note the timeliness of the adoption of the Decree of the Government of the Russian Federation "Plan for the implementation of the Fundamentals of State Policy in the Field of Chemical and Biological Safety" dated August 28, 2019 No. 1906-r, the implementation of which will contribute to the growth of alertness among business entities, medical structures and will lead to the improvement of medical technologies used in the elimination of medical and sanitary consequences of chemical emergencies.

Assessing the overall health care capabilities of the country in the event of a large-scale emergency of a chemical nature, we believe that, as in the case of the COVID-2019 pandemic, the mobilization of all medical forces and means will be required to eliminate its health consequences.

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