

HOSPITALS AND THE SAN FERNANDO EARTHQUAKE OF FEBRUARY 1971:  
the operational experience

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## PREFACE

The original intent of this research was to discuss the problem of maintaining function in hospitals after an earthquake and to report on the cost and effectiveness of alternative measures to improve the probability of survival. Our initial studies showed, however, that to attempt to do this was to enter the problem at a level unsupported by any detailed empirical study of the actual experience of an earthquake in a hospital. Hence the study was re-shaped to provide some of the empirical experience upon which useful conclusions might be drawn and upon which later studies might be structured.

As we developed the study we also began to understand that the concept of hospital function changes in an emergency. If the hospital is to continue to function as a revenue producing entity (or full service public institution) then little damage or improvisation can be tolerated. However, even if it lacks all services, its windows are broken, and its contents are strewn across the floor, if the building structure remains intact, it can be valuable in the immediate aftermath of the disaster. For this reason, this report focuses both on the experience of the disaster itself and on the long term effect to reinstitute the hospital as an economic entity, because these are two related parts of the problem of hospitals.

The method used is to describe the experiences of five hospitals in the San Fernando, California, earthquake of 1971, and covers the five most seriously damaged buildings. The engineering damage to these buildings has been extensively reported (1) but little systematic analysis has been done on the effect of the earthquake on occupants,\* its impact on the function and purpose of the hospital, and its long term organizational effect on the hospital as an economic entity. The object of this report is to indicate to the hospital administrator and staff at all levels what they may expect if their institution is subjected to a major earthquake.

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\* The Imperial County Earthquake 1979, occurred while this report was underway and as an extension to this study a special investigation was conducted into occupant behavior in the Imperial County Services Building. This study, "Imperial County Services Building, Occupant Behavior and Operational Consequences as a Result of the 1979 Imperial Valley Earthquake," was published by BSD in August 1982.

The main source of information has been through interviews with staff of the five hospitals. This method is inevitably selective - only a small number of those that experienced the earthquake were interviewed - and subjective, in that a common general experience may be recorded in different ways according to the precise experience, circumstances, and temperament of the subject. But our main concern is with people, for the function of the hospital is accomplished by people, working in a physical setting provided by the building, and using equipment and services in support of their patients.

To the extent that the building, services, and equipment are damaged and their functional effectiveness reduced by the earthquake, the staff must improvise services and revert to more fundamental levels of patient care that are less dependent on power and equipment. The important aspect of the personal narratives in this report lies not in the attempt to discern what the earthquake felt like, but what people were able to do. In the interviews, questions were focused on major issues of fact - where were you, what did you do, what did you see - with the object of gathering information on the operational limits of an organization undergoing extreme stress.

The hospitals described here represent a spectrum of damages, from the total collapse and tragedy at the Veterans Hospital, to the damage at Kaiser, Panorama City, which, though slow and expensive to repair, did not at any time result in injury or cessation of service. In addition, Appendix I provides a description of the events at three hospitals in Imperial County, 1979, experiencing an earthquake at which time damage just begins to occur. This spectrum is representative of what will happen in any major earthquake: in a more severe event, there may be more total collapses; in a less severe earthquake, the less severely damaged buildings at San Fernando or the buildings at Imperial County may represent the maximum extent of damage.

The information in this report provides the basis for some conclusions, aimed at clarifying our understanding of the effect of earthquakes on the hospital, and providing a factual basis for evaluating measures to improve the ability of the hospital to function after an earthquake, to reduce injury, and to reduce economic losses.

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Christopher Arnold was Principal Investigator for the study: the interviews in Los Angeles were all conducted by Michael Durkin. Dianne Whitaker was responsible for the graphics, and the report was typed by Nancy Hutcheson. Robert Reitherman also assisted in the early stages of the study.

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## I. INTRODUCTION

The San Fernando earthquake occurred at 6:01am on February 9, 1971. At this time it was still dark, the air dry and cool, though well above freezing. The shocks occurred completely without warning at a time when most people were asleep; some early workers were on the way to work or beginning preparations for their work day. In the hospitals, the night shifts were completing their duties in preparation for leaving, some patients were awake, others were asleep: in the surgical wards, patients scheduled for early surgery were beginning to be prepared.

The terror, injury, death and destruction of an earthquake lasts a few seconds. The instruments at Pacoima Dam, near the epicentral region of greatest shaking, recorded a bracketed duration of approximately 12 seconds; this is the duration of shaking above 0.05g.\* At this value the shaking would be perceptible to most people, but would not be starting to cause damage. The duration of shaking at 0.1g, at which acceleration damage would begin to occur to weaker structures and to building interior components, accompanied by noise, was also approximately 12 seconds at the Pacoima instrument. The V.A. hospital, where the collapse of two buildings caused the loss of 48 lives, is located approximately 1.25 miles from this instrument. Olive View Hospital, where 3 people died and extreme damage was caused, was located approximately 3.25 miles from the instrument. Pacoima Hospital and Holy Cross Hospital, which both suffered severe damage, were respectively 3.75 and 5.25 miles away (Figure 1).

For people on upper floors and further away from the epicenter the strong shaking would appear to continue longer, though the accelerations and displacements would be less. At the roof of the 9 story Millikan Library, in Pasadena, 23 miles from the epicenter, the duration of clearly perceptible shaking was between 35-40 seconds.

Even in the close-in hospitals, such as the Veterans Hospital and Olive View, it would take a few seconds for even an alert observer to realize that the unusual sensations were those of a large earthquake; but a patient, lying awake, perhaps awaiting the nurse to arrive for surgery preparation, might more quickly sense the onset of terror.

\* "g" represents acceleration equivalent to the force of gravity.

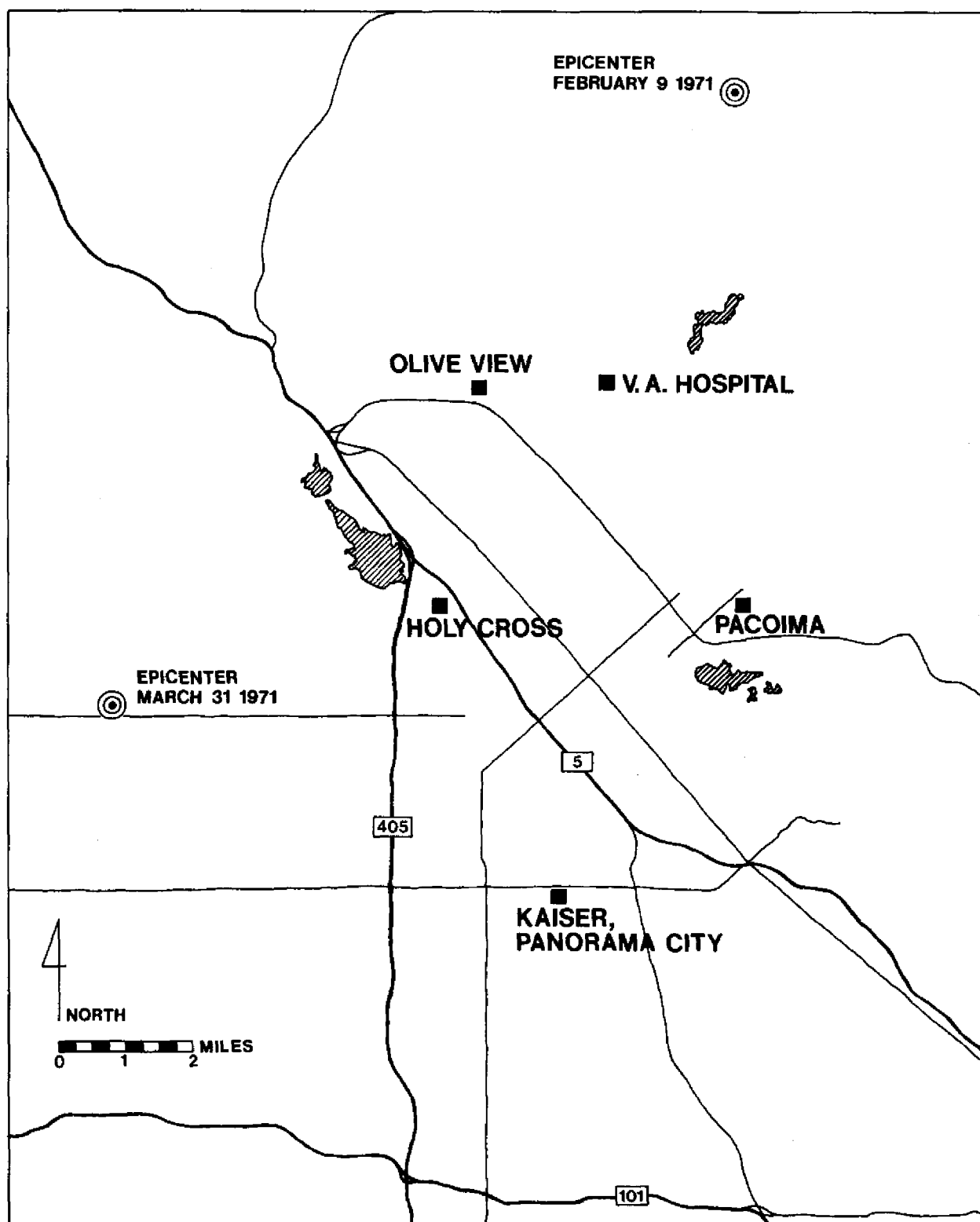


Figure 1: Location of San Fernando Hospitals in relation to epicenter.



Although the first few seconds brought the noise of materials grinding together, and of equipment moving, and clearly perceptible shaking, only in perhaps the last few seconds of the 12 seconds of strong shaking would damage begin to occur: television sets to be shaken from their ceiling or wall supports, pieces of ceiling to fall, partitions to deform and crack, glass to crash down on the floor, and the distortion and fracturing of structural elements to become apparent. So the most terrifying and destructive sensations occupied perhaps only 3-5 seconds; but at the beginning of that time there was no clue as to how long the severe shaking would continue and whether it would result in total collapse.

The aftermath of this few seconds of vibration will live forever in the minds of those that experienced it. Even to restore an institution back to something resembling its pre-earthquake operation may take 10 years, as will be seen from the descriptions that follow.

Table I, reproduced from the "San Fernando Earthquake of February 9, 1971" (2) summarizes the effect of the earthquake on hospitals in the San Fernando area. This was published in 1973, and estimates of replacement cost and dollar loss reflect knowledge and costs prevalent at the time. The five hospitals which form the subject of this study are designated in this table, and represent those which suffered the greatest dollar loss.

The incidence of casualties is tabulated below:

	Injured	Killed	Out-patients treated
Olive View	6	2 patients 1 staff	approx. 50
Pacoima Memorial	0	0	400
Holy Cross	0	0	350
Panorama City	0 patients 2 staff (minor)	0	1 (not in heavily affected area)
VA San Fernando	Not Available	47	

Facilities and Services										Earthquake damage and losses							
Location-City	Owner-ship (1)	Year founded (2)	Preearth-quake licensed bed-capac.	Licensed bed use (3)					Est. repl. value, bldg. & equip. (\$ millions)	Dollar loss		Bed loss	Shut-down		Start-up	Remarks	
				A.G.	Mat.	Ped.	Psy.	R-C		E.C.	Other		Bldg.	Equip.			Date
1 Burbank	N.P.	1905	115	108	7				2.0	0	0	0					
2 Burbank	N.P.	1944	370	324	23	23			11.0								
3 Canoga Park	Prop.	1968	72						2.2	2,000	1,000	0					
4 Canoga Park	Prop.	1958	112	108		4			2.0	0	0	0					
5 Canoga Park	Prop.	1962	116	116					2.0	0	0	0					
6 Canoga Park	Prop.	1962	80	64	13	3			2.75	50,000 (combined)		0					
7 Encino	Prop.	1954	189	144		18		27	6.6	0	0	0					
8 Encino	N.P.	1955	152	104	34	14			2.1	0	0	0					
9 Glendale	N.P.	1947	98	84	14				3.0	0	0	0					
10 Glendale	N.P.	1905	380	252	27	17	60	24	11.4								
11 Glendale	N.P.	1954	152						5.3								
12 Glendale	N.P.	1926	310	270	28	12			10.9	20,000	0	0					
13 Glendale	Prop.	1955	31	27	4				0.9	0	0	0					
14 Glendale			22						0.66	0	0	0					
15 Granada Hills	N.P.	1966	201	169	16	16			6.0	5,000	0	0					
16 North Hollywood	Prop.	1969	73	59	8	6			2.2	0	0	0					
17 North Hollywood	Prop.	1952	84	84					2.5	5,000	5,000	0					
18 Northridge	N.P.	1955	206	134	13	28	11	20	6.0	300,000	55,000	0					
*19 Olive View	L.A. Co.	1920	888	120	(Postearth-quake)	100		25					643 2/9/71	10 a.m.	9/71	1,4 (OV)	
a. Medical Treatment and Care Bldg.																	
b. Psychiatric Bldg.																	
c. Central Heating Plant																	
*20 Pacoima	N.P.	1957	110	82			28		1.5	375,000							
*21 Panorama City	N.P.	1962	321	202	41	32		46	4.75	6,000,000 (combined)	110 2/9/71	6 a.m.	3/2/71			4 (PL)	
*22 Panorama City			96						9.1	250,000 (combined)	0					4 (PC)	
*23 San Fernando	N.P.	1961	259						3.0								
*24 San Fernando	Prop.	1922	69	69					9.0	4,000,000	1,000,000	209 2/9/71	3 p.m.	3/72 (tent)		2,4 (RC)	
*25 Sepulveda	F.G.	1955	906	385			341	80	1.4	1,000	1,000	0					
*26 Sherman Oaks	Prop.	1959	160	148		12		100	30.00	900,000 (combined)		0					
*27 Sun Valley	Prop.	1967	111	99	12				4.8	0	0	0					
*28 Sylmar	F.G.	1926	365						4.0	1,000	0	0					
*29 Van Nuys			113						15.00	10,000,000 (combined)	365 2/9/71	6 a.m.				4 (VET)	
30 Van Nuys	Prop.	1929	66	66					3.0	500	0	0					
31 Van Nuys	N.P.	1958	281	235	28	18			2.0	0	0	0					
32 Van Nuys	N.P.	1964	63						18.00	70,000	5,000	0					
33 Woodland Hills	N.P.	1921	180	73			10	97	2.0	0	0	0					
TOTALS			6,751						223.06	52,979,500	1,067,000	1,327					3

Remarks: 1. Hospital was not operating at licensed capacity.  
2. In-patients facilities temporarily closed.  
3. Cottage style (58 occupancy) on grounds.  
4. OV = Olive View, PL = Pacoima Lutheran, RC = Holy Cross, VET = Veterans Hospital, PC = Panorama City Medical Center.

Note: Where replacement values were unknown, a value of \$20,000 to \$35,000 per bed was used.

(1) N.P. = Nonprofit. Prop. = Proprietary. L.A. Co. = L.A. County.  
 F.G. = Federal Government.  
 (2) All structures on site not necessarily erected this date.  
 (3) A.G. = Acute General. Pod. = Pediatrics. R.C. = Rehab.-Convalescent.  
 Mat. = Maternity. Psy. = Psychiatric. E.C. = Extended Care

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Table I. Hospitals, San Fernando Valley. (Chart from Murphy, Leonard M., Scientific Coordinator, San Fernando, California, Earthquake of February 9, 1971, U.S. Department of Commerce, Washington, D.C., 1973.)