

# An Emergency Medical Service System— *Analysis of Workload*

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**K**NOWLEDGE of the population, nature and distribution of emergencies, and geography and physical environment of a community is a basic requirement for setting up an emergency medical system and can be used to evaluate existing or proposed systems and facilities. But there have been no such data with which to work. The San Francisco study was undertaken to accumulate samples of these data.

## The San Francisco Study

San Francisco has many advantages as a subject of a systems analysis of an urban emergency medical service because of the organization of services and the interest of the department of public health, which operates the emergency hospitals and their ambulances.

A 1963-64 study by the San Francisco Department of Public Health and the Injury Control Program, Public Health Service, was undertaken to develop methodology and data as a partial basis for improving timeliness and adequacy of emergency care systems. The study is concerned with the initial phases of emergency care—from the time the patient is discovered until he leaves the emergency hospital.

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While the information gathered has certain values unique for San Francisco, the intent has been to obtain data broadly applicable for systems analysis.

The study had five specific objectives.

1. To determine the nature and distribution of emergencies and the workload of the emergency medical services system.
2. To determine the sequence of times from occurrence of injury to discharge of the patient from the system.
3. To analyze the cases of patients who were dead on arrival.
4. To derive a general, predictive mathematical model of the operation of an emergency medical system.
5. To evaluate the method with respect to future studies.

This paper discusses background information and the findings concerning the first objective.

## Method and Sample

Staff members of the Injury Control Program were assigned to the San Francisco health department to accumulate reports on emergency patients treated by the San Francisco emergency medical service. The study group was headed by Dr. Walter Clowers, a now-retired medical director, Public Health Service.

For the study, emergency patients were persons treated at emergency clinics, including outpatients, and all ambulance patients. The report forms were filled out by personnel of the emer-

gency services system. Separate forms were used for ambulance and nonambulance patients.

The report on ambulance patients had four sections. Section a, completed by the ambulance steward, recorded home station of the ambulance, site of the emergency, time and circumstances of the run, acquisition of the patient, and transport or reason for nontransport of the patient. Section b, completed by the steward or driver, included personal data on patient, type of emergency, state of consciousness, aid given prior to arrival of ambulance, and action taken by the crew at the scene and on returning to hospital. Section c, completed by the emergency room nurse, recorded time of emergency and discharge and disposition of the patient. Section d, completed by the physician, called for provisional diagnosis, treatment, condition of patient, and judgment on the urgency for treatment and use of ambulance. The report on nonambulance patients included only sections c and d.

Reports were deposited in a box at each hospital and retrieved by study group personnel who reviewed them onsite and attempted to obtain missing data and verify questionable responses. The census tract in which the emer-

gency occurred was determined and the reports numbered sequentially for each participating hospital. Data reduction and subsequent analysis were done by Public Health Service staff in Washington. Data were collected for 13 months, April 1963–April 1964. The 13th month was included because of omissions and inappropriate responses in the early part of the study. Data were collected from four participating emergency hospitals; Mission Emergency, the emergency station of the San Francisco General Hospital, was not included.

Mission Emergency is not only a unit of the emergency medical system, but also an admission unit for San Francisco General Hospital. To use reports from Mission in this study, it would have been necessary to change the system to separate the receiving and emergency admissions functions.

It has been questioned whether data reported from the four other emergency units were representative of the San Francisco emergency service workload or if the portion of the total emergency calls, about 16 percent, that went to Mission differed in nature from those received by the other four units. While direct evidence concerning differences between the nature and dis-

**Table 1. Ambulance and nonambulance patients, by area of residence and race, San Francisco emergency medical service**

Area of residence and race	Total		Ambulance				Nonambulance			
			Male		Female		Male		Female	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
All areas <sup>1</sup> -----	10,765	100.0	1,846	100.0	1,203	100.0	5,243	100.0	2,473	100.0
White-----	8,822	82.0	1,492	81.0	951	79.1	4,357	83.1	2,022	82.0
Negro-----	1,431	13.3	244	13.2	173	14.4	668	12.7	346	14.0
Oriental-----	338	3.1	66	3.6	58	4.8	136	2.6	78	3.2
Other-----	174	1.6	44	2.4	21	1.7	82	1.6	27	1.1
Urban San Francisco <sup>2</sup> ---	9,498	100.0	1,467	100.0	1,054	100.0	4,713	100.0	2,264	100.0
White-----	7,684	81.0	1,157	79.0	826	78.0	3,875	82.2	1,826	81.0
Negro-----	1,343	14.1	214	14.5	157	14.9	634	13.5	338	14.9
Oriental-----	317	3.3	61	4.2	54	5.1	128	2.7	74	3.3
Other-----	154	1.6	35	2.4	17	1.6	76	1.6	26	1.1
Other <sup>3</sup> -----	1,267	100.0	379	100.0	149	100.0	530	100.0	209	100.0
White-----	1,138	90.0	335	88.4	125	83.9	482	91.0	196	93.8
Negro-----	88	6.9	30	7.9	16	10.7	34	6.4	8	3.8
Oriental-----	21	1.6	5	1.3	4	2.7	8	1.5	4	1.9
Other-----	20	1.5	9	2.4	4	2.7	6	1.1	1	.5

<sup>1</sup> Race of 230 patients unknown.

<sup>2</sup> Race of 199 patients unknown.

<sup>3</sup> Race of 31 patients unknown.

**Table 2. Urban San Francisco population and emergency patients, by age, San Francisco emergency medical service**

Age group (years)	San Francisco population		Ambulance patients		Nonambulance patients		Total emergency patients	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Total.....	740,316	100.0	2,950	100.0	7,837	100.0	<sup>1</sup> 10,726	100.0
Under 1.....	12,098	1.6	21	0.7	70	0.9	91	0.8
1-4.....	47,053	6.4	81	2.7	818	10.4	899	8.4
5-9.....	50,374	6.8	82	2.8	684	8.7	766	7.1
10-14.....	47,815	6.5	89	3.0	571	7.3	660	6.2
15-19.....	42,080	5.7	179	6.1	705	9.0	884	8.2
20-24.....	49,075	6.6	280	9.4	775	9.9	1,055	9.8
25-34.....	97,926	13.2	380	12.9	1,233	15.7	1,613	15.0
35-44.....	101,136	13.7	424	14.7	1,145	14.6	1,569	14.6
45-54.....	105,875	14.3	461	15.6	896	11.4	1,357	12.7
55-64.....	93,274	12.6	448	15.2	548	7.0	996	9.3
65-74.....	63,046	8.5	329	11.1	243	3.1	572	5.3
75-84.....	26,115	3.5	176	6.0	88	1.1	264	2.5
85 and over.....	4,449	.6	0	-----	61	.8	0	-----

<sup>1</sup> Does not include 61 nonambulance patients age 85 and over.

tribution of the workload imposed by the Mission district population and that of the rest of the urban population was lacking, those concerned with the operation of the ambulances and the emergency stations believe that if such differences did exist, they were not meaningful as far as this study is concerned.

### Emergency Medical Services System

The 1960 census listed the urban population of San Francisco as 740,316 persons, the San Francisco-Oakland area as 2,395,098, and the Standard Metropolitan Statistical Area (San Francisco-Oakland) as 2,783,359 (1). Emergency patients of the San Francisco emergency medical service were principally from the urban population. Each health department emergency unit was staffed by a physician, a nurse, and ambulance crews of a medical steward and ambulance driver. There were 51 persons and 16 ambulances. The emergency services operated in an area of 50 square miles at all times. In 1964, the population served by the medical services system included 753,000 residents and 199,000 transients.

Mission Emergency had immediately adjacent-supporting facilities. The other four emergency hospitals—Central, Harbor, Alemany,

and Park—did not have X-ray or other major medical and surgical facilities required for definitive care. They were not really hospitals, but rather emergency aid stations.

The total cost of operation to the city and county was approximately \$1,100,000 per year or just under \$1.50 per person in the urban population. No charge was made to persons using this service.

### Characteristics of Emergencies

There were 18,350 reports on ambulance patients and 39,470 reports on nonambulance patients from participating hospitals. The 20 percent sample used, every fifth report from each hospital, included reports on 3,431 ambulance runs involving 3,670 patients. Reports on 147 patients dead on arrival were limited to the notation D.O.A. Data on more than 400 additional records were limited because the patient refused treatment or was referred to a private physician. In 98 ambulance runs the patient left before the arrival of the ambulance. Patients were transported in approximately 70 percent of the runs, and items relevant to transport and delivery were not applicable for the other 30 percent. Thus the base number is less than 3,670 for various factors analyzed.

There were 7,894 reports in the 20 percent sample of the nonambulance patients. Data were provided on more than 95 percent of the patients.

*Race, sex, and age distributions.* The proportion of white emergency patients was nearly equal to the proportion of white persons in the urban population. The proportion of Negroes was more than 1.4 times their representation, and that of "others," principally Indians, was four times as great as their representation. Orientals constituted 7.9 percent of the urban population but only 3.3 percent of the emergency cases (table 1). Among white persons, the percentage of ambulance patients was slightly less than the percentage of nonambulance patients.

The differences in proportion of males and females were less than 1 percent for both white and nonwhite ambulance patients, and not greater than 1.5 percent for nonambulance patients for the races reported. The racial composition of a population may be significant in estimating the workload on the medical system and the location of emergency facilities.

The distribution of emergencies by age of patients showed somewhat more marked differences between ambulance and nonambulance patients (table 2). Except for persons in the age groups 15-24 years, persons from under 1 year

to 35 years constituted a smaller percent of ambulance cases than their representation in the San Francisco urban population. The differences at ages 15-19 and 25-34 are small. The percentage of total cases involving persons 35-84 years was from 1 to 2.6 percent greater than their representation in the population.

The percentages of nonambulance patients in age groups 1-44 years were greater than their representation in the total population; for persons 45-84 years the situation was reversed, with a relatively rapid falling off of nonambulance emergencies.

*Types of cases.* Information on the type of emergency was provided by the ambulance crew and for the nonambulance emergencies by a nurse at the emergency hospital. More than 66 percent of 11,000 persons suffered accidental injury, more than 6 percent were victims of assault or were suicides or attempted suicide, and more than 27 percent were ill. For 5 percent of the total sample, the type of emergency was not stated (table 3).

Perhaps the most striking features of the distributions were the high proportion of accidental injuries reported for both the ambulance and nonambulance patients and the considerable differences between the proportion of various injuries among ambulance and nonambulance patients. The reports did not list the type

**Table 3. Ambulance and nonambulance patients, by type of emergency, San Francisco emergency medical service**

Type of emergency	Total patients		Ambulance patients		Nonambulance patients	
	Number	Percent	Number	Percent	Number	Percent
Total sample.....	11, 000	100. 0	3, 184	100. 0	7, 816	100. 0
Assault.....	641	5. 8	183	5. 7	458	5. 9
Suicide or attempted suicide.....	100	. 9	84	2. 6	16	. 2
Accidental injury.....	7, 272	66. 1	1, 707	53. 6	5, 565	71. 2
Traumatic.....	7, 071	64. 3	1, 637	51. 4	5, 434	69. 5
Motor vehicles.....	1, 279	11. 6	838	26. 3	441	5. 6
Falls.....	2, 090	19. 0	582	18. 3	1, 508	19. 3
Other accidents.....	3, 702	33. 7	217	6. 8	3, 485	44. 6
Poisoning.....	201	1. 8	70	2. 2	131	1. 8
Illness.....	2, 987	27. 1	1, 210	38. 0	1, 777	22. 7
Psychiatric.....	37	. 3	21	. 7	16	. 2
Alcoholic.....	300	3. 0	79	2. 5	221	2. 8
Obstetric.....	51	. 5	44	1. 4	7	. 1
Medical.....	2, 411	22. 0	1, 040	32. 7	1, 371	17. 5
Not further classified.....	188	2. 0	26	. 8	162	2. 1

**Table 4. Selected diagnoses among ambulance and nonambulance patients, San Francisco emergency medical service**

Diagnosis	Total patients		Ambulance patients		Nonambulance patients	
	Number	Percent	Number	Percent	Number	Percent
All cases .....	10,361	100.0	2,482	100.0	7,879	100.0
No apparent illness or injury .....	179	1.7	75	3.0	104	1.3
Injuries .....	7,632	73.7	1,626	65.5	6,006	76.2
Fractures .....	686	6.6	303	12.2	383	4.9
Dislocations, strains, sprains .....	473	4.6	112	4.5	361	4.6
Head injury, except face .....	612	5.9	210	8.4	402	5.1
Lacerations and open wounds .....	3,230	31.2	461	18.6	2,769	35.1
Contusions and crushing .....	1,024	9.9	262	10.6	762	9.7
Foreign body in orifice .....	437	4.2	5	.2	432	5.5
Burns (except sunburn) .....	240	2.3	16	.6	224	2.8
Superficial injury .....	534	5.2	110	4.4	424	5.4
Poisoning .....	252	2.4	96	3.9	156	2.0
Gas inhalation .....	26	.3	15	.6	11	.1
Overdose of medicine .....	159	1.5	63	2.5	96	1.2
Other (including food) .....	67	.6	18	.7	49	.6
Other injuries; other external causes .....	144	1.4	51	2.1	93	1.2
Illness .....	2,550	24.6	781	31.5	1,769	22.5
Allergic, metabolic, nutritional .....	235	2.3	30	1.2	205	2.6
Mental, psychoneurotic personality, excluding alcoholism .....	652	6.3	167	6.7	485	6.2
Alcoholism .....	522	5.0	110	4.4	412	5.2
Nervous system; sense organs, excluding vascular lesions and convulsions .....	389	3.8	139	5.6	250	3.2
Vascular lesions (CNS) .....	60	.6	51	2.1	9	.1
Convulsions .....	85	.8	68	2.7	17	.2
Circulatory system .....	156	1.5	96	3.9	60	.8
Respiratory system .....	194	1.8	51	2.1	143	1.8
Digestive system .....	265	2.6	68	2.7	197	2.5
Other .....	659	6.4	230	9.3	429	5.4

of injury or probable cause of death for persons dead on arrival.

*Nature of emergencies.* A provisional diagnosis was entered for the 10,361 persons seen by a physician at one of the emergency hospitals (table 4). Of these patients, 73.7 percent were injured, more than 90 percent of these in accidents. Lacerations and open wounds were the most frequent injuries, with contusions and crushing the second most frequent; together these amounted to more than 40 percent of total injuries. Fractures ranked third. Emergencies resulting from mental, psychoneurotic, and personality disorders, including alcoholism which was responsible for four-fifths of these cases, ranked fourth. Head injuries (excluding facial injuries) were fifth. For 32 percent of the ambulance patients with diagnoses involving alcohol, there were multiple diagnoses with mention of alcohol, and for another 2 percent there were

“possible” or “probable” multiple diagnoses with mention of alcohol.

*Distribution of workload.* The workload was fairly evenly distributed throughout the week with some increase over the weekend for both ambulance and nonambulance emergencies (table 5). If the reports in which alcohol was mentioned are considered separately, the distribution started building up Friday and continued through Tuesday; for the ambulance emergencies, however, Sunday was an exception and showed the second lowest percent in the week. The maximum difference in daily workload for all cases was about 3 percent; the maximum difference for ambulance cases in which alcohol was mentioned was about 4 percent.

The composition of the caseload changed with day of week, with the ratios of injury to disease among ambulance patients highest for the weekend (table 5).

About 30 percent of all ambulance calls and nonambulance emergency admissions occurred between midnight and noon. The same percent applied to the ambulance patients with alcohol mentioned in their diagnoses. About 40 percent of nonambulance patients involved with alcohol were admitted between midnight and noon. Calls and admissions increased at 4 p.m. to 6 p.m. and reached a peak for ambulance calls between 10 p.m. and midnight, with an earlier peak between 6 p.m. and 8 p.m. for nonambulance admissions (table 6).

### Ambulance Runs

In addition to transporting emergency patients, ambulances were used to transport non-emergency patients and distribute supplies and equipment. Transfer runs, not considered in this study, amounted to an average of 24 calls a day in 1963-64. Further, an ambulance stands by at large fires and during events attended by many people.

*Emergency workload.* The average number of ambulance responses per day for the four emergency hospitals was at least 43. Central ranked first and Harbor second in the number of runs. The distribution of runs and the reported number of patients per run are shown in table 7.

Two ambulances stationed at Central for transfer runs were available for reassignment to pick up and transport patients during peak workloads. One of the Central ambulances was available for special assignments and was dispatched to work out of another emergency hospital from 4 p.m. to midnight when needed.

*Notification and dispatch.* The notification initiating an ambulance run was received at an emergency hospital for 91 percent of total runs. In about 2 percent the ambulance was dispatched by two-way radio while enroute. Less than 1 percent of the notifications were received at other institutions and 6 percent at other places.

Of the 3,431 runs, the point of origin was the home station about 85 percent of the time and other emergency hospitals 6 percent of the time. Both crew and ambulance were reported available for dispatch without delay in 99 percent of the runs. In 97 percent of the 3,063 runs for which time was recorded, dispatch occurred within 1 minute.

The distances from place of origin to the place of emergency was reported for 2,208 ambulance runs. In more than 55 percent of the runs the distance was less than 1 mile; in 85 percent, less than 2 miles. The distance exceeded 4 miles in less than 2 percent of the runs. In runs of 3 miles or less for which the time is known, approximately 18 percent reached the scene of the emergency within 4 minutes after dispatch, 70 percent within 5 minutes, and more than 99.5 percent within 15 minutes. Detailed consideration of time sequences for the total operation is beyond the scope of this report.

*Right-of-way.* Information on use of siren, emergency lights, and overriding of traffic controls is known for approximately 3,400 runs. En route to the emergency no signals were used or traffic lights overridden in about two-thirds of the runs. All resources were exercised in about 23 percent of the runs, lights only in 8 percent, and lights and siren in about 3 percent. Use of

**Table 5. Percent distribution of workload by day of week, San Francisco emergency medical service**

Patients	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Unknown
Ambulance patients-----	14.9	13.4	13.1	13.1	14.4	14.0	16.1	1.0
Nonambulance patients-----	16.1	13.1	13.1	13.7	13.5	14.6	15.9	0
Alcohol mentioned:								
Ambulance patients-----	10.0	18.2	17.3	12.7	9.1	14.5	17.3	.9
Nonambulance patients--	15.5	14.8	14.1	13.6	13.3	14.1	14.6	0
Ratio of injuries to disease among ambulance patients--	4 : 2	2 : 2	2 : 2	2 : 2	2 : 7	3 : 4	3 : 1	-----

**Table 6. Percent distribution of average weekly workload, by time of day, San Francisco emergency medical service**

Patients	A.M.						P.M.					
	12:00-1:59	2:00-3:59	4:00-5:59	6:00-7:59	8:00-9:59	10:00-11:59	12m.-1:59	2:00-3:59	4:00-5:59	6:00-7:59	8:00-9:59	10:00-11:59
Ambulance patients.....	6.7	5.3	2.3	3.7	6.5	7.5	11.1	9.2	13.3	9.6	8.9	15.9
Nonambulance patients.....	5.8	4.4	2.0	2.1	6.3	10.0	10.7	11.9	12.3	13.6	11.9	8.9
Alcohol mentioned:												
Ambulance patients.....	5.4	4.5	.9	6.4	9.1	6.4	9.1	7.3	10.0	7.3	13.6	20.0
Nonambulance patients...	10.7	7.3	3.2	3.9	7.0	9.2	6.1	6.1	9.0	9.9	16.0	11.6

these devices was not related to distance traveled.

When transporting a patient to an emergency hospital no right-of-way was exercised in more than 92 percent of the runs. All resources were used in less than 3 percent, lights only in about 5 percent, and siren only in less than 1 percent of the return trips.

*Place of emergency.* There are 3,095 ambulance reports stating the place the emergency occurred. Of these, 35 percent cite the home as place of emergency, 43 percent the street or highway, and 22 percent public buildings, resident institutions, industrial premises, schools, parks, and elsewhere. The percent of runs not completed because of wrong or inadequate address is negligible.

In only a few emergencies were rescue operations by the ambulance crew required to gain access to or free the patient.

*Situation at the scene.* The type of emergency, based on information given the crew by the patient, police, other officials, friends, relatives, and people who had witnessed the accident, and upon judgments of the crew, was stated in 3,184 reports (table 4).

Not less than 9 percent of the patients were either gone when the ambulance arrived or refused service. The condition of the patient when the ambulance arrived was stated for 2,570 persons, (approximately 80 percent of the emergencies in which the patient remained at the scene). Of these, 90 percent were reported to be conscious, 6 percent unconscious, and about 2 percent judged dead. Approximately 5 percent

of the patients were referred to a private physician.

Time spent on patients not carried by the ambulance is part of the workload. The crew must survey the situation, reassure the patient and others in attendance, and make phone calls when warranted. In about 6 percent of all emergencies, the coroner or a private physician was notified, and his instructions were carried out.

In 67 percent of the emergencies in which the 252 telephone calls were made, the time spent at the scene was 15 minutes or more; in 25 percent, 5 minutes; and in 8 percent, less than 4 minutes. For the 3,106 other emergencies for which the time at the scene is known, nearly 40 percent of the reports showed 15 minutes or more; 30 percent, 5 minutes; and the other 30 percent, less

**Table 7. Patients carried on each ambulance run, by home station of ambulance, San Francisco emergency medical service**

Patients carried per run	Total runs reported		Number of patients by home station			
	Number	Percent	Central	Harbor	Alemany	Park
All runs.....	3,431	100.0	1,429	826	539	637
0.....	979	28.5	353	219	208	199
1.....	2,218	64.6	995	555	289	379
2.....	162	4.7	54	38	31	39
3.....	36	1.0	15	7	6	8
4.....	19	.6	7	2	2	8
Not stated....	17	.5	5	5	3	4

than 4 minutes. If an ambulance remained at the scene longer than 15 minutes, the crew reported to the home station that they were temporarily out of service and confirmed their location.

*Patient management.* Three percent of all patients present when the ambulance arrived received emergency care, guidance, and reassurance but required no further treatment and were not transported.

There were 75 patients (about 3 percent) who were transported with no injury or illness apparent and no emergency measures at the scene indicated who did not require any treatment at the emergency hospital (table 4).

For persons whose treatment at the scene and provisional diagnosis upon arrival at the hospital is known, the most frequent injuries were lacerations and open wounds, head injuries, contusions and crushing, superficial injuries, and fractures of limbs, nose and jaw, skull except face, and spine and trunk. Relatively few instances of illness treated at the scene with subsequent provisional diagnosis are reported; the most frequent are psychoneurosis or psychoses, alcohol, and heart disease.

The listing of emergencies for which a provi-

**Table 8. Frequency of equipment and supply use at scene and en route to hospital, San Francisco emergency medical service**

Equipment used	Times used	At scene	Enroute	At scene and enroute
Number of patients <sup>1</sup> .....	781	528	47	187
Wheel chair.....	1	1	0	0
Emesis basin.....	3	1	2	0
Oxygen tank.....	89	12	29	48
Medications.....	15	11	0	4
Gauze.....	379	337	3	39
Adhesive.....	6	5	0	1
Bandage.....	479	424	3	52
Splint, not otherwise specified..	4	3	0	1
Splint, arm.....	20	19	0	1
Splint, leg.....	63	55	0	8
Pulmotor.....	1	0	0	1
Obstetrical equipment.....	4	3	0	1
Other.....	69	26	10	33

<sup>1</sup> Number of times equipment used is greater than number of patients because more than 1 piece of equipment could be used per patient.

**Table 9. Frequency and location of specific actions taken by ambulance crew, San Francisco emergency medical service**

Action taken	Times action taken	At scene	En route	At scene and en route
Number of patients <sup>1</sup> .....	765	529	47	189
Drugs administered.....	2	0	0	2
Delirium tremens mix.....	16	3	0	13
Internal medications or nourishment or both.....	13	7	0	6
Bandage or dressing applied.....	439	377	3	59
Splints applied.....	86	76	0	10
Artificial respiration.....	5	2	0	3
Heart massage.....	16	3	3	10
Airway inserted.....	3	0	2	1
Oxygen administered.....	112	12	28	72
Put to bed, made comfortable..	22	3	0	19
Delivery or assisted at delivery.....	5	4	0	1
Gave advice to patient or family.....	68	31	0	37
Supportive care.....	12	5	3	4
Treatment for or prevention of shock.....	8	1	1	6
Elevated body or part of body..	3	1	2	0
Quieted or restrained patient..	4	1	1	2
Treatment attempted, could not be completed.....	2	1	1	0
Aroused or attempted to arouse patient.....	1	1	0	0
Cleared mouth of mucus, blood; kept airway open.....	7	3	1	3
Other.....	52	24	2	26

<sup>1</sup> Number of specific actions taken are greater than the number of patients because more than 1 action could be taken per patient.

sional diagnosis was made subsequently at the emergency hospital (table 4) demonstrates the variety of principal medical conditions with which the ambulance crew may be confronted.

*Equipment used or needed.* The medical equipment and supplies normally carried on the San Francisco ambulance are listed (see box, p. 1006). Queries on the ambulance report called for information on equipment used, missing, or needed but not routinely carried. The question excluded blankets, pillows, poles, and stretchers. Use of equipment or supply items was reported for 781 emergencies (table 8). Only two reports listed equipment missing—one a pressure bandage, the other a crowbar. Most responses concerning the need for equipment not routinely carried were negative. The affirmative responses



which were given in about 1 percent of the cases noted different items such as resuscitators, an inhalator, demerol, and special stretchers. Only one item was mentioned in more than two reports—the resuscitator was mentioned in eight. The number of times that ambulance crews took certain actions and the place where these actions were taken is shown in table 9.

If an ambulance crew attending an emergency requires supplies or equipment, they radio or phone Central and an ambulance is dispatched with the required items.

*Delivery of the patient.* Patients were transported in about 72 percent of ambulance runs, covered by 73 percent of the reports. One patient was carried in about 65 percent of the runs, two patients in about 5 percent, and more than two in about 2 percent (table 7).

There were 2,253 patient-carrying runs of 3 miles or less for which the time from the site of the emergency to the hospital is known. In 11 percent of the runs, the elapsed time was less than 4 minutes, in 56 percent within 5 minutes, and in 98.5 percent within 15 minutes.

Two-thirds of the runs carrying patients from the scene of the accident returned to their home station (table 10). Mission was the first alternative to home station and Central the second. The straight line distance from Mission to Central is less than 2 miles, and from Mission to Alemany, Harbor, or Park is 3 miles or less. Delivery to an alternate station nearer to the site of the emergency than the home station may be elected in urgent cases. Park and Harbor are within less than 2 miles straight line distance from Central and deliver there as an alternative.

Direct delivery to Mission may be made when there is some urgency and delivery to the nearest hospital is indicated or when the nature of the injury indicates that the facilities of a general hospital will be needed. In the majority of emergencies the distance will not exceed 4 to 5 miles.

*Change in the patient's condition.* The attempt was made to determine any change in the patient's condition because of handling or management or because of time intervening between injury and obtaining adequate medical care. The report form called for information from the steward concerning care given the patient prior to arrival of the ambulance and for judgment concerning any change in condition of the patient observed at the time of delivery to the hospital. The physician was asked to evaluate early management and judge the influence of elapsed time.

In the 1,825 reports (for about 75 percent of the persons transported) in which the effect of patient management prior to delivery at the hospital was stated, 85 percent had no mention of observable effect of the action taken on the patient's condition. Management having a favorable effect included careful handling of about 8 percent of the patients; bandage or tourniquet applied, 2 percent; splint applied, 1 percent; and all other acts such as assisting respiration, inducing vomiting, and administering drug, less than 1 percent. Unfavorable effects were reported for less than 1 percent of the patients. These resulted from the patients' delay in seeking treatment, rough handling, unnecessary moving, and the like.

**Table 10. Place to which patient was first transported, by home station of ambulance, San Francisco emergency medical service**

Patients transported to—	Total runs		Central		Harbor		Alemany		Park	
	Number	Per-cent	Number	Per-cent	Number	Per-cent	Number	Per-cent	Number	Per-cent
All runs.....	2, 455	100. 0	1, 076	100. 0	604	100. 0	336	100. 0	439	100. 0
Home station.....	1, 630	66. 4	693	64. 4	417	69. 0	212	63. 1	308	70. 2
Mission.....	432	17. 6	232	21. 6	72	11. 9	93	27. 7	35	8. 0
Other emergency hospitals.....	251	10. 2	110	10. 2	88	14. 6	12	3. 6	41	9. 3
Other.....	62	2. 5	15	1. 4	7	1. 2	7	2. 1	33	7. 5
Not stated.....	80	3. 3	26	2. 4	20	3. 3	12	3. 6	22	5. 0

The relation of state of consciousness and type of accident was reviewed with respect to change in the patient's condition. No change was observed in 80 percent of the 2,318 patients about whom this information was reported, improvement in about 20 percent, and some deterioration in about 1 percent. A greater percent of those who were unconscious (134 persons) showed a worsening of condition than of those who were conscious (by a factor of 5).

Thirty-five of the 36 persons judged to be dead and transported to the hospital by the ambulance were pronounced dead by the hospital physician. Others judged dead were picked up by the coroner.

The type of injury or illness did not appear to have an important influence on change of condition. From 66 to 75 percent of the patients underwent no change in condition before reaching the hospital. Those patients who improved en route ranged from about 10 percent of those who attempted suicide to about 29 percent of those who were poisoned. Those patients who deteriorated ranged from about 1 percent of those involved in motor vehicle-pedestrian accidents and falls to about 3 percent of the obstetrics patients.

*Time spent at the hospital.* The duration of hospital stay was recorded for 72 percent of the ambulance patients. Approximately 4 percent remained 5 minutes or less; 17 percent, 15 minutes or less; and 30 percent, a half hour or less. About 40 percent of the patients remained from 45 minutes to 12 hours—approximately half for more than 2 hours and 10 percent from 9 to 12 hours. An additional workload was imposed by

patients referred to Mission Emergency with its more extensive medical facilities for further emergency care. This type of referral involved not less than 5 percent of the ambulance patients.

*Patient disposition.* Forty-five percent of the ambulance patients for which both disposition and provisional diagnosis were reported were sent to their homes upon discharge. About 46 percent were referred for further care and of these, 18 percent were sent to the San Francisco General Hospital for hospitalization or further care, 18 percent to private hospitals, and 10 percent to their own physicians. Six percent were discharged to the police and less than 1 percent each went back to work or were discharged to the coroner.

The referrals were about equally distributed between injury and illness. The patients sent to San Francisco General for hospitalization were predominantly those who were ill, while most sent to other hospitals for hospitalization or further treatment were injured.

The type of transportation by which 2,400 ambulance patients left the hospital is known. Of these, approximately 12 percent left by public ambulance, 12 percent by private ambulance, 6 percent by police vehicle, and 70 percent by other means.

#### Nonambulance Patients

An average of 143 persons per day were admitted to the four hospitals—100 nonambulance and 43 ambulance patients. This average was essentially in agreement with the average of 148 per day for the four reported in 1962 (2).

**Table 11. Means of arrival of nonambulance patients, by nature of emergency, San Francisco emergency medical service**

Nature of emergency	Total		Police vehicle		Private ambulance		Other	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Patients.....	7, 847	100. 0	778	100. 0	4	-----	7, 065	100. 0
No apparent illness or injury.....	103	1. 3	15	1. 9	0	-----	88	1. 3
Injury.....	5, 975	76. 1	502	64. 5	3	-----	5, 470	77. 4
Illness.....	1, 754	22. 4	257	33. 0	1	-----	1, 496	21. 2
Dead on arrival.....	4	-----	1	. 1	0	-----	3	-----
Not seen by physician.....	11	. 1	3	. 4	0	-----	8	. 1

**Table 12. Time spent in emergency room and disposition of nonambulance patients, San Francisco emergency medical service**

Elapsed time from arrival to discharge	All patients		Patients sent home		Patients referred for further care		Other patients	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Total	7,689	100.0	5,417	100.0	1,492	100.0	780	100.0
5 minutes or less	989	12.9	752	13.8	143	9.6	94	12.0
15 minutes	5,211	67.7	3,748	69.2	931	62.5	532	68.2
30 minutes	752	9.8	490	9.0	184	12.3	78	10.0
45 minutes	235	3.0	144	2.7	69	4.6	22	3.0
1 hour	94	1.2	49	.9	39	2.6	6	.8
1½ to 2 hours	106	1.4	47	.9	45	3.0	14	1.8
2¼ to 3 hours	21	.3	14	.3	6	.4	1	-----
5 hours	28	.4	17	.3	8	.5	3	.4
9 hours	22	.3	10	.2	8	.5	4	.4
12 or more hours	231	3.0	146	2.7	59	4.0	26	3.3

Approximately 10 percent of the nonambulance patients arrived in police vehicles; of these, 65 percent were injured (table 11). Ninety percent arrived by other means, such as walking, public transportation, taxi, or private car. Only four patients arrived by private ambulance.

Of the 7,671 patients for which the information was reported, 87 were judged to have needed an ambulance. Eighteen of these were transported by the police and 67 by other means. The method of arrival was not stated for two such patients. More than 70 percent of the patients who arranged their own means of arrival were accompanied by friends, relatives, or the police.

More than two-thirds of the patients for whom time spent in the emergency hospital was given remained for 15 minutes. About 80 percent of all patients were discharged in 15 minutes or less (table 12). The patients who were referred for further care showed the similar patterns but at lower percentages with the distribution shifting to somewhat longer durations.

Three percent of the patients spent 12 hours or more at the emergency hospital. Of the 37 diagnostic categories shown for those spending 12 hours or more, those applicable to more than five persons are laceration and open wounds, 69 patients; alcoholism, 23 patients; contusion and crushing, 20 patients; fractures, strains, sprains, and foreign body in the eye, 13 patients each;

superficial injury, 15; head injury except facial, 9.

Seventy percent of the nonambulance patients were sent home and about 20 percent referred for further care. Other dispositions were reported for the remaining 10 percent (table 12). Of those referred for further care, about 62 percent were sent to their own physicians, 20 percent to the San Francisco General Hospital either for further emergency treatment or for hospitalization, and 18 percent to another hospital.

**Discussion**

The San Francisco study is the first attempt to do a systems analysis of the operation of an emergency medical service system known to the authors. The intent was to investigate an established system in terms of its components and their interrelations as a basis for a general description, such as a mathematical model, suitable for analysis and evaluation of other existing or contemplated emergency medical care systems. Of course, the findings per se are more pertinent to large urban than to rural communities, and considerable caution is essential in generalizing from data specific for San Francisco.

In San Francisco, the workload did not vary greatly by day of the week. The peak loads which occurred on Saturdays and Sundays involved an average of 160 patients for the four

## Standard equipment carried by ambulances

### General equipment

1 fire axe	6 towels	1 Thomas splint
1 fire extinguisher, Ansul	4 pieces sheet wadding 6 in. × 2 yd.	4 padded, arm-shaped splints
1 crowbar	1 sheet	4 padded, leg-shaped splints
4 stretchers	1 life preserver and 100 ft. rope	1 emesis basin
4 stretcher poles	1 battery lantern	2 restraint straps
4 blankets	2 road flares or fuses	2 oxygen tanks, D-size
2 pillows and cases	2 molded splints	1 oxygen regulator, hose, mask

### Maternity grip

1 sterile sheet	Sterile umbilical tape	Coramine, 2 amps.
4 sterile towels	Silver nitrate 1 percent solution, 2 amps.	Montrazol, 2 amps.
1 pair sterile gloves, size 8	Alcohol 50 percent, 4 oz.	1 sterile 2-cc. luer, 2 needles 25× $\frac{5}{8}$
4 peripads	Pituitrin, 2 amps.	4 hemostats
1 hot water bag	Ergostrate, 2 amps.	1 sterile surgical scissors

### Antidote grip

Universal antidote, 4 oz.	Ammonia, 4 oz.	Megimide, 1 amp.
Alcohol 95 percent, 4 oz.	Chalk, 4 oz.	Dimercaprol, 1 amp.
Olive oil, 4 oz.	Milk of magnesia, 4 oz.	1 lavage tube
Starch, 4 oz.	Metrazol, 2 amps.	1 medicine glass
Acetic acid, 4 oz.	Coramine, 2 amps.	1 tongue forceps
	Sodium pentothal, 1 amp.	1 jaw expander

### General grip

1 holocaine ointment	Aminophyllin, 2 amps.	4 eye pads
1 yellow mercuric oxide ointment	Adrenalin, 6 amps.	Gauze 2×2; 4×4
Pyrol, 8 oz.	Sterile water, 2 amps.	Bandages, 1 in., 2 in., 3 in.
Ampojel, 4 oz.	Nitroglycerin 1/100, 24 tablets	Swabs
Peroxide, 4 oz.	Grade 5 aspirin, 50 tables	Tongue blades
Ringer's solution, 4 oz.	1 sterile 2-cc. luer	Adhesive $\frac{1}{2}$ in.; 1 in.
Merthiolate, 4 oz.	2 sterile needles 5/8 in. ×25 gauge	4 sterile hemostats
Nitrite amyl, 6 amps.	1 sterile intracard needle, 20 gauge	1 band scissors
Ammonia, 6 amps.	×3 in.	1 sterile surgical scissors
Metrazol, 2 amps.	1 tongue clamp	1 sterile bayonet forceps
Coramine, 2 amps.	1 tourniquet	1 sterile scalpel
Caffeine, 2 amps.	1 eye dropper	1 intubation tube
	1 thermometer	
	1 sterile tracheotomy set, threaded sutures	

emergency hospitals combined. On Tuesday when the minimum workload occurred, the average was 131 patients. The average of the ambulance runs by day of week did not vary by more than 10. About half the runs for a single day were made between 4 p.m. and midnight.

The crews, ambulances, equipment, and central support personnel constituted one of two principal subsystems within the total emergency medical service system. In operation, however, it interacted with and actively participated in the operation of the second subsystem—the emergency hospital.

The central communication station served all emergency hospitals and performed services for

them in addition to receiving emergency calls and dispatching ambulances.

In about a third of the runs, no patient was delivered. When first aid was adequate or action limited to surveillance pending the arrival of a private physician, the ambulance subsystem acted as an extension of the emergency hospital by dealing with a part of its workload. At the hospital ambulance stewards who are registered nurses serve as nurses, and others serve as aides in the emergency clinic.

In planning or improving community emergency medical services, certain aspects of the San Francisco operation warrant consideration from the viewpoint of economy and effective-

ness. The single system serves patients with injuries and those who are ill. The combined resources of the system provide flexibility in use of equipment and personnel for emergency calls, transfer runs, and patient management at the scene, enroute, and at the emergency hospital; the organization offers career opportunities for personnel and retains most of the benefit of their initial and continued training. Ambulance personnel also stand by at fires and public gatherings, transfer equipment, supplies, and patients, and make vehicle maintenance and repair runs.

Most illnesses and injuries are common to many, if not all, communities and can be predicted from general medical knowledge. Thus, special studies are not needed to determine content for comprehensive training courses. Some conditions, such as extreme heat and cold, venomous reptiles, and various types of industrial or farm hazards are associated with specific environments.

While the proportion and rate of occurrence of the common emergency conditions may be fairly similar in urban and rural communities, such an assumption should be carefully examined in considering a particular community. In applying mathematical models for establishing a community emergency service system, it is desirable to have input data from a number of urban and rural areas to establish similarities and differences.

Determining the training required for an ambulance crew in a given community involves a number of considerations. Civil authorities and local medical societies must consider the community's emergencies in relation to distances, terrain, and location of emergency hospitals or clinical facilities in establishing what ambulance crews will be authorized to do and what training they need to provide the authorized measures.

In remote locations, where acquisition and transport of the patient requires considerable time, more far-reaching authorization may be warranted. Equipment and supplies must be adequate to enable the crew to carry out authorized measures.

Ambulance stewards, however experienced, cannot be expected to be diagnosticians. The emergency care they provide should be the minimum needed to sustain the patient until the

physician can take over. Hence, their training should instill judgment of emergencies so that handling of patients will minimize their possible deterioration and reduce suffering. Quite different emergencies may fall within a single category. For example, acute heart failure and head injury may cause difficulties in breathing and make it necessary to transport the patient in a sitting position.

The crew may receive information concerning the condition of the patient from the patient himself as the great majority are usually conscious, as well as from police and others. Such information must, however, be evaluated and does not substitute for the stewards' judgments. The significant number of alcoholics with and without injuries require special caution and a high degree of judgment by the crew. The high proportion of injuries among emergency patients is especially important for community planning in locations lacking specialized facilities staffed with physicians experienced in treatment of trauma.

The priority of communications equipment in the ambulance should be considered with respect to access to a specialized dispatching system and the availability of telephones and of police and fire communication networks. In certain locations direct communication may be essential for en route dispatch, calls for help, obtaining instructions, or alerting clinics or facilities. In urban areas such as San Francisco there is less need for a communication system to dispatch ambulances en route or notify an established emergency hospital to expect an emergency since police-fire emergency networks or public telephones are usually adequate in limited emergencies. In a metropolitan area, however, the toll of injuries may be high in a single emergency and the police and fire network may become overloaded with other emergency control communications and official notifications. A separate channel for emergency medical communications is necessary for such situations so that ambulance personnel can request supplies, reassign equipment, and notify other hospitals to supplement emergency facilities. Radiotelephone equipment is also needed to maintain continuous surveillance over the vehicles with the system.

Not unexpected was the finding that in only

a few cases was there evidence of deterioration of patients during transport. Staffing by a professional, full-time crew and the relatively short time spent in acquisition and transport undoubtedly contribute to the satisfactory patient maintenance.

The accumulation of information on cases of individual patients provides input data for developing computer simulation studies on distribution of the workload in the emergency hospital and in other parts of an emergency medical service system. Such data are useful for determining for a moment, or any given

period of time, how many people are being transported, waiting for treatment, being treated, or being discharged. If a system has bottlenecks, proposed methods of correction can be tested by computer simulation.

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## Medical School Course in Community Health

A new medical school course in comprehensive and community health management, based on Student Health Organization members' reactions to participation in poverty area programs, is being designed at the University of Southern California and the University of Chicago schools of medicine.

Funded by the Public Health Service's Division of Physician Manpower, the new course is intended to help medical students work as part of a health team in the community and to help them understand and treat patients as total persons living in a community setting, rather than as disease entities. The contracts include awards of \$40,282 to the University of Chicago and \$37,264 to the University of Southern California.

The Student Health Organization, founded in 1964 at the University of California, is a group of students of medicine, dentistry, nursing, and related health professions. The organization's community programs are financed by the Office of Economic Opportunity and the Fund for Medical Education.

In 1966, prompted by the organization, 90 students from 11 States and 40 professional

schools plus 15 workers from marginal income areas spent the summer among migrant farmworkers and in depressed areas of California. In the California school's 1967 summer program were 106 health science students, representing 60 schools and 15 States, and 15 community workers.

At the University of Chicago in summer 1967, there were 96 participants from 33 schools. Sixty were from 20 medical schools; the others were from schools of related health professions and law. They worked closely with 68 high school students, members of the Neighborhood Youth Corps from poverty areas. The corpsmen, who helped with patients, were involved also in medical conferences and encouraged to pursue health careers. The Chicago group's major project was Woodlawn Clinic, operated under the Welfare Administration's Children's Bureau.

In California the students may again work with migrants of Central Valley. During their 1967 experience there, they learned how far removed from the mainstream of American life the migrants are.