

THE PHILLIPS 66 COMPANY HOUSTON CHEMICAL COMPLEX EXPLOSION AND FIRE:

INJURY MORTALITY AND MORBIDITY

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INTRODUCTION

At approximately 1:00 p.m., on October 23, 1989, explosions and fires rocked the Phillips 66 Company, Houston Chemical Complex in Pasadena, Texas. Twenty-three employees were reported killed and more than 130 individuals were reported injured (1). Property damage was estimated at \$750 million (2). This was one of the worst industrial worksite accidents in the country in the past two decades (3).

The Phillips Complex covers an area of about 16 acres and produces a plastic material used to manufacture milk bottles and other containers (4). The approximately 1,150 company and contract employees working that day were engaged mainly in new plant construction and maintenance activities (5). The explosion resulted when process gas was released during maintenance operations and traveled to an unidentified ignition source (6). The initial explosion (there were a total of 10) was equivalent to an earthquake registering 3.5 on the Richter Scale and had the force of 2.4 tons of TNT (7). Debris was tossed as far as 6 miles into the surrounding community (8). Two production plants on-site were completely destroyed. The resulting fires were brought under control within approximately 10 hours (9).

The Injury Control Program, Texas Department of Health (TDH), initiated an investigation to assess the health impact of this incident. With the cooperation and assistance from the Harris County Health Department and the City of Pasadena Health Department, the Injury Control Program staff reviewed the medical records of persons treated in six area hospitals for injuries related to this incident. In addition, death certificates for those killed were reviewed.

METHODS

Six area hospitals (all but one were within five miles of the plant) provided all emergency room and admission records for those persons injured in this incident and seen within the first 24 hours after the initial explosion. Limited program resources prevented examining a larger time period. Information on demographic characteristics, presenting injuries and complaints, and hospitalization experience was abstracted from the hospital records.

Death certificates of those killed were obtained from the TDH Bureau of Vital Statistics. The demographic characteristics and the immediate cause of death was obtained from the certificates, and the recorded occupation was coded to the 1980 Bureau of the Census Classified Index of Industries and Occupations.

## RESULTS

### Overview:

Twenty-three persons were killed and a total of 131 individuals were seen in six area hospitals within the first 24 hours for injuries and complaints related to the explosion.

### A) Mortality:

Twenty-three persons were killed in this incident. Twenty-two died at the scene; one died later in the hospital (see below). One body was not recovered until 10 days after the explosion.

As recorded on the vital record, the immediate cause of death for the 22 individuals killed at the scene included charred body/remains (64%), crushed/mangled body (32%), and asphyxia due to soot inhalation and charred body (4%).

The individuals who died ranged in age from 27-62 years; mean age of those killed was 36.8 years. As illustrated in Figure 1, 20 (87%) were between the ages of 25-44 years.

Twenty-two (96%) of the fatalities were male; one (4%) was female. Of those killed, ten (43.5%) were white (non-Hispanic), ten (43.5%) were Hispanic, and three (13%) were black. All of the deceased were U.S. citizens except one, who was a Mexican national. Eighteen (78%) of those killed were married, two (9%) were single, two (9%) were divorced/separated, and one (4%) was widowed.

Table 1 lists the industry/occupation of those killed. Nineteen (83%) were employed in plastics, synthetics, and resin manufacturing. Their occupations included, for example, miscellaneous plant and system operators, machine operators, and supervisors. Four (17%) of those killed were employed in construction. Their occupations included mechanics and repairers, industrial engineer, and construction laborer.

### B) Morbidity:

During the first 24 hours after the incident, a total of 131 individuals were seen in six area hospitals for injuries and complaints related to the plant explosions and fires.

The ages of those in this hospital-based injury surveillance ranged from 13-77 years. The mean age of the patients was 35.5 years. As illustrated in Figure 2, 90 (68.7%) were between 25-44 years of age. The majority (85%) of the patients were male. Males outnumbered females 5.6:1 (111 males versus 20 females).

Information regarding race/ethnicity was available for 115 (88%) of the patients. Seventy-six (66%) were white (non-Hispanic), 27 (24%) were Hispanic, and 12 (10%) were black. Marital status was available for 107 (82%) of those injured. Sixty-nine (64%) were married, 33 (31%) were single, three (3%) were widowed, and two (2%) were divorced/separated.

The patients who were seen in area hospitals resided in 24 different locations (see Table 2). For which information is available (128), 52 (40.6%) of the patients lived in Houston. Others lived in cities such as Pasadena (26.6%), Baytown (5.5%) and Deer Park (3.9%).

Information on employment was available for 126 (96%) of the patients (see Table 3). Sixty-seven (53.2%) were employed by Phillips Petroleum. Other major employers of those injured included Fish Engineering & Construction and Brown & Root (11%, respectively). Of those not working (n=3), one was retired, one was a student, and the other was unemployed. The employment status of two patients was unknown.

Data on the individual's activities at the time of the explosion was known for 127 (97%) of the patients. Although 124 (98%) were at the plant, three individuals (2%) were not. These three patients were treated in the emergency room and released. They included an elderly woman at home when an object from the ceiling (either a tile, light fixture, or sprinkler) fell on her head, a young female student at a nearby school injured when a desk fell on her foot, and a middle-aged female shopper hit by a swinging door while exiting a local store. These latter two patients were within approximately three miles of the plant.

Table 4 lists the injuries and complaints reported by more than five percent of the patients. Patients could have multiple complaints. The seven most frequently reported injuries/complaints included contusion (31%), laceration (24%), abrasion (17%), smoke inhalation (17%), shortness of breath (16%), chest pain (10%), and strain (8%). Seven (5%) experienced "psychological stress" from the incident (reported as panic attack or anxiety).

Five (4%) of the patients reported chemical inhalation. Two were treated in the emergency room and released. The other three were hospitalized for one day, and then discharged home.

Medical records provided insight into the etiologies of some of the injuries sustained to patients. Individuals were injured when: a) thrown down to the ground/floor or into an object (e.g., pipes, walls, office furniture) by the force of the explosions; b) hit by debris such as glass, rocks, wood, or metallic sheets; c) smoke was inhaled; d) fleeing (e.g., sprinting, jumping fences, leaping ditches); e) pinned by others fleeing; f) burned; g) helping injured individuals; or h) fighting fires. Some individuals were injured in a combination of ways.

The length of time between the incident and subsequent hospital visit (within the 24-hour study frame) was available on 128 (98%) patients. As Figure 3 illustrates, 65 individuals (50.7%) went to a medical facility within the first two hours, whereas 19 (15%) sought treatment at least seven hours or more after the initial explosion.

Of the 131 patients, 97 (74%) were treated in the emergency room and released, 33 (25%) were hospitalized, and one (1%) left against medical advice.

Among hospital admissions, the length of stay ranged from 1-46 days. The mean length of stay was 5.2 days (Standard Deviation of 9.7 days). As Figure 4 shows, 25 patients (78.2%) stayed two days or less. The three patients hospitalized 17 days or longer suffered burn injuries. All of those hospitalized arrived within the first five hours after the initial explosion.

The discharge status of one hospitalized patient was unknown. However, of those other hospitalized (n=32), 30 (94%) were discharged home, one (3.0%) died, and one (3.0%) was discharged to a rehabilitation center. This latter patient sustained third degree burns.

The nine most frequently reported injuries/complaints of the hospitalized patients included smoke inhalation (42%), shortness of breath (30%), laceration (27%), contusion (27%), abrasion (21%) chest pain (21%), burns (18%), coughing (12%), and light headedness (12%) (see Table 5).

## DISCUSSION

The results of this investigation indicate that the plant explosion had considerable impact in the Pasadena area in terms of emergency room visits, hospitals admissions, and fatalities.

Approximately 13% (147/1150) of the company and contract employees working that day at the plant were either killed or treated for injuries in area hospitals. This is calculated by dividing the number of employees killed or treated for injuries in area hospitals (147) into the estimated workforce that day (1150). (The numerator is based upon 23 killed and 124 employees treated at six local hospitals.) Lack of information on the exact composition of the entire workforce prevents detailed risk analysis.

The explosions and fires at the Phillips Complex resulted in the deaths of 23 workers. All of those killed on the scene (22) were within 250 feet of the process gas release point (15 were within 150 feet) and one person died later in the hospital (10).

If these workers had not died prematurely, they would have continued to be productive for a number of years. A statistic called "years of potential life lost" (YPLL) is commonly used in injury epidemiology to measure premature mortality. The value represents the total number of years of potential life lost by those individuals who die before reaching the age of 65 years. By calculating and summing this statistic for each deceased, we determined that 647 years of potential life was lost as a result of this particular tragedy.

This investigation also revealed that plant employees/workers were not the only ones that were treated for injuries/complaints related to the explosions. Although almost all (98%) of the individuals were at the Phillips Complex at the time of the incident, three individuals were in the community. These included an elderly woman at home when an object from the ceiling fell on her head, a young female student at a nearby school injured when a desk fell on her foot, and a middle-aged female shopper hit by a swinging door while exiting a local store. These latter two patients were within approximately three miles of the plant.

This study provides interesting insights into the etiologies of injuries sustained in plant explosions and fires. Individuals in this particular incident were injured when: 1) thrown down to the ground/floor or into an object (e.g., pipes, walls, office furniture) by the force of the explosions; 2) hit by debris such as glass, rocks, wood, or metallic sheets; 3) smoke was inhaled; 4) fleeing (e.g., sprinting, jumping fences, leaping ditches); 5) pinned by others fleeing; 6) burned; 7) helping injured individuals; or 8) fighting fires. Some people were injured in a variety of ways.

This investigation has documented and described injuries/complaints experienced by individuals involved in explosions and fires. The five most frequently reported injuries treated by hospital personnel, included contusion, laceration, abrasion, smoke inhalation, and shortness of breath. Five percent of the patients experienced psychological stress from this incident. Emergency medical personnel and hospitals near plants will find this report interesting and hopefully useful in anticipating what they might experience if a similar incident occurred in their community. Hospital staff need to be cognizant that persons who were injured in an incident of this type may not immediately go to a hospital for medical assistance. Although over half of the patients in this incident sought treatment within the first two hours, 15 percent arrived at the medical facility at least seven hours after the incident. However, the most severely injured patients (as defined by hospital admissions) arrived at area hospitals within the first five hours.

It is important to mention that those killed and injured are not the only ones affected by this tragedy. Over three-quarters (78%) of the deceased and nearly two-thirds (64%) of those injured were married.

In conclusion, it should be pointed out that survey results of these six hospitals do not necessarily represent the entire health impact of this incident in the area. This hospital-based surveillance involved only a 24 hour time period after the initial explosion; anecdotal information indicates that a number of individuals arrived in these facilities later. Another limitation of this study is that individuals may have sought treatment in other hospitals, as well as other medical facilities (e.g., minor emergency clinics, private physicians). This is plausible given the fact the Pasadena borders a large metropolitan area (Houston) and the patients seen in this investigation lived in twenty-four different cities. Furthermore, this investigation examined and described some of the acute health effects (i.e., reported injuries and complaints), but none of the long term consequences of such effects (e.g., physical therapy, rehabilitation).

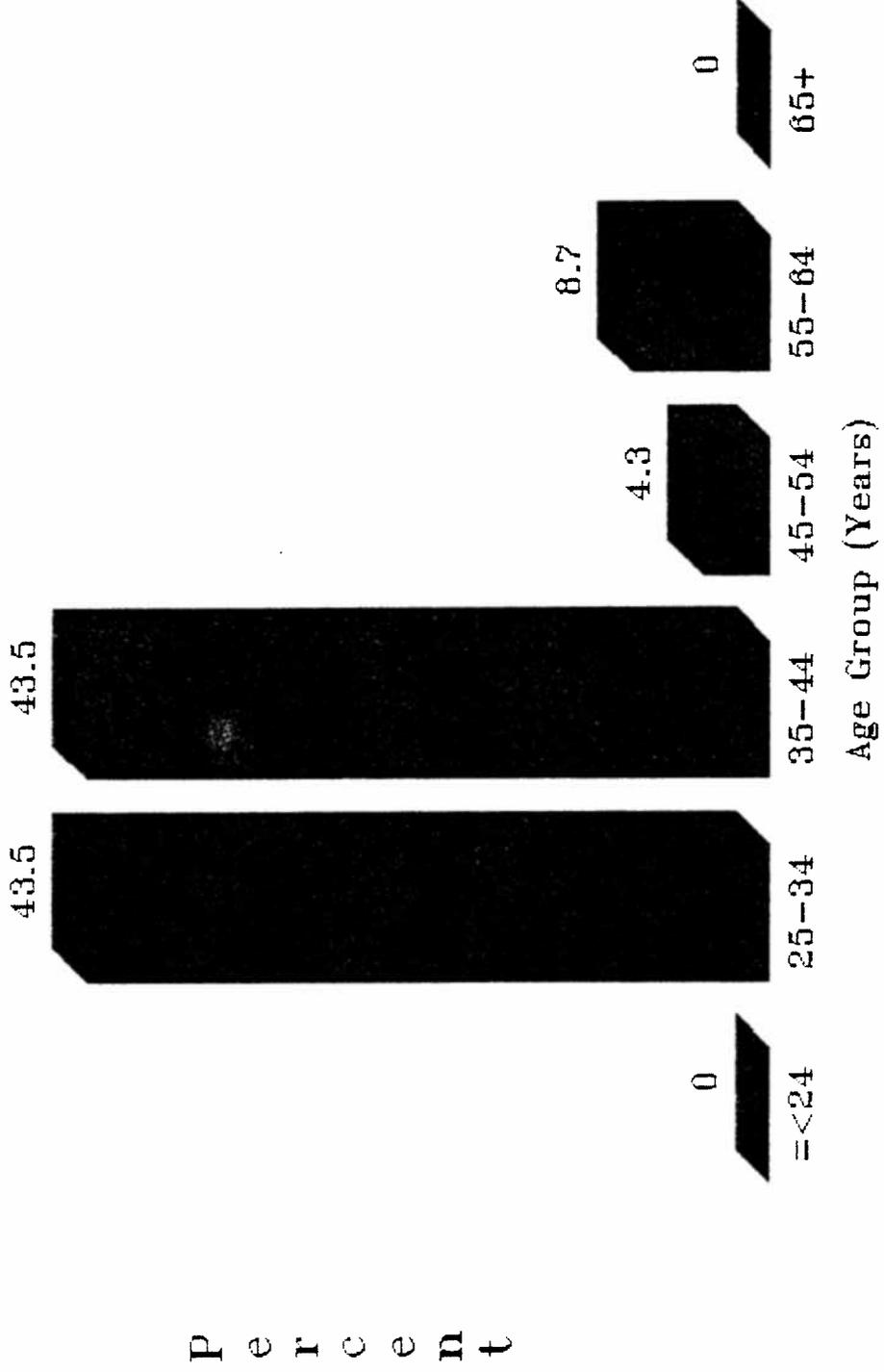
RECOMMENDATION:

- 1) This information should be shared with the petrochemical industry, health professionals, and the public.

## REFERENCES

1. U.S., Department of Labor, Occupational Safety and Health Administration, Phillips 66 Company Houston Chemical Complex Explosion and Fire: A Report to the President, April 1990, p. 1.
2. Ibid.
3. Ibid.
4. Ibid., p. x.
5. Ibid., p. 2.
6. Ibid., p. 5.
7. Ibid.
8. Ibid.
9. Ibid., p. 11.
10. Ibid., p. 23.

FIGURE 1: AGE OF THOSE KILLED



N=23

**TABLE 1**  
**INDUSTRY AND OCCUPATION OF THOSE KILLED**

Industry/Occupation	Number	Percent
<b>Industry:</b> Plastic, Synthetic, and Resin Manufacturing	19	83
<b>Occupations:</b>		
- Miscellaneous plant and system operators	5	26.3
- Machine operators (not specified)	4	21.0
- Miscellaneous machine operators	2	10.5
- Supervisors, production occupations	2	10.5
- Laborers, except construction	2	10.5
- Chemical engineer	1	5.3
- Specified mechanic and repairer	1	5.3
- Furnace, kiln, or oven operator	1	5.3
- Unknown	1	5.3
<b>Industry:</b> Construction	4	17
<b>Occupations:</b>		
- Mechanics and repairers	2	50
- Industrial engineer	1	25
- Construction laborer	1	25

FIGURE 2: AGE OF PATIENTS SEEN  
IN AREA HOSPITALS

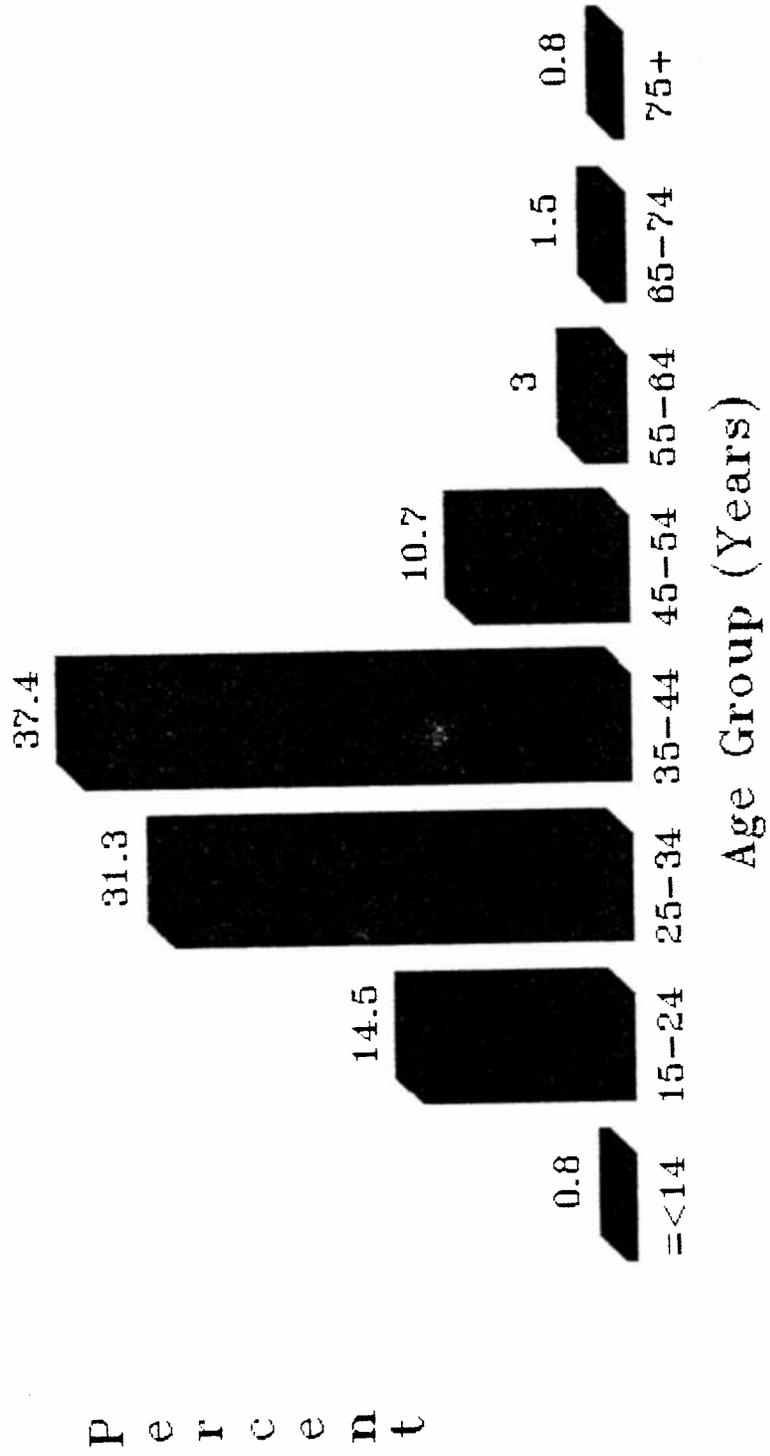


TABLE 2

## PLACE OF RESIDENCE OF PATIENTS SEEN IN AREA HOSPITALS

Place of Residence	Number	Percent
Houston	52	40.6
Pasadena	34	26.6
Baytown	7	5.5
Deer Park	5	3.9
La Porte	4	3.1
Friendswood	4	3.1
League City	2	1.6
Webster	2	1.6
Spring	2	1.6
Sabinal	2	1.6
Bay City	1	.8
The State of Indiana	1	.8
Alvin	1	.8
Conroe	1	.8
Channelview	1	.8
Brownsville	1	.8
Sugarland	1	.8
Tomball	1	.8
Croskey	1	.8
Richmond	1	.8
Hoffman	1	.8
Dayton	1	.8
Humble	1	.8
Missouri City	1	.8
Total	128	100.0

TABLE 3

## EMPLOYER OF PATIENTS SEEN IN AREA HOSPITALS

Employer	Number	Percent
Phillips Petroleum	67	53.2
Fish Engineering & Construction	14	11.0
Brown & Root	14	11.0
Kenmore Electric	3	2.4
HB Zachary	3	2.4
D.S.I.	3	2.4
Industry Security Services	2	1.6
Dacon Corporation	2	1.6
Bay Area Crane Services, Inc.	2	1.6
Ten Napel Sheet Metal	2	1.6
Johnson Program Services	1	.8
Masonry Power	1	.8
Commercial Cartage	1	.8
Al Sandblasting	1	.8
International Guards	1	.8
Fidelity Bank	1	.8
Oates, Troy, Melissa, Reid	1	.8
Thrasher Trucking	1	.8
B and D Construction	1	.8
Olshen Demolition	1	.8
Mungle Trucking	1	.8
PasTex	1	.8
Keith Plumbing	1	.8
Self Employed	1	.8
Total	126	100.0

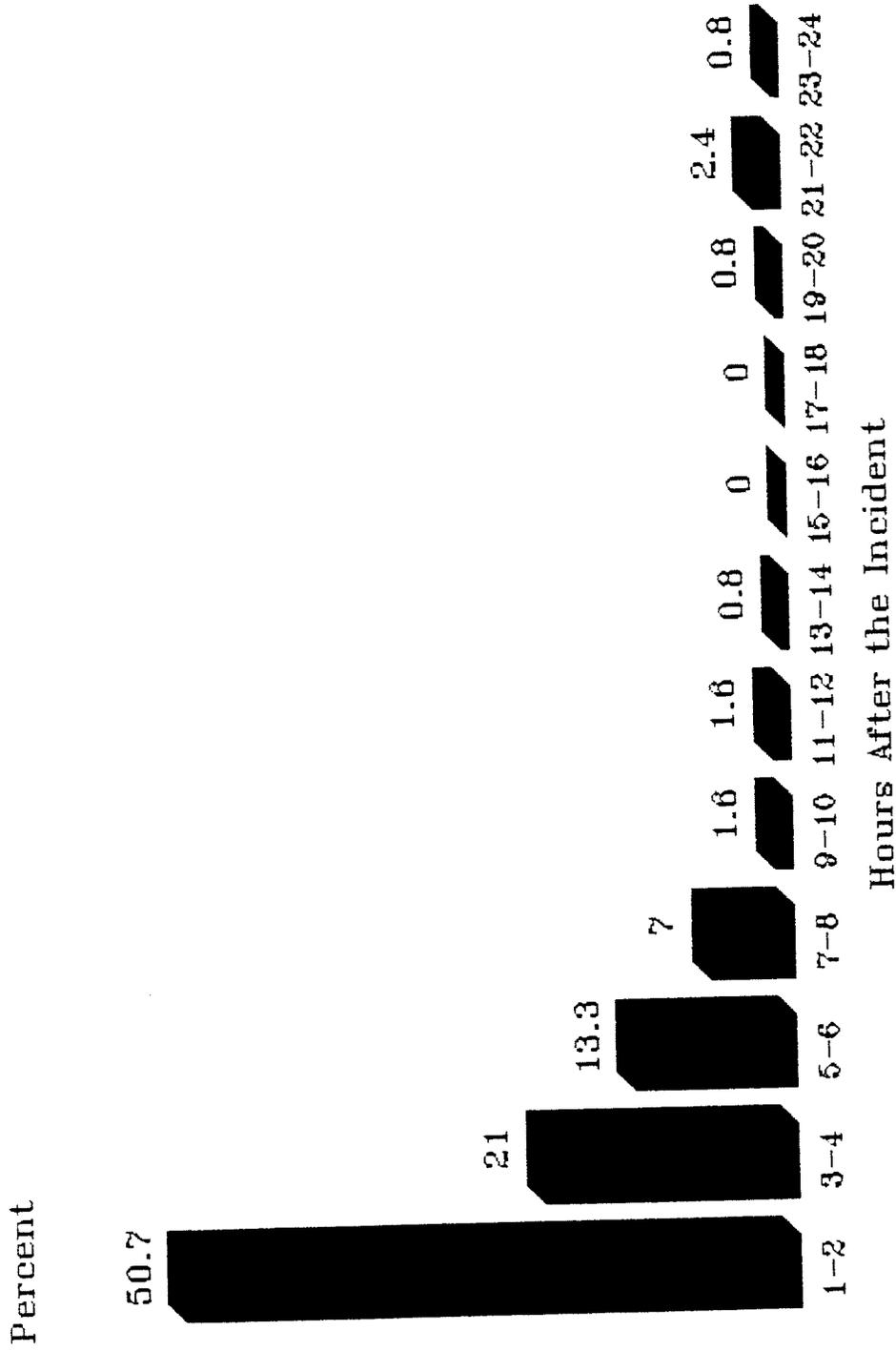
TABLE 4

MOST FREQUENT INJURIES/COMPLAINTS REPORTED AMONG PATIENTS  
SEEN IN AREA HOSPITALS \*

Injury/Complaint	Number	Percent
Contusion	41	31
Laceration	32	24
Abrasion	22	17
Smoke Inhalation	22	17
Shortness of Breath	21	16
Chest Pain	13	10
Strain	11	8
Sprain	9	7
Ringling in the Ears	9	7
Light Headedness	9	7
Nonspecific ear complaints	7	5
Coughing	7	5
Burns to Skin	7	5
Psychological Stress	7	5

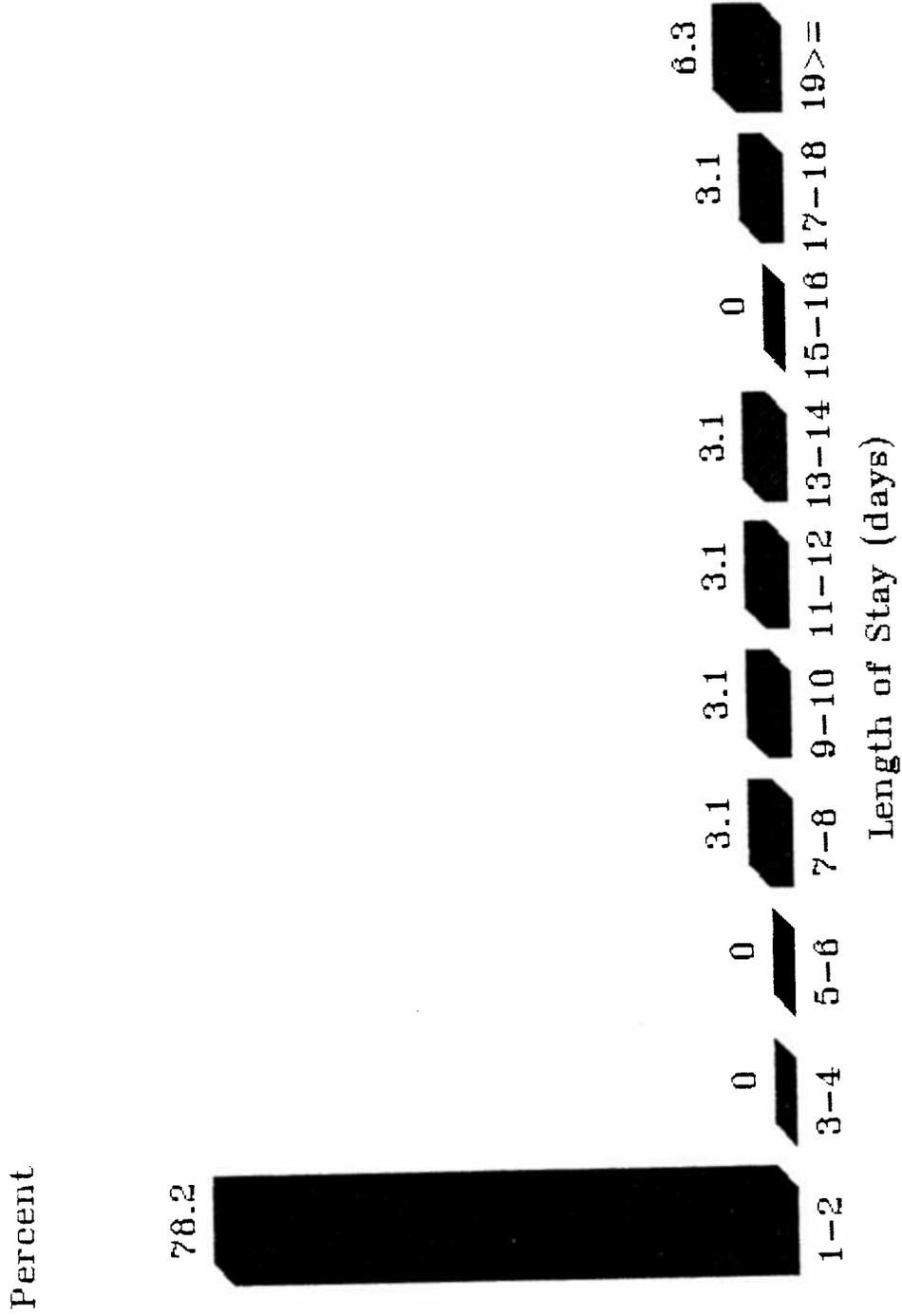
\* Injuries/Complaints reported by more than 5 percent of the patients.

FIGURE 3: ARRIVAL TIME OF PATIENTS SEEN  
IN AREA HOSPITALS



N=128

# FIGURE 4: LENGTH OF STAY OF ADMITTED PATIENTS IN AREA HOSPITALS



N=32

TABLE 5

MOST FREQUENT INJURIES/COMPLAINTS REPORTED AMONG HOSPITALIZED PATIENTS

Injury/Complaint	Number	Percent
Smoke Inhalation	14	42
Shortness of Breath	10	30
Laceration	9	27
Contusion	9	27
Abrasion	7	21
Chest Pain	7	21
Burns to Skin	6	18
Coughing	4	12
Light Headedness	4	12