EPIDEMIOLOGIC STUDIES FROM THE 1988 ARMENIA EARTHQUAKE: IMPLICATIONS FOR CASUALTY MODELLING

Eric K. Noji, M.D., M.P.H.
U.S. Centers for Disease Control

Introduction

Better epidemiologic knowledge of the causes of death and the type of injuries and illnesses caused by earthquakes is clearly an essential requirement for determining appropriate relief supplies equipment and personnel needed to respond effectively to such catastrophic events.[1-4] At 11 41 AM on December 7, 1988, an earthquake registering 6.9 on the Richter scale hit the northern part of the Armenian Soviet Socialist Republic, one of the most seismically active regions of the Soviet Union[5-8]. Caused by movement along a geological fault near the town of Spitak in the northwestern part of the country, the quake affected 40% of the national territory.[9,10] Of the 150 villages damaged, 58 were completely destroyed. A high percentage of Armenia's housing (eleven percent) was destroyed or rendered uninhabitable, and 500,000 to 700,000 persons were made homeless.[11] Bridges, lifelines (e g., water, power, gas, sewage systems), and industrial facilities were also severely damaged.[12] The toll in human terms was devastating: 40,000 persons were reported trapped in collapsed buildings, of whom 15,000 were successfully rescued; 25,000 bodies were recovered from the rubble. Another 31,000 were known to be injured, of whom, 12,200 required hospitalization.[11,13]

This paper describes the results of two studies of earthquake-related morbidity and mortality following the Armenian earthquake and the implications of these results to earthquake casualty modelling. The first study consisted of a rapid survey undertaken during the period immediately following the earthquake to assess the epidemiological impact of the disaster and to develop an understanding of the relationship between building characteristics, occupant actions, search and rescue, medical care and patient outcome. After completing this rapid on-site survey in December, 1988, we conducted a case-control study in Leninakan to compare persons hospitalized with injuries with controls who remained unscathed following the earthquake

I. <u>Immediate Post-Earthquake Survey</u>[14]

I Immediate Post-Earthquake Survey[14]

The population under study were inhabitants of three towns within the rural areas most affected by the earthquake, covering an area of 80 sq km in northwest Armenia The total population of these three towns was approximately 8,500 people prior to the earthquake

In the three towns, the crude death rate (the percentage of residents found dead on extrication) was 49.4%, with a crude injury rate of 28.9% and an overall casualty rate (deaths and injuries) of 64.1% (Table 1) At the time of the impact, most (83.8%) of the people were indoors The mortality rate was significantly greater for these individuals (55 1%) than for those who were outdoors (8.8%) ($p <$ 01) (Table 1). Injury rates were also significantly greater for those inside (36.3%) than for those outside (1.7%) ($p < .01$) (Table 1) Of the total population, 60 1% were reported to have been trapped. Death rates were 81 4% for trapped individuals as compared to 1.2% for those who were not trapped ($p < .01$). Injury rates were 100% and 8.8%, respectively for the same groups (Table 1). Thus, deaths were 67 times and injury rates 11 times higher among trapped than non-trapped victims. The casualty rates were reported to be 100% for trapped people as compared to 9 9% for non-trapped individuals. For those trapped, the ratio of injuries to deaths was 0.23, whereas for non-trapped individuals, it was 7.2.

All buildings in the three towns sustained severe damage or complete collapse. Almost all of the residential dwellings were one-story unreinforced stone masonry structures built from carved blocks of tuff (a lightweight volcanic stone) set in mortar to form walls. Most of these dwellings partially or totally collapsed. There were two types of precast concrete buildings in the three towns studied. Precast concrete elements refer to concrete structural components which have been fabricated at a factory, then transported to the construction site for erection, as opposed to pored-in-place concrete elements. Most industrial facilities in the towns studied were of the precast-concrete frame type, consisting of precast concrete columns and beams welded or tied together to form frames; there was a smaller inventory of precast-concrete panel structures. Of these three types of building systems, poorly reinforced or unreinforced stone masonry buildings performed most poorly in terms of number of complete and partial collapses.

According to statistics collected by the Armenian Ministry of Internal Affairs and the State Committee for Construction, most of the fatalities occurred in the collapse of these stone masonry buildings (Table 2). Precast-concrete-frame type buildings, however, were associated with highest mortality per building. Detailed statistics were available for 8 buildings of this type in Nalband Of the occupants, 87% were killed (Table 2). The risk of death was 6.8 times greater in these eight frame buildings than in stone masonry buildings based on this limited sample ($p < .01$). In the sample of precast frame buildings, two of the structures which collapsed resulted in an exceptionally high rate of mortality. One was a sewing factory with 212 workers, of whom 205 (97%) died. The other was a school with 302 children of whom 285 (94%) died. The precast-concrete panel buildings were also more lethal than the stone masonry structures ($p < .01$).

Of 240 patients reported by the Ministry of Health to be evacuated from the three towns, 23 (9.6%) developed crush syndrome as a result of limb compression, and 11 (4.6%) developed secondary acute renal failure requiring renal dialysis. All evacuated patients were reported to suffer from varying degrees of hypothermia. Postmortem examinations of eight victims removed from the site of a building collapse revealed large amounts of dust in the nasal cavities, throat and respiratory passages of each of these victims suggesting that airway obstruction and asphyxiation from dust was the cause of death. This forensic evidence was corroborated by interviews with local residents of Nalband, who described large and dense dust clouds created by pulverization of the stone and concrete walls of falling buildings.

Data collected 14 days after the earthquake on 4832 patients admitted throughout hospitals in Armenia (Table 3) showed that combination injuries constituted 1918 (39.7%) of the cases. Superficial trauma such as lacerations and contusions were the most frequently observed (24 9%), followed by head injuries (22%), lower extremity injuries (19%), crush syndrome (11%), and upper extremity trauma (10%).

According to information provided by the local Army command center in Nalband, the great majority of those rescued alive from collapsed buildings (89%) were extricated during the first 24 hours (Figure 1) The probability of being extricated alive from the debris declined sharply over time. There were no live rescues after day 6

II Case-Control Study[15]

Following the completion of the above preliminary survey, we conducted a more in-depth analytic study using the case-control method. The study population was defined as all hospitalized injuries from the city of Leninakan Based on detailed maps of the city of Leninakan, on each of the days of interviewing, a random city block was selected from this map and the neighborhood polyclinic for that specific block was contacted to identify the cases of hospitalized injuries due to the earthquake. The names of each of the identified hospitalized cases from these neighborhood searches were checked against the list of all patients discharged from the hospitals. This information was provided by the Computer Information Center at the Ministry of Health in Yerevan, to ascertain the validity of our local polyclinic-based case selection For each of the cases, a non-hospitalized control with no or minimal injuries was selected from another household in the same neighborhood block. An effort was made to have the controls matched to the cases for sex and age within five years. A total of 189 cases and 227 controls were interviewed. Of the total cases identified, the refusal rate for interviewing was less than one percent.

Following a definition of the variables of interest, most of the questions were formulated and a questionnaire was developed in Armenian and pretested in Armenia on a sample of 14 cases and 14 controls. Questions focused on type of building damaged, circumstances of entrapment, behavior immediately following the impact, victim rescue process, type and severity of injuries sustained and descriptions of on-site medical care. Based on observations and problems recorded by the interviewers during the pretesting phase, the final format of the questionnaire was developed and used for the current study.

Each of the questionnaires was coded and entered into a mainframe computer format for processing and analysis in Armenia and Baltimore. Following simple frequency distributions, cases were compared to the controls and odds ratios and confidence intervals were calculated. Multivariate analyses were done using the logistic regression method.

The cases and controls were similar on a number of social and demographic characteristics (Table 4). There were no significant differences between the comparison groups as to age, sex, and education. Similarly there were no differences between these groups as to factors related to general health behavior, such as smoking, exercise and alcohol consumption

98% of the cases were inside a building at the time of the earthquake compared to 83% of the controls strengthening the results observed in the previous study (OR=12 20, 95% C I 3/62-63 79). Finding oneself in a taller building when the earthquake struck also predisposed to more severe injuries. The odds ratio for being in taller buildings, defined as having five floors and higher compared to being in lower buildings was 3 65 (95% C I. 2 12-6 33) (Table 5) There was also a significant "dose-response" increase in risk for injury for persons located at successively higher floors of a building at the moment of the earthquake The odds ratio for being on the second to the fourth floor at the time of the earthquake compared to the first floor was 3 84 while the odds ratio for being on the fifth floor and higher compared to the first was 11.20 (Table 6).

A review of the first reaction of individuals following the initial shock of the earthquake revealed that immediately running out of the buildings was a protective behavior for those individuals who were within a building at the moment of the earthquake (Table 7). Multivariate adjustment of the previously discussed findings using the logistic regression models, did not alter the results to any appreciable degree (Table 8).

Not surprisingly, rapidity of rescue is very important. A greater number of the uninjured controls (58.8%) compared to hospitalized cases (33.8%) were rescued during the first hour after impact (Table 9). Those rescued after one hour had a nearly 3 fold probability of requiring hospitalization compared to those rescued before one hour (Table 9). Entrapment for over six hours raises the risk for serious injury even further, that is, to nearly a four fold increase in risk for hospitalization compared to rescue prior to one hour (Table 10).

In addition to length of entrapment, rapidity of access to medical care is also important. A greater number of the uninjured controls (85.3%) compared to hospitalized cases (71.4%) received medical care during the first hour after impact (Table 11). Those given medical care after one hours had a greater than double the probability of requiring hospitalization compared to those receiving medical care before one hour (Table 11) Among those who were trapped, 94.8% were rescued by untrained local inhabitants who used primarily their hands or other unsophisticated tools (eg. shovels, picks).

Discussion

1 Implications of Armenian Investigations for Casualty Estimation Modelling

Past studies have stressed the importance of critically analyzing earthquakes in order to develop methods of rapidly assessing health care needs and improving disaster relief [16] Epidemiologic studies on earthquake-related injuries have indicated that a quantitative relationship may exist between morbidity and mortality.[17,18] For example, in the Guatemala and Nicaragua earthquakes, there were about three injured for every dead person. In the area of Armenia studied here, this ratio was reversed, that is, three dead for every person injured. This suggests the extraordinary lethality of the Armenian event.

The Armenian earthquake was of less magnitude than the 1989 Loma Prieta earthquake in California. However, its consequences were incomparably greater. primarily because of the design and quality of construction of buildings in the area. The primary cause of death, injury, and destruction was the total collapse of buildings that were not adequately designed for earthquake resistance.

Past studies have shown that factors determining the number of people killed after a building collapses include entrapment, the severity of their injuries, how long they can survive without medical attention, and time to rescue and medical treatment.[19-22] The most important findings in the case-control study related to the significant differences between the two groups as to location at the time of the earthquake, circumstances and length of entrapment, and behavior immediately following the impact. A 1977 study on the Guatemala earthquake concluded that deaths and injuries are critically dependent on housing damage and construction materials used.[23] Results reported in our study carry this concept further by suggesting that different building types and structural systems have different collapse mechanisms and patterns of cavity formation when they fail under the influence of earthquake ground motion. The limited survey of three building types in Nalband (e.g., stone masonry, precast-concrete panel and precast-concrete frame) showed death rates of 12%, 46%, and 87% respectively, suggesting that the type of building and collapse pattern affect survival rates (Table 2). In the case-control study, we found that not only is type of building an important determinant of morbidity, but also victim location at the time of impact. Those persons located at lower floors in a multistory building were able to escape injury or severe injury requiring hospitalization.

Infill masonry, panels and bricks often fell off, killing persons both inside and outside and the frequent collapse of stairways made it particularly difficult for people to escape, since many of these buildings had only one stairway. In all three building types, the collapse of non-structural elements such as parapets caused many serious injuries. The total collapse ("disintegration") of the precast-concrete-frame buildings was associated with particularly high mortality rates (greater than 90%) because the characteristic failure pattern of this type of construction greatly complicated the search and rescue effort and reduced significantly the opportunity for occupant survival. We observed that the fragmentation of the floor system resulted in very tight packing of the rubble with no cavities or "void spaces" for possible survival of victims. The distribution and amount of void space in the collapsed structure and the most likely locations of those voids are of importance in locating and rescuing trapped people quickly. Such information may help to guide future search and rescue operations by pointing out those collapsed buildings that have the greatest probability of containing survivors and by indicating the location of likely void spaces.

As might be expected, entrapment appears to be the single most significant factor associated with death or injury. Death rates were 67 times and injury rates more than 11 times higher for trapped than non-trapped people. Death rates for those inside greatly exceeded those for persons outside: and over 80% of those trapped died.

This earthquake substantiated past observations that response time for search and rescue is absolutely critical. Our observation that the proportion of people found alive declined with increasing delay in extrication, parallels the observations made in Italy after the Campania-Irpinia earthquake in 1980[24-25] and the Tangshan earthquake in 1976.[26] In the Italian study, a survey of 3619 survivors showed that 93% of those who were trapped and survived were extricated within the first 24 hours As suggested by our data, if any significant reduction in earthquake mortality is to be achieved, attention should be given to appropriate search and rescue action within the first 2 days after the impact.

In the Italian study cited above, 95% of the deaths recorded were among those trapped in rubble who died prior to extrication [24] Estimates of survivability among entrapped victims buried under collapsed earthen buildings in Turkey, and China, indicate that within 2 to 6 hours, less than 50% of those buried are still alive.[24-25] Although it is not possible to determine whether a trapped person died immediately or survived for some time under the debris, it is undoubtedly true that more people might have been saved if they had been extricated sooner. Safar, studying the 1980 earthquake in Italy,[27] concluded that 25% to 50% of victims who were injured and died slowly, could have been saved if initial life-saving first aid had been rendered immediately.

In the three towns visited during our reconnaissance mission, very little in the way of basic medical care was administered to persons who had been located and were actively being extricated from the debris. The provision of basic supportive care, such as intravenous fluids might have gone a long way toward reducing morbidity and mortality, particularly in preventing the development of crush syndrome.[28-34]

We are currently conducting a longitudinal study of 12,000 patients who sustained injuries severe enough to require hospitalization following the December 1988 earthquake. The objective of this study is to characterize injury severity case-mix for the collapse of buildings in Armenia of a given design and construction using anatomic descriptors of injury such as the AIS and/or ISS This has involved retrospective review of medical records and results of autopsies. Secondly, this study hopes to test the utility of the AIS/ISS in predicting outcome (eg. death, degree of permanent disability) for victims of building collapse. This will allow us to choose those parameters which predict mortality best for earthquake-injured patients. In other words, results from this study should indicate what revisions to the AIS and/or ISS are necessary to render them more applicable to the study of earthquake-related injuries.

The validation phase will be a step-wise process designed to answer important questions about the appropriateness of the proposed changes in the AIS/ISS. The relationship between the modified AIS/ISS severity scoring methodologies and mortality will be explored. Mortality is a widely used measure to test the goodness of a severity scale It is hypothesized that as severity increases, mortality also increases and several appraisals of the ability of the modified AIS/ISS to predict outcome will be considered. If the changes made have improved the scales' ability to characterize building collapse-related injuries, then mortality predictions derived from these modified scales should also be improved. Perhaps factors postulated to influence injury severity may need to assume a variety of values or weights depending on their importance, as well as uncertainties in the data and/or various interpretations of the data.

Ultimately, we hope to incorporate our analysis of injury severity patterns in the Armenian earthquake into a model of casualty estimation that will allow us to predict the percentage of deaths and range of injury severity sustained for principal building types and occupancies.

Future Research Needs in Earthquake Casualty Modelling

There is a need for a sound research program on earthquake epidemiology, particularly with regard to injuries and deaths following building collapse. Multidisciplinary teams should be formed to coordinate research activities from both the engineering, epidemiology, emergency medical, and search and rescue perspective. Some of the important aspects to be addressed by such a research program include:

1. Development of Simple, Rapidly Applied Physiologic Methods to Assess Severity of Injuries for Victims of Building Collapse.[35] Evaluation of the efficacy of search and rescue and medical care rendered, as well as determination of time trends for morbidity and mortality will require calculation of injury severity at various points in

time. This will require the use of physiologic injury scales such as the Trauma Score (TS) or a modification thereof since physiologic scales are the only ones that reflect changes in the patient's clinical condition over time and which are also easily calculated with information available in the field We are currently investigating the utility of an injury assessment tool called "RPV Assessment Method" which is a rapid and simple method to determine the severity of a casualties that can be performed by non-medical personnel under adverse conditions and which also has prognostic value. The RPV Assessment Method utilizes the three physiologic parameters of Respirations, Pulse, and best Verbal response based on the Glasgow Coma Scale (Table 12). A person with absolutely no health care background can determine the RPV score of an injured person simply by measuring the respiratory and pulse rates and determining the best verbal response to specified questions, then summing the coded values assigned to those rates and responses. The underlying assumption is that the human body responds in specific ways to injury, depending on the severity of the trauma. More severe injuries result in physiologic changes from normal which are greater than those associated with less serious trauma. This relationship is reflected in the assignment of coded values to various degrees of physiologic derangement, as seen in Table 12. There is also indication that RPV has excellent predictive value regarding the ability to estimate the probability of survival after injury (Table 12). As with all physiologically based severity indexes, the time interval between injury and assessment can affect the score, since the response of body systems to trauma is not instantaneous, but worsens or improves over time. The value of serial assessments and charting of changes over time is obvious for reasons outlined previously. The RPV Assessment Methodology is a rapid and simple way to determine the severity of a casualty's injury. It can be performed by non-medical personnel, under adverse conditions, with a minimal amount of training. Ultimately, we hope to be able to apply the RPV Methodology at specific points in time (eg. when victim first accessed, when extricated, when first seen by medical care provider, when transportation initiated, upon arrival at hospital), in order to assess the efficacy of search and rescue and medical care rendered.

2. Development of rapid assessment methods for establishing the cause and approximate time of death of a body removed from a collapsed structure. These techniques are already used by medical examiners and pathologists in post-mortem examinations to determine cause and time of death. We hope to analyze autopsy results to estimate time of death for victims of earthquake-induced building collapse. This estimate should then be correlated with length of entrapment. In addition to the above, the location of the body in the particular structure will be ascertained. Calculation of the AIS may also require autopsy results on those killed by building collapse to determine precise description of anatomic/tissue damage. The aim of the above three data collection strategies is to ascertain the nature and severity of injuries throughout a structure as a function of time. It is noted that existing earthquake epidemiology studies probably make some attempt to at least pinpoint the location of each survivor or body found. The above study attempts to add the time dimension and information on injury severity to this data base.

3. Development and validation of means to assess the number of fatalities and likely number of injured survivors. Could we develop a rapid sampling frame with which to quickly estimate number of injuries and severity of the injuries? Analyses should be conducted of previous earthquakes and a study protocol developed to collect data prospectively in the next big earthquake. The protocol should be developed in consultation with existing experts in the field.

4. Better survey instruments must be developed to assess the health impact of earthquakes.[36] This should include development of the most appropriate sampling techniques in the field. How can reliable data on injuries be collected under difficult field conditions? An extensive review should be conducted of previous research on

casualty estimation. The work should be critically evaluated by engineers, epidemiologists, and physicians with training in emergency medicine.

5. More research is needed on factors related to the survival of those rescued following building collapse.[37] Why did some survive and others were killed? What is the relationship to building structure design or to non-structural components in the building? What is the most appropriate place to be in a building that will increase the chance of survival? Is it possible to predict likely places where survivors could be located and thus better direct search and rescue efforts?

6. Can knowledge of injury patterns following an earthquake be used to suggest design changes in the structural and non-structural components of a building? What are the weak links in the search and rescue effort?

7. Need to be able to collect data on types of lesions and injuries as associated with types of building materials. Can we predict injuries so that we will know what types of injuries to expect when an earthquake occurs given a knowledge of building design, age of building, population density, etc.[38]

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TABLE 1. Location of Individuals and Entrapment Status: Association with Death and Injury

	Population (N)	% Deaths	Relative Risk (95% CI)	No. Survivors	% Injured	Relative Risk (95% CI)
LOCATION OF INDIVIDUALS						
Outside	651	8.8	1.0	594	1.7	1.0
Inside	7120	55.1	6.3 (5.4-7.4)	3197	36.3	21.6 (15.1-30.9)
Unknown	729	30.5		507	14.6	
Total	8500	49.4		4298	28.9	
NON-TRAPPED PERSONS	3390	1.2	1.0	3349	8.8	1.0
TRAPPED PERSONS	5110	81.4	67.3 (49.7-91.3)	949	100.0	11.4 (10.2-12.7)

TABLE 2. Effect of Building Type on Survival in Nalband

Building Type	No. of Buildings	No. of Occupants	Death Rate % (N)	Relative Risk	95% Confidence Interval	P Value
Stone Masonry	38	415	12.8% (53)	1.0		
Precast Concrete Panel	2	40	47.5% (19)	3.7	2.46 - 5.61	< .01
Precast Concrete Frame	8	577	87.0% (502)	6.8	5.29 - 8.78	< .01
TOTAL	48	1,032	55.6% (574)			

TABLE 3. Distribution of Hospitalized Injuries By Site As Reported to the Ministry of Health of Armenia Following the December 7, 1988 Earthquake

Injury		Number	Percentage
1.	Head/Face	1040	22.0
	Skull, facial fractures	130	2.7
	Brain concussion	417	8.6
	Other internal head trauma	173	3.6
	Open head/facial wounds	320	6.6
2.	Upper extremities	475	10.0
	Upper extremity fractures	265	5.5
	Traumatic amputations, arms	197	4.1
	Elective amputation, arms	13	0.3
3.	Lower extremities	915	19.0
	Lower extremity fractures	584	12.1
	Open wounds, legs	102	2.1
	Traumatic amputations, legs	170	3.6
	Elective amputation, legs	59	1.2
4.	Superficial trauma	1203	24.9
5.	Crush Syndrome	533	11.0
6.	Other	633	13.1

Table 4

Earthquake Injuries in Leninakan
Distribution of Study Groups by Some Characteristics

	Hospitalized Cases		Non-Injured Controls		Mild Injury Controls	
	n	%	n	%	n	%
Females	120	63.5	95	59.8	42	62.7
Education						
<High School	41	24.3	31	27.7	16	24.6
High School	47	27.8	35	31.3	27	41.
Technical	40	23.7	24	21.4	10	15.4
University	31	18.3	14	14.3	11	16.9
Age in Years						
<17	33	19.9	18	16.4	5	7.7
17-22	21	12.7	13	11.8	10	15.4
23-39	54	32.5	34	30.9	17	26.2
40-59	48	28.9	32	29.1	16	38.5
60+	10	6.0	13	11.8	8	12.3
Smokers +	37	21.9	20	18.5	14	21.5
Alcohol +	35	20.8	28	26.7	9	14.1
Regular Exercise +	71	42.8	44	40.7	22	33.9
TOTALS	169		112		65	

Table 5

Earthquake Injuries in Leninakan
Distribution of Cases and Controls by Number of Floors
in the Building at the Moment of the Earthquake

Number of Floors	Hospitalized Cases n	Hospitalized Cases %	Non-Hospitalized Controls n	Non-Hospitalized Controls %
≤ 4	92	50.8	102	79.1
5+	89	49.2	27	20.9
TOTAL	181	100	129	100

Odds Ratio for 5+ = 3.65
95% Confidence Limits: 2.12 - 6.33

Table 6

Earthquake Injuries in Leninakan
Distribution of Cases and Controls by Location by Floor
Within the Building at the Moment of the Earthquake

Floors	Hospitalized Cases n	Hospitalized Cases %	Non-Injured Controls n	Non-Injured Controls %
1	30	16.8	60	46.9
2 - 4	121	67.6	63	49.2
5+	28	15.6	5	3.9
TOTAL	179	100.0	128	100.0

Odds Ratios	95% C.L.
2-4 vs. 1 = 3.84	2.18- 6.79
5+ vs. 1 =11.20	3.62-37.03
M-H weighed = 4.95	3.04- 8.16

Table 7

Earthquake Injuries in Leninakan
Distribution of Cases and Controls by Reaction After First Shock

	Hospitalized Cases		Non-Injured Controls	
	n	%	n	%
Stayed Indoors	144	90.0	88	67.2
Ran or Jumped Out	16	10.0	43	32.8
TOTAL	160	100	131	100

Odds Ratio for Stayed Indoors = 4.40

95% Confidence Limits: 2.24-8.71

Adjusting for Age group and the other variables

	Odds Ratio (95% C.I.)
Floors in the building 5+	3.45 (1.76 - 6.74)
Located on floors 2-4 vs 1	2.60 (1.42 - 4.75)
Located on floors 5+ vs 1	4.02 (1.08 - 14.9)
Stayed indoors vs ran out	4.84 (2.34 - 10.00)

Table 9

Earthquake Injuries in Leninakan
Distribution of Cases and Controls by
Length of Entrapment

	Hospitalized Cases		Non-Hospitalized Controls	
	n	%	n	%
> One Hour	125	66.2	28	41.2
< One Hour	64	33.8	40	58.8
TOTAL	189	100.0	68	100.0

Odds Ratio for > One hour = 2.79

95% Confidence Limits: 1.52 - 5.13

Table 10

Earthquake Injuries in Leninakan
Distribution of Cases and Controls by
Length of Entrapment

	Hospitalized Cases		Non-Hospitalized Controls	
	n	%	n	%
> Six Hours	62	49.2	10	20.0
< One Hour	64	50.8	40	80.0
TOTAL	126	100.0	50	100.0

Odds Ratio for > One hour = 3.88

95% Confidence Limits: 1.69 - 9.10

Table 11

Earthquake Injuries in Leninakan
Distribution of Cases and Controls by Length of Time
Between Extrication and First Medical Care Received

	Hospitalized Cases		Non-Hospitalized Controls	
	n	%	n	%
> One Hour	54	28.6	10	14.7
< One Hour	135	71.4	58	85.3
TOTAL	189	100.0	68	100.0

Odds Ratio for > One hour = 2.32

95% Confidence Limits: 1.05 - 5.23

Table 12

Coding of Physiologic Variables Used in RPV and RPM

Respiratory Rate	Coded Value
0	0
1-9	1
10-24	4
25-34	3
35 and greater	2

Pulse	Coded Value
0	0
1-40	1
41-60	2
61-120	4
120 and greater	3

Best Verbal Response	Coded Value
None	0
Incomprehensible Sounds	1
Inappropriate Words	2
Confused	3
Oriented	4

Best Motor Response	Coded Value
None	0
Extension/Flexion	1
Withdraws (Pain)	2
Localized Pain	3
Obeys Command	4

Probability of Survival as Function of RPV Score *

R	1	0.089
P	2	0.157
V	3	0.265
	4	0.409
S	5	0.571
C	6	0.719
O	7	0.832
R	8	0.905
E	9	0.948
	10	0.972
	11	0.985
	12	0.992

* BASED ON WASHINGTON HOSPITAL CENTER PATIENTS