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EMERGENCY MEDICAL CARE ASPECTS OF THE LOMA PRIETA EARTHQUAKE

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INTRODUCTION

The Loma Prieta earthquake of October 17, 1989 created significant property damage and social disruption in the San Francisco Bay Area. Initial government estimates formulated a few weeks after the event indicated that over 22,000 residential structures, 1,567 businesses, and 137 public buildings in the area of impact were destroyed or sustained significant damage (Federal Emergency Management Agency, 1990). Approximately 10,000 persons lost their homes as a result of the earthquake. Early reports estimated that direct economic losses ranged between $6 and $10 billion (Monroe, 1989; Earthquake Engineering Research Institute, 1990). Additional short-term indirect economic losses attributed to the earthquake included declines in tourism revenues, losses due to business interruption, and retail sales declines resulting from disruptions in the regional transportation system.

Loma Prieta was clearly a major earthquake for the San Francisco Bay Area. However, at M 7.1, with a relatively short period of strong ground shaking, it was significantly less severe than both the 1906 San Francisco event and the great earthquake that is expected to strike on one of the major faults in the Bay Area some time in the next two to three decades. Except in Santa Cruz County, which was hardest-hit, the dollar value of the losses produced by the earthquake constituted only a tiny fraction of the wealth and economic activity of the affected communities. The relatively rapid restoration of key transportation routes such as the Bay Bridge helped contain indirect economic losses. Various forms of assistance--while not provided as promptly as earthquake victims and local officials would have liked--also helped offset earthquake losses. Major sources of disaster assistance funds included the Federal Government, the State of California, and voluntary relief organizations. Insurance companies and private lenders also provided funds to assist with recovery.

The earthquake was also moderate in the number of casualties produced. Sixty-two people died as a consequence of the earthquake, a smaller death toll than might have been expected for an event of that size. Of this group, all but twenty were killed in the collapse of a single structure, the two-level Cypress Street overpass on Interstate Highway 880 in Oakland. Thirteen of the

remaining deaths were caused by the collapse of buildings in San Francisco's downtown and Marina Districts and in downtown Santa Cruz. As the discussion below will show, the number of earthquake-related injuries was considerably lower than initial projections, and the majority of those injuries were not severe. Additionally, although a number of operational problems were encountered following the earthquake, the capacity of the region's health-care system was more than sufficient to handle the demand.

This paper provides an overview of medical care aspects of the earthquake, including preliminary data on the nature of injuries and the extent of the demand the earthquake placed on the health-care system. The information contained in the paper is synthesized from several sources, but much of the material consists of initial findings from a study conducted by the San Francisco Emergency Medical Services Agency, with technical assistance from the Disaster Research Center (hereafter referred to as the EMS/DRC study). In this project, which was funded by the California Emergency Medical Services Authority and the Federal Emergency Management Agency, data concerning emergency medical aspects of the earthquake were obtained using three main approaches: (1) interviews with hospital administrators, emergency department nurses, and emergency department physicians, as well as with emergency communications center staff members, medical base station personnel, and other emergency care providers in the affected region; (2) questionnaires distributed to ambulance company personnel concerning their activities on the night of the earthquake; and (3) hospital emergency department logs, which contained a large amount of information about patients who sought care at the time of the earthquake.

PREDISASTER MEDICAL SYSTEM CAPABILITIES

At the time of the earthquake, there were just over four million persons living in the Bay Area communities that were most directly affected (see Table 1).[1] The region is jurisdictionally complex, and the population is very diverse, particularly with respect to race and ethnicity. The population of San Francisco is approximately 22% Asian and 12% Hispanic. Caucasians are a numerical minority in Oakland, which is about 47% African-American and 10% Hispanic. The geographic area affected by the disaster contains a range of community types: high-density, built-up urban areas, like San Francisco and Oakland; large, sprawling metropolitan centers, such as San Jose; and comparatively rural, low-density counties, such as Santa Cruz and San Benito.

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[1] The following six Bay Area counties were hardest-hit in the earthquake and were the focus of our research: Alameda, San Benito, San Mateo, San Francisco, Santa Clara, and Santa Cruz.

During the time period in question, variations existed in both the supply of health-care resources and the quality of care available in Bay Area communities. The health-care system of the City and County of San Francisco was experiencing tremendous financial strain, due in part to the need to cope with the AIDS crisis. Hospitals designated as trauma centers, which were intended to provide a rapid care to victims of major trauma, were also having financial problems, and the effectiveness of the trauma care network was declining. As is typical of large metropolitan systems in the U. S., medical resources in the Bay Area were maldistributed. Access to adequate medical care was problematic for some segments of the population, particularly the poor and the uninsured. Available resources were inadequate to meet the demand for care in some parts of the region--especially the largest cities--while in other areas there was an overabundance of hospitals and physicians.

However, despite these shortcomings in the distribution of health-care resources, the regional system as a whole was one that can be characterized as very rich in resources, with a significant capacity for coping with both everyday medical emergencies and disasters. There are sixty-five general (medical-surgical) hospitals located in the six county area most strongly affected by the earthquake, with nearly 15,000 hospital beds, or about one bed per three hundred area residents (see Table 2 for a listing of hospitals and hospital beds by county).[2] Among these hospitals are several large and prestigious medical institutions with major teaching and research programs, such as Stanford University Hospital, the hospital at the University of California at San Francisco, and San Francisco General Hospital. Also located throughout the Bay Area are a number of specialty hospitals, clinics, and urgent-care facilities that do not typically treat serious medical emergencies, but that could be used to treat victims in a disaster situation.

In the cities and counties of the Bay Area, emergency transportation for victims requiring hospital treatment is provided by a mix of public and private ambulance companies. In the six-county area on which our research focused, there were thirty-five companies in operation at the time of the earthquake, employing 1,505 paramedics and emergency medical technicians (see Table 3 for county-by-county breakdowns). In the Bay Area, public ambulances and rescue units are typically operated by fire departments or

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[2] This is something of an overstatement, because this tally includes several hospitals that are part of the Veterans Administration network, as well as facilities that serve the U. S. military. Such facilities are not available for use by the general public during normal times. However, they could be used during disaster times, if needed, and at least one military hospital did treat a number of victims following the earthquake.

local government emergency medical service agencies, and private ambulance services usually contract with cities or counties to provide emergency transportation.

At the time the earthquake occurred, all the affected counties were using sophisticated communications systems for receiving and responding to emergency calls, typically accessed through a central "911" telephone number. All calls of an emergency nature (fire, police, medical emergencies) are routed through this number. In the six-county area most severely affected by the earthquake, there were an estimated twenty-one emergency dispatch centers serving the various jurisdictions. Rather than having a consistent form of organization and operation in all jurisdictions, the centers varied rather widely in their capabilities and modes of organization.

Most "911" communications/dispatch centers in the area were what are termed "enhanced" centers, in which a caller's address is automatically identified and the call logged by computer. Some "911" centers, such as the center in San Francisco, had computer-assisted dispatch capability; in other cases, the operator dispatched emergency vehicles and personnel.

IMPACT OF THE EARTHQUAKE ON THE EMERGENCY MEDICAL CARE SYSTEM

While a number of individual organizations in the emergency medical care delivery system experienced serious damage and disruption as a result of the earthquake, the regional system responded remarkably well. This section of the paper contains a brief overview of how the earthquake affected emergency medical care providers.

Communications. Of the various components of the emergency medical care system, communications facilities such as the "911" dispatching centers were perhaps the most seriously affected by the earthquake. Problems with communications and dispatching systems stemmed from a variety of causes: earthquake-induced power failures; damage to the buildings in which the facilities were housed; damage to critical equipment, such as computers; loss of computer-aided dispatching capability; disruptions in communications between the centers and the outside community, particularly phone communications; damage to message transmission facilities; and excess radio traffic that made communications difficult (Pre-Hospital Care Seminar, 1990; Earthquake Engineering Research Institute, 1990).

These forms of disruption made emergency communications very difficult, especially during the first few hours after earthquake impact. Occasionally, conditions in communication facilities bordered on chaos, particularly in hard-hit communities close to the epicenter. However, evidence suggests that the disruption did

...affect the ability of most centers to perform emergency functions. For example, interviews with personnel in nine communications centers, conducted as part of the EMS/DRC study, indicate that most computer systems did not fail following the earthquake; most centers were able to keep contact with their units in the field during the night of the earthquake; and in the seven centers where the commercially-provided electrical power failed, emergency generators were used more or less successfully. Of seven centers that maintained "911" emergency telephone lines, only two reported interruption in the "911" system. Six of the nine centers reported that they had a sufficient number of radios and frequencies to handle radio traffic on the night of the earthquake. Six centers also reported supplementing their systems with cellular telephones to handle some types of emergency communications after the earthquake.

Cellular telephones were used by a range of emergency organizations, which helped with the resolution of some communications problems. Other approaches were also used to compensate for disruptions in the emergency communications system. Among the strategies noted in a recent report (Earthquake Engineering Research Institute, 1990) were: instructing ambulance drivers to cut down on radio communications, in order to prevent congestion of the airwaves; using of HAM radio operators; using electronic pagers; and giving ambulance personnel more autonomy to function in the field without communicating with dispatch centers. In cases where damage to communications facilities made their use problematic, alternative facilities (e.g., mobile vans) were activated within a short period of time.

Emergency Transportation. The Bay Bridge, one of the region's major transportation routes, was rendered impassable and was closed due to earthquake damage. The damage effectively isolated the City of San Francisco, making it impossible for the City to receive emergency assistance from the East Bay communities of Alameda and Contra Costa Counties. However, San Francisco did not actually require outside assistance in the earthquake, and thus the loss of the bridge did not significantly affect its emergency response capability.

Evidence suggests that the number of ambulances responding following the earthquake was more than adequate throughout the region. In fact, because off-duty personnel reported to their units in very large numbers, and because some vehicles came into the impacted area from outside as part of "mutual aid" arrangements, there was an oversupply of emergency vehicles in the most of the affected communities. For example, within a short time after the earthquake, there were approximately forty-five ambulances available in San Francisco, while the maximum used at any one time was twenty-six (Pre-Hospital Care Seminar, 1990).

In the East Bay, emergency vehicles converged at the scene when they received notification of the Interstate 880 collapse. Resources continued to converge into that area for several days after the earthquake. At the peak of the rescue operation, there were literally hundreds of emergency vehicles of all types at the site.

In damaged areas throughout the region, ambulance personnel were dispatched (or responded on their own, without being dispatched) to sites where radio messages indicated that people might need assistance. The number of ambulances reporting often greatly exceeded the need. Ambulance teams would go to a site, only to find that the victims they had intended to assist were no longer on the scene, having already been transported by family members, other neighborhood residents, or some other emergency vehicle.

The massive ambulance response was very understandable, given the nature of the event. Especially in the first hour or two after the earthquake, there was considerable confusion about the size of the earthquake, the area affected, and the extent of damage and injuries. Initial mass media projections overestimated both the damage and the number of casualties expected. With normal communications systems disrupted, personnel in the emergency health-care system had little solid information on damage in the Bay Area and very idea of the number and types of casualties to expect. The most logical alternative for many emergency-care organizations seemed to be to rapidly mobilize as many resources as possible. Later, in questionnaires distributed to ambulance personnel as part of the EMS/DRC project, 313 of the 483 respondents indicated that they had originally expected to provide service to more victims than they actually treated.

Hospitals. A similar pattern occurred in hospitals. Major damage was confined to a few facilities, such as Watsonville Community Hospital in Santa Cruz County. The following is a partial list the types of damage an engineering reconnaissance team observed in that facility: broken windows; disruption of the water supply inside the hospital; chemical spills in the laboratory; loss of electricity for lights and for key hospital functions; failure of emergency generators; and loss of elevators. The damage was so overwhelming that the hospital was evacuated, some patients were transferred out to other facilities, and treatment was provided to disaster victims and other patients on the hospital lawn and in adjacent areas outside (Earthquake Engineering Research Institute, 1990). The Veterans Administration Medical Center in Palo Alto and a tower at Peralta Hospital in Oakland also sustained serious structural and nonstructural damage (Federal Emergency Management Agency, 1990).

Nonstructural damage, disruption of utilities (particularly electricity), and damage to various building systems were

widespread among Bay Area hospitals. Interviews with administrators in 51 hospitals conducted as part of the EMS/DRC project[3] indicate that in at least half of the hospitals, administrators reported that there were difficulties with operating important medical equipment and machines, that critical equipment and building systems sustained earthquake damage, and that they were initially concerned about the structural integrity of their facilities.

Nevertheless, the damage and disruption apparently did not reduce the ability of hospitals to provide emergency care. Like ambulance personnel, hospital staff members mobilized rapidly to care for victims. In the EMS/DRC study, 94% of the hospital administrators interviewed indicated that off-duty staff members spontaneously reported for duty at their hospitals, and 86% reported that volunteers not on their staffs also came to the facilities to offer assistance. Nearly 90% of the administrators stated that the supplies they had on hand were sufficient to handle treatment demands on the night of the earthquake. As Table 4 indicates, the majority of the administrators responding to questions about the disruption of key hospital services and activities following the earthquake assessed that disruption as minimal or nonexistent.

A similar picture was obtained from interviews with physicians and nurses who had first-hand experience with how their emergency departments handled the situation on the night of the earthquake. A majority of the physicians interviewed indicated that the physicians on duty in their hospitals when the earthquake occurred would have been capable of handling the patient load even if more physicians had not reported to emergency departments to assist victims. Nearly one-half of the physicians indicated that there were actually too many physicians on hand in the first hour after

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[3] In this phase of the EMS/DRC project, 51 hospitals in the six-county area were identified as having provided care to patients in their emergency departments on the night of the earthquake. The administrators of these hospitals were interviewed by project staff and were also asked to complete written questionnaires containing additional information on how their hospitals responded. The head emergency physicians and emergency department nurses in each of these hospitals were also contacted by telephone to obtain information on emergency department activities following the earthquake. Because the data were collected several months after the earthquake, some of the physicians and nurses who had major responsibilities at the time of the earthquake had moved and could not be located. For that reason, only 47 nurses and 46 physicians were interviewed.

the earthquake.[4] The vast majority of the doctors interviewed considered the number of nurses on hand sufficient to handle the patient load. While 43% of the respondents indicated that they ordered fewer medical procedures for patients on the night of the earthquake than they would have normally, none of the physicians believed that this affected the quality of care patients received. Eight out of ten physicians reported that they were able to get needed diagnostic tests done when they requested them. Roughly the same proportion indicated that their emergency departments had no problems accepting and treating major trauma patients on the night of the earthquake.

Nurses interviewed also considered the number of physicians available to treat patients adequate on the night of the earthquake. Only 10% of the nurses considered the number of nurses available in the emergency department insufficient to handle patient demand in the first hour after the earthquake, and only 4% judged the supply of nursing personnel to be inadequate during the remainder of the night. Interviewees indicated that although the number of nurses physically present in the emergency departments when the earthquake struck would probably not have been sufficient to handle the patient load, there was a rapid and significant response by nurses who were working in other hospital wards at the time of impact, by off-duty staff members who returned to work spontaneously, and by nurses not on the regular staff who came to the hospital to offer their services.

More than 80% of the nurses interviewed reported that all or most emergency care supplies were present in sufficient amounts in their emergency, although some nurses indicated there could have been a need for more dressings and more intravenous fluids. All the nurses reported that they were able to obtain needed supplies from other locations within their own hospitals, and one-third reported that their hospitals gave supplies to ambulance personnel who requested them for their runs.

In summary, while emergency medical system components were damaged and disrupted by the earthquake, the system's overall capacity to respond to the emergency was not compromised. The system had ample resources with which to respond, and only a few facilities were seriously overburdened following the earthquake.

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[4] In somewhat contradictory statements, about three-fourths of the physicians indicated that during the remainder of the night following the earthquake, it might have been helpful to have had more physicians on hand, but 90% of the respondents said that the medical specialists best suited to provide care for the types of problems seen were available in the emergency department.

FACTORS CONTRIBUTING TO THE SUCCESSFUL MEDICAL RESPONSE

High Capacity, Coupled with High Levels of Mitigation and Preparedness. The ability of the system to respond so well and retain so much capacity in an earthquake of this magnitude can be attributed to several factors. Perhaps most important among these factors are the laws, standards, and policies that were instituted in California to enhance seismic safety in hospital facilities, particularly codes related to hospital construction. As a condition for receiving accreditation from the Joint Committee on Accreditation of Hospitals, hospitals are also required to engage in disaster preparedness activities, including the preparation of written plans and participation in disaster drills on a regular basis.[5] Hazard mitigation and emergency preparedness activities clearly helped contain earthquake damage, limited disruption, and enabled key organizations to respond effectively.

Another strength of the system was its high degree of flexibility and redundancy. Except in smaller, relatively isolated communities, a broad set of resources existed for transporting and treating earthquake casualties, so that the loss of any one element--or even several elements--would not have diminished the overall quality of the response. In critical facilities such as hospitals and emergency dispatch centers, back-up power sources compensated for the loss of commercial electrical power; without these kinds of resources, the medical care system would have been crippled. Redundancy was particularly evident in the area of emergency communications, in which alternative communication modes partially overcame earthquake-induced failures.

Additionally, disaster preparedness activities--especially preparedness for earthquakes--had been pursued with an increasing level of commitment in the Bay Area in the years preceding the earthquake. Damaging earthquakes in Mexico City in 1985 and Southern California in 1987 as well as continuing public education campaigns and earthquake forecasts had helped make the public increasingly aware of earthquake hazards.

Relatively Low Demand and Few Severe Problems. It would be tempting to conclude on the basis of its performance in this earthquake that the medical care system in the Bay Area is capable of responding effectively in even larger events. However, such a conclusion would be unwarranted. In understanding why the system was able to perform so well in Loma Prieta, it is also important to point out that the number of casualties produced was actually quite low, relative to the overall capacity of the system. Indeed, several health-care professionals in the Bay Area noted that from

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[5] All of the 51 hospitals contacted in our study had developed written disaster plans, and all but four activated those plans on the night of the earthquake.

the perspective of the emergency medical system, Loma Prieta was a virtual "nonevent;" hospitals and ambulance companies mobilized massively to deal with a patient load that never materialized. These observers have suggested that the system worked so well because, except for in a few situations, it was not actually taxed.

Data collected by the EMS/DRC project support this claim.[6] Table 5 shows a graph of emergency department visits for hospitals in the six-county region for the two-week period that surrounds the earthquake. Considered on a regional basis, emergency department utilization was higher on October 17 and 18, but not markedly so. Tables 6, 7, and 8 show data for the same time period for three counties--San Francisco, San Benito, and Santa Cruz. For San Francisco, the largest of the three counties, the increase in patient emergency department visits following the earthquake was not particularly large. Since hospitals and other response agencies could draw upon off-duty personnel and volunteers who mobilized in great numbers, the system experienced little actual strain. San Francisco's pattern of emergency department utilization was similar to the pattern that was recorded in the other populous, urbanized counties. In contrast, the increases in patient load were much more significant for San Benito and Santa Cruz counties, which were closer to the epicenter, and resources were less abundant. In short, the data seem to suggest that for most facilities in the Bay Area's larger population centers, the demand for emergency care following the earthquake was not much greater than during normal times and was relatively easy to handle.

By reading emergency department records, EMS/DRC project staff were able to determine which hospital visits involved earthquake-related problems and which did not.[7] Table 9 classifies the

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[6] In this phase of the study, two kinds of data were collected from hospital emergency departments in the region: (1) information on the number of patients served in hospital emergency departments, and the dispositions of those cases, for the two-week period surrounding the earthquake (October 10-23); and (2) data from the hospital records of all individuals who sought treatment between the time of earthquake impact and 6:00 am the following day. The record includes data on 49 hospitals and 2,382 patients. Facilities were not included in the data set if they saw no patients at all on the night of the earthquake. Facilities were dropped from analyses of utilization if a complete set of data could not be obtained for the two-week period. Despite these limitations, all the major hospitals in the six-county area and all significant providers of emergency medical care are included in the sample.

[7] Patient charts typically indicated whether or not the complaint was related to the earthquake. Occasionally, the individuals abstracting the records made a judgment that the

emergency department visits at 51 Bay Area hospitals on the night of the earthquake according to the cause of the complaint. As might be expected, a significant proportion of the visits--about 54%--were apparently unrelated to the earthquake. Although the number of earthquake-related complaints we recorded through our procedures (1,102) is very likely an undercount,[8] it does point out that both early projections and later official statistics overstated the medical impact of the earthquake.

Although we have no data to directly address this issue, the pattern of patient utilization in the immediate period following the earthquake probably reflects two trends. First, the earthquake obviously created a demand for hospital care on the part of those who were injured or otherwise in distress. However, this trend may have been partially offset by a decrease in utilization by individuals who might have visited emergency departments for treatment under normal conditions. Many people in large U. S. cities use hospital emergency departments, rather than physicians or clinics, for complaints that do not actually warrant hospital care. These individuals may have decided not to seek hospital treatment for their problems in the first few hours and days following the earthquake.

Focusing specifically on the earthquake-related problems treated in Bay Area hospitals, Table 10 contains preliminary figures on the incidence of different types of complaints.[9]

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complaint was "probably" or "probably not" related to the earthquake, based on the nature of the diagnosis and the time when the patient arrived at the hospital.

[8] These statistics do not include people who may have sought medical assistance at places other than hospitals, such as Red Cross shelters, health clinics, and urgent care centers. It also does not include individuals who sought emergency treatment on the days following the earthquake. As noted earlier, the two-week trend data indicate that the demand for treatment was quite high on Wednesday, October 18. Project resources were too limited to permit an exhaustive analysis of records for the period after the earthquake. Despite these limitations, we believe that our data accurately portray the pattern of victim complaints--particularly serious the injuries.

[9] It should be noted that these figures are very rough and preliminary. Of the 1102 records, 153, or just under 15%, had either not been categorized or could not be categorized at the time of this initial analysis. Some records may have been misclassified, and some double-counts may exist. At the present time, the data suggest general patterns in the need for emergency medical services, but they should not by any means be considered definitive. Considerable additional work will be required before

Injuries of various types accounted for the majority of earthquake-related emergency department visits. Within the injury category, wounds, abrasions and contusions, and fractures were the most common complaints. With respect to severity of complaints, of the 1,102 earthquake victims, about 73%, were treated in the emergency department and released, rather than being admitted to the hospital. Approximately the same proportion of patients with non-earthquake-related complaints were treated and released. This suggests not only that most earthquake-related problems were relatively mild from a medical standpoint, but also that the proportion of less severe medical problems was about the same for earthquake victims as for non-victims.

Approximately 25% of the earthquake-related emergency department visits involved medical complaints, rather than injuries. While a range of medical problems were seen, it is noteworthy that diagnoses related to anxiety and apprehensiveness accounted for a large proportion of this category. Also significant is the fact that a number of cardiac problems and cases of elevated blood pressure were explicitly attributed to the earthquake by hospital personnel who filled out the medical records.

It was noted earlier in the paper that the response by emergency transportation companies and personnel was very large and rapid following the earthquake, and that emergency care providers generally believed that available resources were underutilized. Although the information on utilization of emergency transport that was contained in hospital records was not as complete as we would have liked, such data as were available indicate that only a small proportion of patients were brought to hospitals in ambulances. As Table 11 indicates, 23% of the patients arriving at Bay Area emergency departments came by ambulance, while the remainder were transported by other means, primarily private automobiles. Individuals with earthquake-related problems were slightly more likely than others to use ambulances, but the reasons for this pattern are not clear.[10]

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we have solid numbers in the various categories.

[10] Individuals with earthquake-related problems may have had more of the kinds of complaints that warrant access to ambulance transportation. Another possible explanation is that people with earthquake injuries were concentrated in specific geographic areas, and that ambulances were more likely to go to those areas to offer assistance.

SUMMARY AND CONCLUSIONS

In summary, the response to the Loma Prieta earthquake by the emergency medical care system was very effective. The system was able to function effectively due to a fortuitous combination of three factors: (1) the fact that the area possessed an extremely high level of system capability, as indicated by the quantity and quality of medical resources; (2) the fact that essential health-care resources survived the earthquake well, while flexible and redundant system components compensated for damaged and disrupted elements; and (3) the fact that the earthquake produced a comparatively small number of casualties relative to system capability; moreover, most of the medical complaints that resulted were not severe.

The Bay Area appears to have made impressive progress in improving its ability to reduce damage and to cope with the problems created by earthquakes. These improvements are reflected in the performance of the emergency health-care system. However, it would be a mistake to extrapolate from the Loma Prieta experience to larger events or to the types of earthquakes that are expected to occur on faults such as the East Bay's Hayward Fault. Larger events occurring closer to the Bay Area's large population centers would put infinitely greater strains on the emergency medical care system, because many more building collapses would occur, significantly larger numbers of people would be killed and injured, and key components in the health-care system, such as hospitals, would be extensively damaged and disrupted. Rather than creating complacency, the Loma Prieta earthquake should serve as a warning for what the region can expect in future earthquakes.

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Table 1

Population in Six-County Area Affected by Earthquake

County	Population
Alameda	1,208,000
San Benito	31,000
San Francisco	749,000
San Mateo	613,000
Santa Clara	1,401,000
Santa Cruz	218,000
Total	4,220,000

Source: Municipal Year Book, 1990, based on 1986 population estimates.

Table 2

Hospital Resources in the San Francisco Bay Area[a]

County	No. Hospitals	No. Beds
Alameda	25	3,952
San Benito	1	49
San Francisco	16	4,520
San Mateo	5	998
Santa Clara	14	4,803
Santa Cruz	3	486
Totals	64	14,808

[a]General medical-surgical facilities. Includes children's hospitals, Veteran's Administration and military facilities, as well as university hospitals.

Source: American Hospital Association Guide to the Health Care Field, 1987 Edition.

Table 3

Ambulance Companies and Personnel in the Six-County Study Area

County	Ambulance Companies				Personnel
	Private	Public	Military	Total	
Alameda	5	8	0	13	665
San Benito	1	0	0	1	10
San Francisco	3	1	1	5	320
San Mateo	2	1	0	3	130
Santa Clara	8	2	0	10	323
Santa Cruz	2	1	0	3	57
Totals	21	13	1	35	1,505

Source: Earthquake Project, San Francisco Emergency Medical Services Agency, Dept. of Public Health.

Table 4

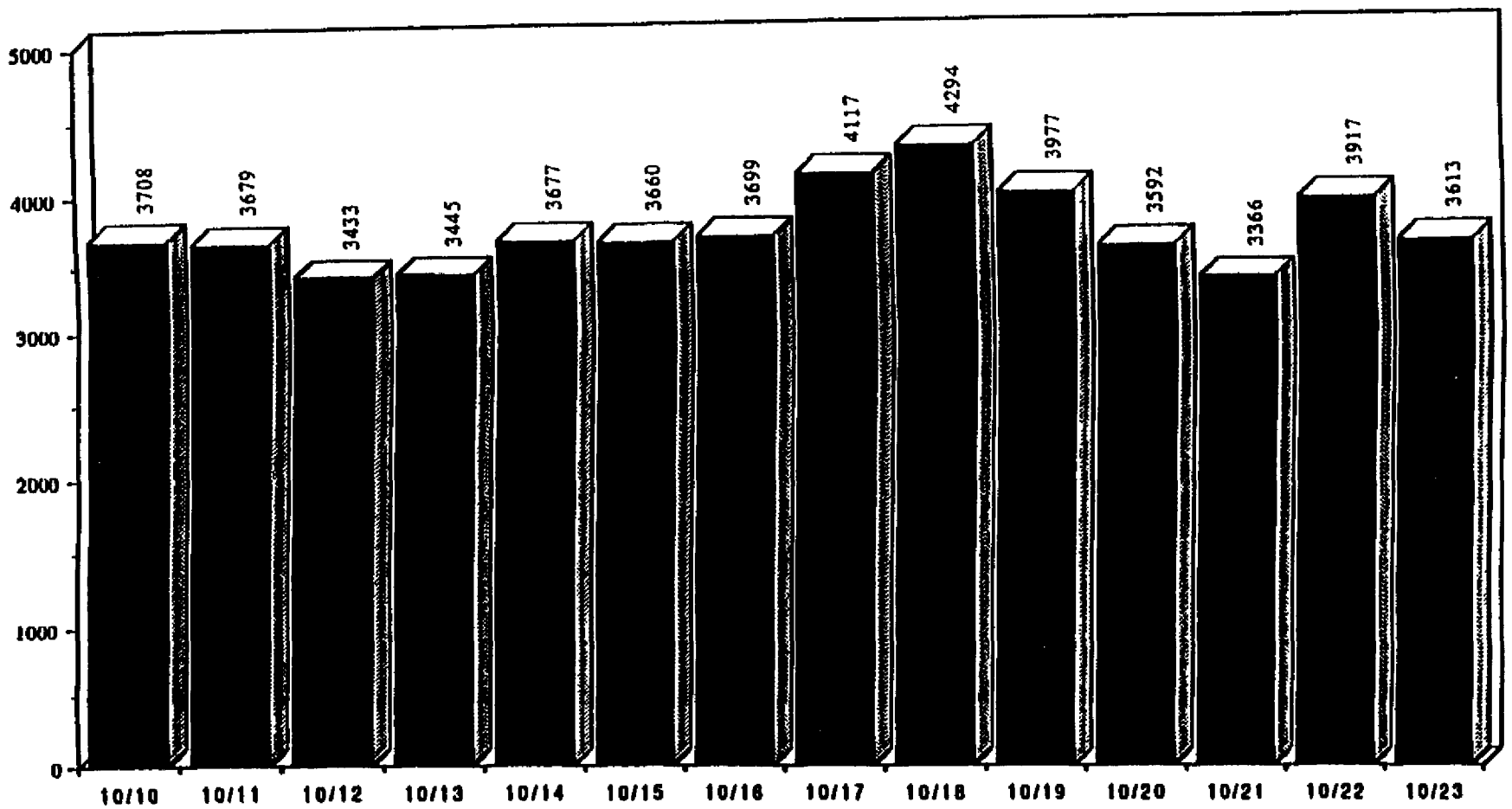
Reported Disruption in Key Hospital Services

Service	Degree of Disruption				Total N
	None	Minimal	Moderate	Complete	
Food Preparation	17 48.6%	11 31.4%	7 20.0%	0 0.0%	35
Supplies	19 59.4	12 37.5	1 3.1	0 0.0	32
Intensive Care Units	27 87.1	2 6.5	1 3.2	1 3.2	31
Surgery	20 58.8	8 23.5	5 14.7	1 2.9	34
Housekeeping/ Linens	27 84.4	4 12.5	1 3.1	0 0.0	32
Pharmacy	23 71.9	9 28.1	0 0.0	0 0.0	32

Source: Written questionnaire distributed to 51 Bay Area hospital administrators.

E.D. Visits by Day for 6 County Area,

Two Week Period Including October 17, 1989

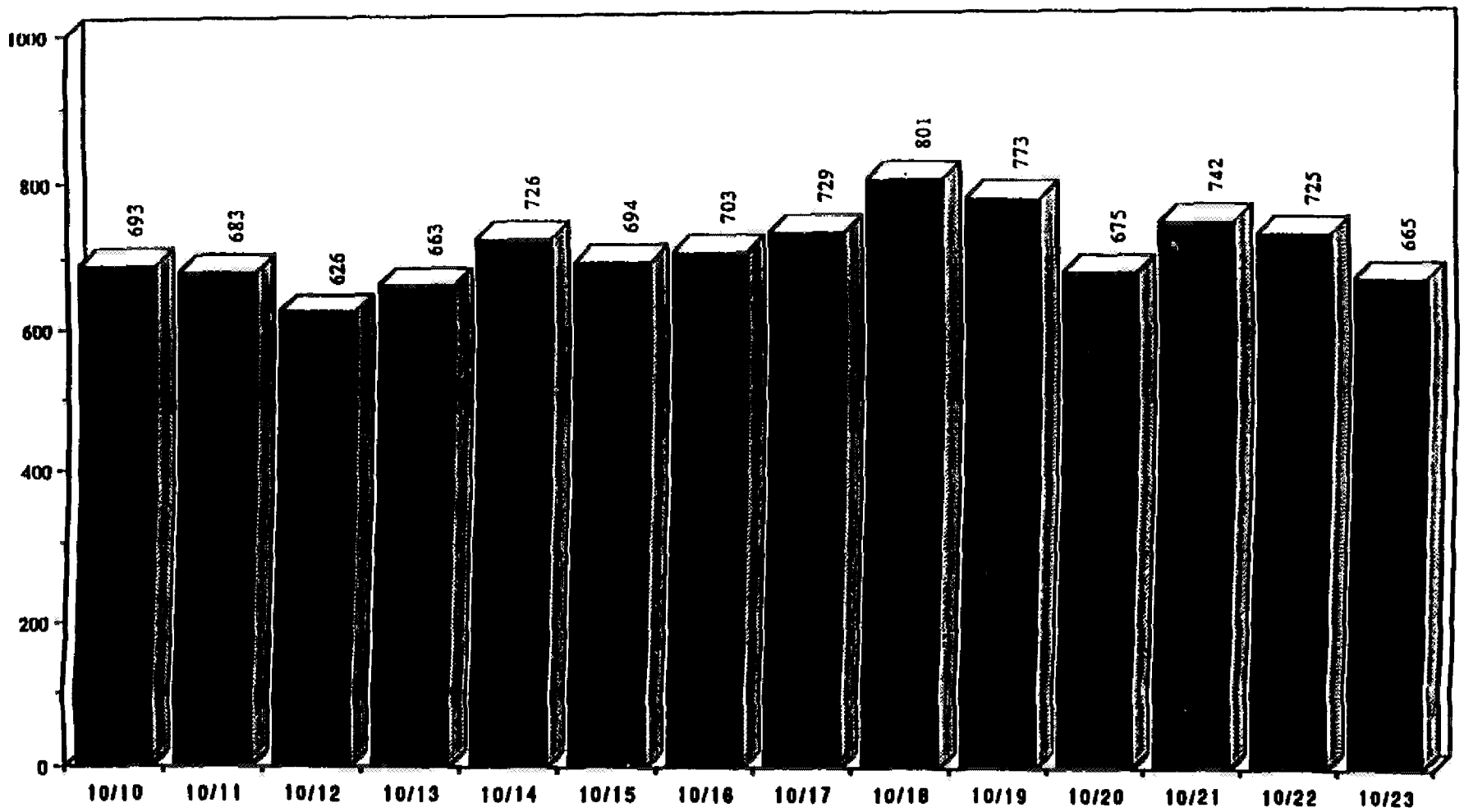


Date (October 1989)

Based on E. D. log data from 37 hospitals in Alameda, San Benito, San Francisco, San Mateo, Santa Clara, and Santa Cruz Counties. Total Hospital N=39 but two hospitals were not included due to missing data.

San Francisco County E.D. Visits by Day,

Two Week Period Including October 17, 1989

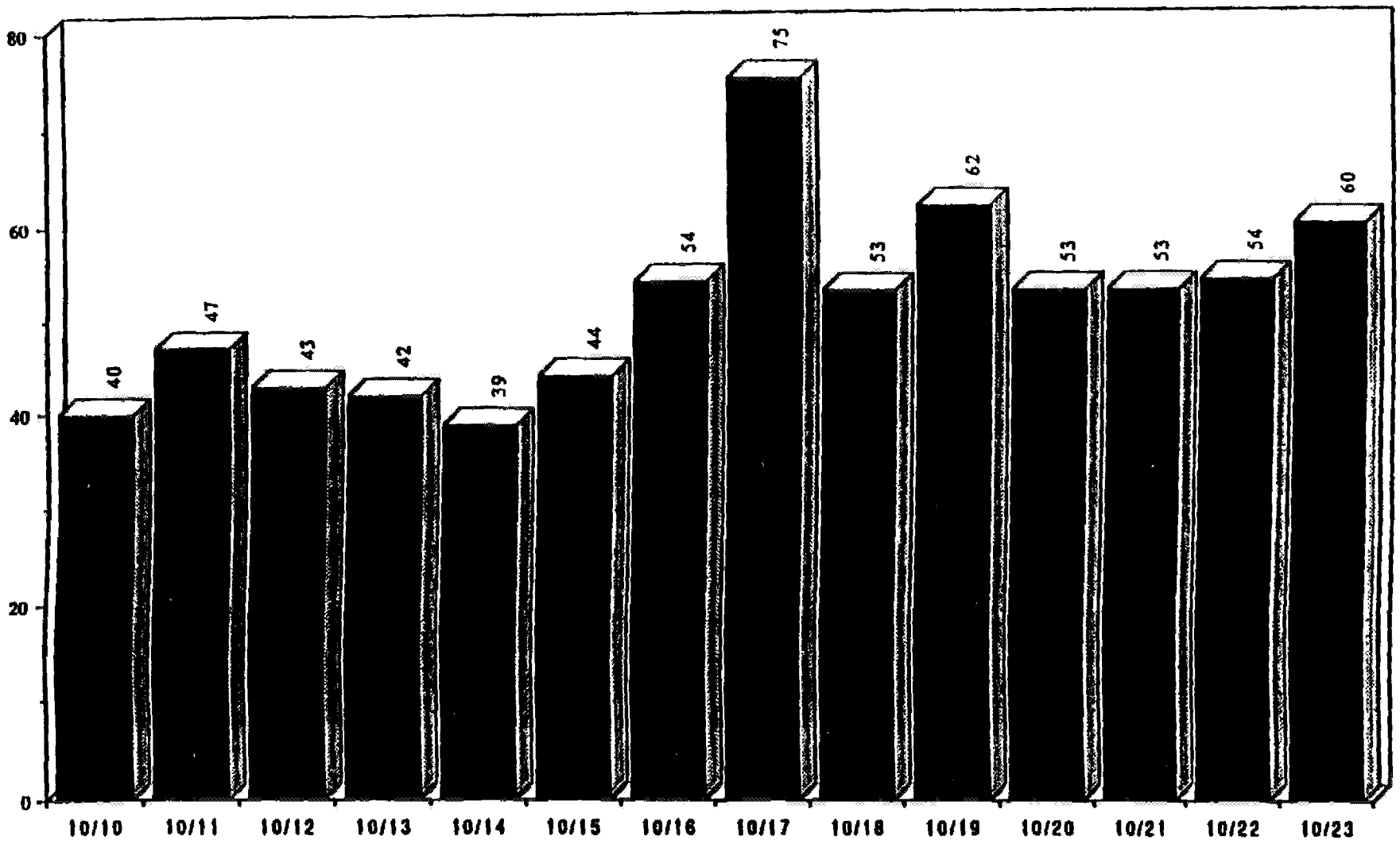


Date (October 1989)

Based on E D. log data from 11 hospitals. Total N=12, but one hospital was not included due to missing data.

San Benito County E.D. Visits by Day,

Two Week Period Including October 17, 1989

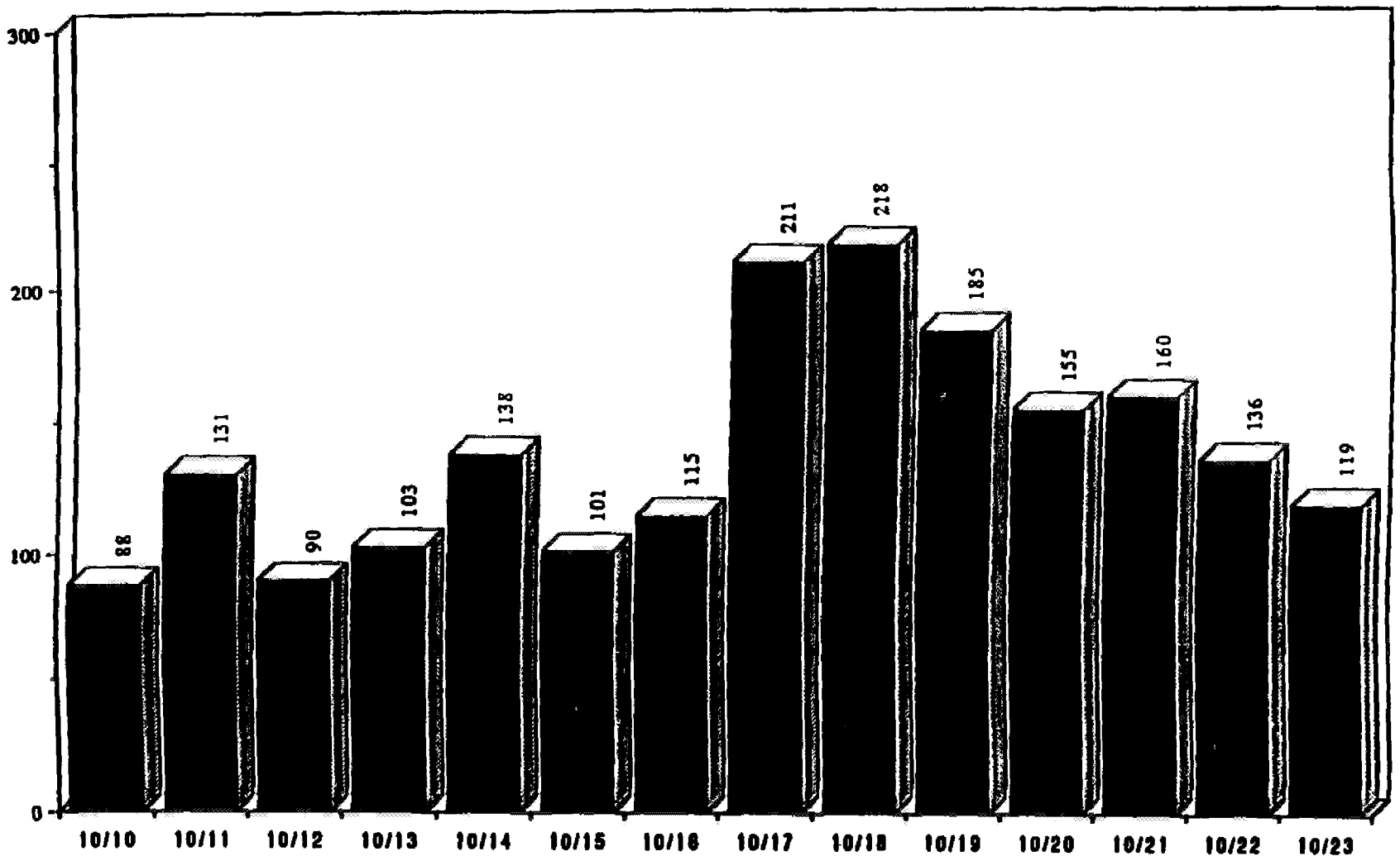


Date (October 1989)

Based on E.D. log data from 1 hospital.

Santa Cruz County E.D. Visits by Day,

Two Week Period Including October 17, 1989



Date (October 1989)

Based on E.D. log data from 1 hospital.

Table 9

Emergency Department Visits On Night of Earthquake, By Source of Complaint and County

County	Not Earthquake-Related	Earthquake-Related	Total Patients
Alameda	393 62.8%	233 37.2%	626 26.2%
San Benito	7 18.4	31 81.6	38 1.6
San Francisco	179 50.9	173 49.1	352 14.7
San Mateo	157 52.7	141 47.3	298 12.5
Santa Clara	397 46.8	451 53.2	848 35.5
Santa Cruz	155 68.0	73 32.0	228 9.5
TOTAL--All Six Counties	1288 53.9%	1102 46.1%	2390 100.0%

Source: Patient Emergency Department Records for 51 Bay Area Hospitals

Emergency Department Diagnoses of Persons with Earthquake-Related Complaints

Nature of Complaint	No. Patients	Totals
Medical Complaints		281 25.5%
Anxiety, Anxiety-related	60	
Other, Potentially Anxiety-related[a]	72	
Cardiac Problems and Hypertension[b]	46	
Pain[c]	12	
Other Medical Complaints[d]	91	
Injuries		668 60.6
Fractures	134	
Dislocations	14	
Sprains, Strains	89	
Concussions and Head Injuries[e]	22	
Wounds	159	
Superficial Injuries	28	
Abrasions and Contusions	138	
Other Injuries and Unspecified Injuries	84	
Not Classifiable		153 13.9
Resolved Without Diagnosis	14	
Record Contains Insufficient Data to Classify Complaint	139	
Total No. Patients		1102 100%

[a] Includes diagnoses such as chest pains, migraine, hyperventilation, difficulty breathing.
[b] Includes diagnoses such as congestive heart failure, angina, myocardial infarction.
[c] Includes lower back pain, unspecified pain.
[d] Includes wide range of medical complaints judged to have been brought on or exacerbated by the earthquake, e.g. dizziness, numbness, abdominal cramps.
[e] Excludes head injuries resulting in skull fractures.

Table 11

Mode of Transport to Hospital on Night of Earthquake, Earthquake and Non-earthquake Patients[1]

Mode of Transport	Source of Complaint: Not EQ-Related	Source of Complaint: EQ-Related	Totals
Ambulance	192 46.8%	218 53.2%	410 23.1%
Other	752 55.1	612 44.9	1364 76.9
Totals	944 53.2%	830 46.8%	1774 100.0%

[1] For 616 persons in the data set (N=2390), no data on mode of transport were contained in the record. However, it is likely that the vast majority were not transported by ambulance.