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# The Earthquake and the Long-Term Crush Syndrome as a Problem of Health Care Management and Medical Strategy

### Abstract

In December 1988, an earthquake with a magnitude of 6.9 on the Richter scale killed more than 25,000 people in Armenia. In the aftermath, the occurrence of nearly 600 cases of acute renal failure created a second catastrophe, subsequently called a "renal disaster." At least 225 victims required dialysis, but despite the availability of more than 36 tons of dialysis supplies, 100 dialysis machines, and volunteer personnel from many countries, the response was ineffective, because no organized international support structure with appropriate training and deployment strategies was available at that time. The poorly organized relief effort with its influx of rescuers and material only worsened the chaos, creating a secondary disaster and interfering with global rescue activities. In this article, we describe management and medical strategies for preventing renal problems related to such disasters.

Keywords: Earthquake; Long-term crush syndrome; Reconstruction of the health care system

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# Muradyan NA, Khachatryan AA, Madoyan TT\*, Petrosyan RM and Martirosyan AA

Department of Emergency Medicine, Yerevan State Medical University, Armenia

#### \*Corresponding author: Madoyan TT

terezamadoyan@yahoo.com

Department of Emergency Medicine, Yerevan State Medical University, Armenia.

Tel: 37494425898

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# Introduction

The earthquake is one of the most powerful and mysterious phenomena or natural disasters. It is an underground shaking that occurs as the result of drastic discharge of the energy accumulated in a certain mass of the earth's crust. There is a law of seismology according to which earthquakes are recurrent in an area where powerful seismic events have already occurred. Such areas are called seismic zones, in one of which is situated Armenia.

On December 7, 1988 at 11.40 a.m. a disastrous earthquake took place in Armenia involving 40% territory of the Republic. In the history it is known as "Spitak Earthquake". 40000 people, 32500 injured were taken out from under the ruins caused by the earthquake. 530000 people became shelter-less; The Republic suffered an economic loss of 13 billion rubles. More than 500 medical institutions were destroyed; hundreds of medical personnel died or were injured. The instantaneous disaster brought to severe multiple and associated injuries of various nature in people. Parallel to the treating activity that involved almost all the scientific medical population, urgent issues, related to the elimination of the consequences of the earthquake, moved forward [1]

In order to elucidate some scientific medical problems a Special Scientific Committee, "Medical problems of eliminating the consequences of the earthquake" was formed adjacent to the Medical Scientific Council of the Health Ministry of Armenia. Themes of the scientific research work have been reviewed, new scientific versions corresponding to the demands of practical medicine i.e., treatment of the injured after the earthquake and medical-social reconstruction, moved forward. Conforming to these programs researches in 10 directions have been conducted in scientific institutions of Armenian SSR Health Ministry: health care organization during the elimination of the earthquake consequences; pathogenesis, clinic and treatment of EChS. Six theses for a Doctor's degree and 22 theses for a candidate's degree have been maintained [2].

# **Materials and Methods**

According to the materials of the scientific conference "Medical standpoints of the consequences of the Armenian earthquake

during the first days of Spitak Earthquake the main part of the injured were being transported to Leninakan Airport, where there were no conditions to show the first medical aid. The victims were brought in personal cars soon after they had been taken out from under the ruins without being shown the first aid.

The medical personnel working at the airport didn't have any skills or practical experience of intensive care and rehabilitation, didn't possess any means of organizing special medical aid for people with severe injuries. The working practice allows to make a conclusion that before transporting the injured, doctors who are expert in intensive care and rehabilitation and who possess quality practical skills in conducting complicated treating measures should be sent to the place for the injured.

Things for disposable use are vital as without them even a great number of the medical staff is not able to improve the quality and results of the victims' treatment [3]. 45000 survivors have been taken out from under the ruins, 12500 have been hospitalized, 120 thousand people have been emigrated, of them 75 thousand emigrated from Armenia. The precise financial damage was 10 billion USD. 84 medical institutions were destroyed [4].

### Discussion

A special attention deserves the fact that in emergency situations, especially during earthquakes, ECS is the most common among the developed injuries. e.g. ECS was met in 23.4% victims during the earthquake in Armenia on December 7, 1988 **(Table 1).** 

We can see from **(Table 1)** that the volume and structure of the loss caused by different disasters ranges and depends on a number of conditioning factors: type of the affecting factor, intensity, number of the population, type of the constructions, protection degree, population's readiness, etc. [5].

The study of the pathological mechanisms and morphological manifestations of ECS hasn't lost its actuality yet. As a rule, impairment caused by the injuries during natural disasters and

earthquakes is on a massive scale. At the same time ECS is one of the most severe among the diseases caused by injuries [6].

During the post-crush period of ECS fragments of myoglobins penetrating into the blood flow from the damaged and exfoliated muscles, reperfusion of the myocardium, blood saturated with hyperoxides can cause myocardial infarction development. Peptides that appear in the result of myoglobin destruction become the cause of affections revealed in the myocardium, the kidneys and the brain [7].

The main causes of severe consequences and grave shortcomings in all the links of seismic protection can be combined in 4 big groups:

- Mistakes made in the sphere of seismic danger evaluation;
- Rough mistakes made when designing, building and exploiting tenement-houses;
- Low level training of the authorities and the population for resisting the earthquake
- Mistakes related to the low level of organizing rescue activities in the zone of disaster management (especially during the first days) [8].

In December 1988 the earthquake with a magnitude of 6.9 on the Richter scale killed more than 25,000 people in Armenia. About 600 cases of acute renal failure was registered, a second catastrophe was created which later was called a "renal disaster." At least 225 victims required dialysis. The rescue and material and technical influx was badly organized, because of which the created chaos made the quality of rescue work and medical service worse [9].

In the article "Management of Crush-Related Injuries after Disasters" by Sever M.S., Vanholder R., Lameire N is spoken about those medical strategies and patients' management that are necessary for preventing renal problems during such

Type of injury	lvanovo (1948)	Ulianovsk (1983)	Sverdlovsk (1988)	Ashkhabad (1948)	Arzamas (1988)	Ufa (1989)	Armenia (Municipal Hospital) (1988)
Severe cranial-cerebral	18.9	23.6	14.0	16.2	20.2	6.9	5.8
Thorax and abdomen		6.2		4.0	3.0	10.7	1.0
Fractures of extremities, pelvis, Spinal column	14.5	43.2	12.6	23.7	11.6	16.1	27.0
ECS	-	-	-	3.7	10.1	-	23.4
Volumetric injuries of the soft tissues	12.2	-	59.0	-	18.0	-	87.1
Injuries of the inner organs (including lung barotraumas)	5.1	-	-	-	2.0	-	-
Body burns	-	-	-	-	-	87.0	-
Eye injuries	-	-	8	-	5.0	15, 4	-
Concussion of the brain, soft tissue wounds	49.3	-	26	51.4	32.6	-	-

 Table 1 Sanitary loss structure according to the number of the hospitalized (%).

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Location and date/year	Number of the dead	ECS	Number of conducted dialysis
Spitak, Armenia (1988)	25.000	600	225-385
Northern Iran (1990)	>40.000		156
Kobe, Japan (1995)	5.000	372	123
Marmara, Region, Turkey (1999)	>17.000	639	477
Chi-Chi, Taiwan (1999)	2.405	52	32
Gujarat, India (2001)	20.023	35	33
Boumerdes, Algeria (2003)	2.266	20?	15?
Bam, Iran, 2003	26.000	124	96
Kashmir, Pakistan, 2005	>80.000	118	65
Total	>217.000	>1900	>1200

#### Table 2 Statistics of drastic earthquakes.

disasters. The strategy is based on the approach of the special "Renal catastrophe" group of the Nephrologists' International Association. This approach was experimented in Turkey in 1999 during the earthquake in Marmara Region (acute renal failure was registered in 639 victims), in Bam, Iran in 2000, in Kashmir, Pakistan in 2005 (Table 2) [10]. During Marmara Earthquake in 1999 783 victims were transported to corresponding hospitals, 3 of them to ICU. The great majority of combined injuries were those of upper, lower extremities and the thorax, valvotomia was conducted in 7 and amputation in 6 victims. For 12 patients lung artificial ventilation device (LAV) was implemented. Respiratory distress syndrome developed in 4, oliguria was noted in 8, hyperkalemia was registered in 6 cases. Urgent hemodialysis was conducted in 4 victims, one person died of hyperkalemia on the way to ICU. In 13 cases acute renal failure was treated by means of hemodialysis and hemoperfusion. 5 victims died of multiorganic failure and 2 – because of sepsis [11].

The most effective way of decreasing the number of the victims after disasters is the treatment of ECS and acute renal failure closely related to it. Unlike the routine medical practice the conducted reasonable planning and medical interventions of local nature are of vital significance during the natural disasters. These principles can also be implemented during technogenic disasters, as the initial period of such events is also characterized by chaos, deficit of medical means and absence of experienced medical staff on the spot.

Thus, being ready for disasters should include:

- 1. Logical ways and plans to move the victims to more proper medical institutions;
- 2. Effective implementation of scanty medical staff and resources.

According to the data during earthquakes 40% of the severely impaired can die under the ruins during the first 6 hours. 60% of the dead can die during the first day, and the others – during 3 days. Victims with mild and moderate injuries die beginning from

the  $4^{\text{th}}$  day and a greater part of the victims i.e., 95%, die after 5-6 days.

The victims with mild and moderate injuries who are under the ruins mainly die of dehydration and frostbite of the organism. During earthquakes ECS can be noted in 3.8% (Ashkhabad), 23.8-29.0% (Armenia, Nephtegorsk) cases, who had severe and moderate degree injuries including about 40% cases with injuries of extremities and 15% cases with combined and numerous injuries.

During the earthquake in Nephtegorsk rescue activities were carried out in a more operative way than in Armenia. If in Armenia during the first 24 hours 9% of survivors were taken out from under the ruins, in Nephtegorsk it was more than 31% and during the first 3 days it was 51% and 85% correspondingly.

The medical strategic situation becomes worse as medical – preventive institutions become useless and also there can be losses in medical staff, e.g. during the earthquake in Tashkent in 140 medical institutions 118 members of the medical staff became injured, of them 22 were totally injured. 37 municipal ambulatory medical centers out of 51 totally or partially discontinued work in their buildings. During the earthquake in Spitak 250 medical institutions were completely destroyed, of 36 hospitals – 24 completely and 8 partially. 97 out-patient departments were in a broken-down state. The loss of the medical staff in some destroyed cities composed about 70%.

# Conclusion

According to international statistic data, if the rescuers can penetrate into the earthquake zone during the first 3 hours, they will be able to save 90% of survivors, 6 hours later the number of survivors can be 50%. Chances for being saved later decreases and after 10 days rescue work becomes meaningless. As it is known the earthquake in Armenia took place on December 7, 1988. The first rescue teams managed to arrive only on December 10 evening. Before that the rescue activities were done only by the military subunits and the police, whereas the rescuers' planned work started only on December 12 morning [12].

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