The Journal of Emergency Medicine, Vol 2, pp 183–189, 1985 Printed in the USA • Copyright © 1985 Pergamon Press Ltd

Selected Topics

Prehospital Care

THE BREAKDOWN OF AN EMERGENCY SYSTEM FOLLOWING A GAS EXPLOSION IN OSAKA AND THE SUBSEQUENT RESOLUTION OF PROBLEMS

Tsuguharu Ishida, MD, PhD,* Muneo Ohta, MD, PhD,† and Tsuyoshi Sugimoto, MD, PhD‡

*Associate Professor, Division of Emergency and Critical Care Medicine, Hyogo College of Medicine, Hyogo
†Chairman of Osaka Prefectural Senri Critical Care Medical Center,
‡Chairman and Professor, Department of Traumatology, Osaka University School of Medicine
Reprint address Tsuguharu Ishida, MD, Associate Professor, Division of Emergency and Critical Care Medicine, Hyogo College of Medicine, 1-1, Mukogawa-cho, Nishinomiya-City, Hyogo, 663, Japan

□ **Abstract—Osaka, a modern urban metropolis in Japan, experienced a tragic gas explosion in 1970 when the dispatch room of the City Fire Department was in the process of being moved to a new building. Many unforseen problems arose during this disaster: eg, there was an overall lack of leadership, confusion of communication, a need for triage, and lack of control of mass media.**

The Osaka Medical Association organized a committee to resolve these problems. Their conclusions and recommendations were that a control headquarters be established at the scene of disaster, the number of ambulances and EMTs be increased, disaster tags be utilized, a special radio frequency be created, and a computer-aided command and control system for fire fighting and ambulance services be introduced. These recommendations have all been followed.

□ **Keywords—disaster management; multiple casualty incident; gas explosion; emergency medical services**

Introduction

Osaka, a modern urban metropolis with an area of 209 sq km and a population of 2.7 million people crammed into its densely inhabited 26 wards, is located in the southwest of Japan. Osaka has been called one of the greatest economic and advanced cities in the world. It has also been recognized for its advanced system of medical services. Emergency medicine in Japan originated in Osaka. Until 1970, when we experienced a tragic gas explosion, we were very proud of our emergency system. The explosion occurred on the day the dispatch room of the City Fire Department was being moved to a new building. Consequently, many unforseen problems arose during this disaster. Without the usual efficient regulation from this dispatch room, the emergency system was swamped and unable to function properly.

Case Report

On April 8th, 1970, at 17:27, leakage from a gas line was found in a subway construction area. One minute later, two repair cars from the gas company arrived on the spot.

Prehospital Care focuses on the issues and practices that directly affect the type and quality of care administered by the emergency physician in the emergency department, and is coordinated by *Peter Pons, MD*, St Joseph's Hospital, Denver, Colorado.

RECEIVED: 23 April 1984; ACCEPTED: 6 August 1984 0736-4679/85 $3.00 + .00

Table 1. Age Distributions of Mortalities

Age (Years)	Male	Female	Total
< 10	4	0	4
11–20	12	5	17
21–30	27	2	29
31–40	13	0	13
41–50	7	3	10
51–60	4	0	4
61–70	1	0	1
>71	1	0	1
Total	69	10	79

Table 2. Categories of Mortalities

Age (Years)	Neighborhood Inhabitants	Pedestrians	Rescuers
<12 (Elementary school)	5	0	0
13–15 (Junior high school)	7	2	0
16–20	1	5	1
21–30	11	17	1
31–40	2	9	2
41–50	7	3	0
51–60	3	1	0
61–70	1	0	0
>71	1	0	0
Total	38	37	4

Table 3. Causes of Death

	No. of Cases
Brain damage	39
Crush injury in the thoracic cavity	10
Crush injury in the abdominal cavity	6
Burn	11
Suffocation	6
Spinal cord injury	3
Hypovolemic shock	3
CO Poisoning	1

While employees were repairing the gas leakage, the driver of one of the two repair cars started the car's engine. A small spark from the engine set the repair car on fire at 17:28. At 17:41 there were several emergency 119 calls. The dispatcher sent four ambulances to the scene immediately. At 17:47 the repair car fire caused an enormous gas explosion, 200 m in length and 16 m in width. The explosion was so strong that the temporary concrete blocks covering the subway construction area were thrown into the air. It was during the rush hour, so many people who had stopped in the area to watch the repair work were caught in the explosion. Several houses and buildings in the area were destroyed by the blast at 17:51. At the same time, fires broke out in several areas. Because the dispatch room was moving that day and not operating at capacity, confusion resulted. Soon after the gas explosion many victims with slight injuries walked or were driven to neighborhood hospitals. Without enough information, the neighborhood hospitals' employees also became confused. It was not until 20 to 30 minutes after the explosion that EMTs were able to evacuate the seriously injured victims from the area. It took four hours to close all the gas lines and bring the fire under control.

This disaster killed 79 people and injured 428. Forty-six houses and buildings were destroyed. The age distribution of mortalities ranged from 6 to 74 years (Table 1). Of the mortalities, 74.7% were 11 to 40 years old. The dead were divided into three categories: neighborhood inhabitants, pedestrians, and rescuers (Table 2). The age distribution of neighborhood inhabitants was wide, ranging from 6 to 74 years, but slightly limited among pedestrians, ranging from 14 to 51 years. The age distribution of the rescuers was very small.

Nearly half of the mortalities were pedestrians, owing to the fact that the explosion occurred during the rush hour. Autopsies were performed on all fatalities. Brain damage was the leading cause of death (approximately 50%), followed by crush injuries of the thoracic and abdominal cavities, burns, suffocation, spinal cord injuries, and so on (Table 3). The 39 cases of brain damage were caused by severe brain contusion in 34 of the cases, hematoma in three cases, basilar skull fracture in one case, and aspiration pneumonitis due to obtunded consciousness. Table 4 shows at

Table 4. Time Elapsed between Explosion and Deaths

Postexplosion	No. of Deaths
Immediately	68
<3 Hr	2
<6 Hr	1
<12 Hr	0
<24 Hr	2
1-2 Days	1
3 Days	0
4 Days	1
5 Days	1
6 Days	1
7 Days	0
10 Days	0
14 Days	2

Table 5. Location of Burns in Mortality Cases

Burn Area	No. of Cases
Whole body	11
Face	9
Upper extremity	1
Lower extremity	2
Face and upper extremity	11
Face and lower extremity	2
Face, upper and lower extremity	5
Upper and lower extremity	1

what time following the explosion the victims were pronounced dead. Of the dead population, 68 victims (86.1%) died immediately after the explosion. Three cases died within six hours after the explosion and are listed as hospital deaths.

Associated injuries of the dead were burns and fractures. Forty-two cases revealed burns that had a wide range of severity. Most of the burn victims were burned in more than one area of the body (Table 5). Nearly all of the burn victims, 38 cases out of 42, had facial burns. This means that many lives might have been saved had we been able to offer the appropriate upper airway management at the scene, transport the victims to the most suitable medical facility, and administer definitive surgery thereafter.

Fractures were noted in 64 cases out of the 79 deaths. Most of the fracture cases were multiple (Table 6). Among them, a combination of skull and lower extremities fractures was striking and was found in more than one-third of all the death cases. Of the 428 who were injured, one-third of the victims suffered injuries of the neck and head. The highest incidence of injury was burns, 85 cases or 19.9%, and the second was fracture, 74 cases or 17.3% (Table 7). Thirty-six victims suffered from burns only; however, the other 49 had multiple injuries, including fractures. Among 74 victims who suffered fracture, 32 had multiple fractures. Beside the 428 who were directly injured by the explosion, 26 cases of related medical problems were treated (Table 8). Eighteen cases of anginal pain, five cases of hypertension, spontaneous

Table 6. Locations of Fractures in Mortality Cases

Fracture	No. of Cases
Skull	14
Cervical vertebrae	1
Ribs and thoracic vertebrae	3
Upper extremity	1
Lower extremity	8
Upper and lower extremity	1
Skull and lower extremity	16
Skull, upper and lower extremity	4
Skull, ribs, and lower extremity	2
Cervical vertebrae and lower extremity	1
Cervical vertebrae, ribs, and lower extremity	1
Ribs and upper extremity	1
Ribs, thoracic vertebrae, and lower extremity	6
Pelvis	2
Pelvis and lower extremity	1

Table 7. Details of Burn and Fracture Victims Who Survived*

	No. of Cases
Burns	85
Alone	36
With multiple injuries	49
Fractures	74
Single	42
Multiple	32

*Of the 428 who were injured, burns and fractures had the highest incidence of injury.

Table 8. Explosion-Related Medical Problems

Complaint	No. of Cases
Anginal pain	18
Hypertension	5
Spontaneous abortion	1
Asthma attack	1
Aggravation of a gastric ulcer	1

abortion, asthma attack, and aggravation of a gastric ulcer were treated. Emotional shock played a very important part in aggravation of these injuries, and should be taken into account at the scene of such a disaster.

Discussion

Under the leadership of the Osaka Medical Association and related agencies, including the police and the fire departments, a committee was organized to investigate the problems that arose during the disaster. First, questionnaires were sent to the 71 hospitals where victims were received. The questionnaires consisted of two questions. No. 1: What part of the emergency system should be improved, as shown by this disaster? No. 2: Who informed you of the disaster? Collection rate of questionnaires was 100%. Results are shown in Table 9. In consensus, there were three problems: (1) an overall lack of leadership and confusion of communication, (2) the need for a triage; and (3) a lack of control of mass media.

1. Due to the lack of leadership there was no central source of information. The police department, fire department, and ambulances were all operating independently, without any intercommunication. In one case, physicians of a well-equipped hospital had 12 dead patients brought to them, but no injured; while other less-equipped hospitals were swamped with the critically injured.

2. Needs for the use of a triage system. In Japan, EMTs are not allowed to diagnose a death; consequently, the emergency

Table 9a. Results of Questionnaire No. 1: Problems that Arose During the Disaster*

Answer	Respondents (%)
Overall lack of leadership and confusion of communication	36.7
Need of a triage	20.0
Lack of control of mass media	16.7
Need of a drill	16.7
Others	9.9

*The questionnaire was sent to the 71 hospitals that received victims of the gas explosion.

Table 9b. Results of Questionnaire No. 2: Who Informed You of the Disaster?*

Answer	Respondents (%)
Radio or TV	27.6
Local fire station	17.2
Arrival of victims	17.2
Explosion sounds	13.8
Ambulatory patient not related to disaster	10.3
Police	6.9
Citizen	3.4
Prefecture	3.4

*The questionnaire was sent to the 71 hospitals that received victims of the gas explosion.

physicians wasted time diagnosing mortalities when they could have been caring for the critically injured victims.

3. Need to control mass media. The press was able to get into hospitals freely where they monopolized the phones, thus hindering the hospital's communication with other agencies.

After much deliberation, the committee submitted a report. Osaka city government reacted favorably to this report and formed a disaster medical services system that organized central headquarters at the scene, increased the number of ambulances and EMTs, utilized disaster tags, originated a special radio frequency, and introduced a computer-aided command and control system for fire fighting and ambulance services. Last year Osaka prefecture provided an insurance coverage for physicians' in juries occurring at the scene of a disaster. From the disaster of 1970, we discovered many flaws in our system. They have been dealt with and solved so that today we feel capable of effectively handling any disaster situation.

Today, the City Fire Department has about 3,500 personnel and 350 vehicles, twice as many as compared with 1970. With one exception, each ward has a fire station, which has three or four substations in its jurisdiction. On the average, dispatchers send fire engines 5.2 times and ambulances 245 times a day. Consequently, the dispatch room of the City Fire Department receives emergency calls more than 900 times a day or every 1.6 minutes. When a disaster occurs in the city of Osaka, it is reported to the dispatch room in the headquarters of the City Fire Department, by citizens using the emergency telephone line, which is universally numbered 119 throughout Japan. On the basis of the information received, the dispatch room sends out vehicles, personnel, and equipment necessary to handle the disaster. They are dispatched, as needed, from the 89 fire stations and fire substations positioned throughout the city. When a disaster begins, the dispatch room collects all pertinent information from the site of disaster by radio, assigns units to be added for reinforcement, directs firefighting schemes, and handles public relations. This nerve center has the capability of taking proper countermeasures to prevent or lessen the effects of a disaster. In the past, the duties of the dispatch room were entirely manual, but as disaster increased in complexity, the computer was introduced in 1978.

A computer-aided command and control system was specially designed for the dispatch room and consists of one main computer (FACOM 230-48) and two minicomputers (PANAFACOM U-400S), the latter also being capable of serving as a backup system (Figure 1). Ninety terminals were installed, one in each station and substation in the city. The system assists the dispatchers in dealing with emergency calls which minimizes time, reduces the probability of error, and cuts down on manpower. In this system a dispatcher receiving an incoming call enters the details of the incident into the system. The system then computes and displays the name of the streets in the neighborhoods of the incident area on a video screen. In case of disaster, in the course of daily ambulance requests, a dispatcher on duty presses the ambulance call panel key. With this simple procedure, a list of the available ambulances in order of their distance from the disaster area appears on a display, along with how many times each of the ambulances was dispatched since midnight, and whether the ambulance has been used during the last 30 minutes. The computer can also tell what kinds of medical specialties and how many beds are available and the distance of the hospital from the disaster area. Information regarding the plans of firefighting tactics for certain buildings can also be retrieved. All directions are printed out through terminals located at each fire station. With this system, all the necessary processes are usually completed by the time the dispatcher ends the telephone communication. In the conventional manual operation, the commands were carried out after the telephone communication. The time elapsed was usually more than 30 seconds, which has now been cut through the use of this system.

In addition, information necessary for emergency services is stored in the computer and can be easily retrieved by the dispatchers (Table 10). This results in quicker

Table 10. Main Functions of the Computer-aided Command and Control System for Fire-fighting and Ambulance Services

1. Emergency telephone call reception
2. Location input
3. Decision of the type of the incident
4. Assignment of dispatch unit
5. Processing for fire hydrants
6. Dispatch
7. Tracing and recording of the action taken concerning the disaster
8. Management of use of the various types of fire-fighting information

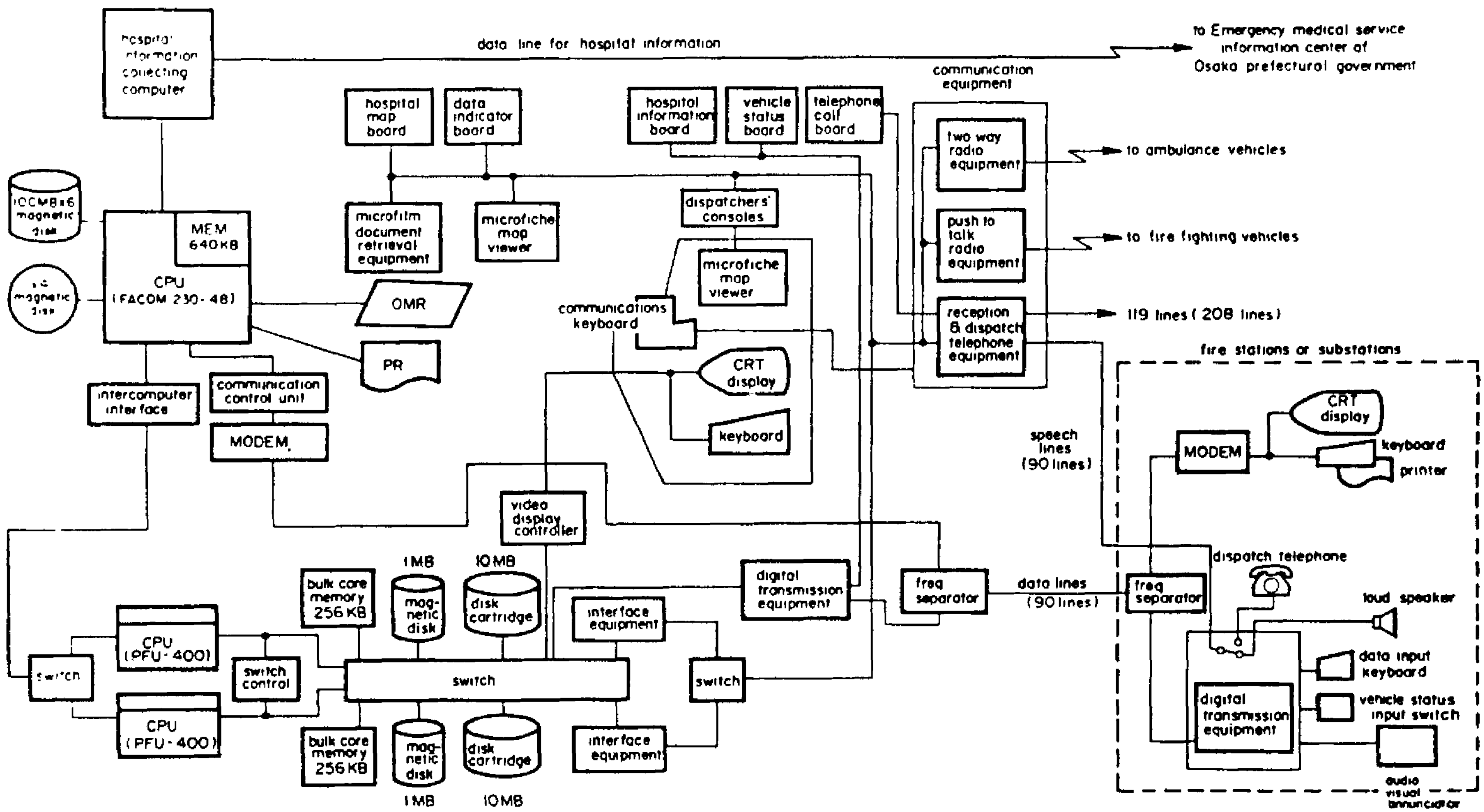

Figure 1. Osaka's computer-aided command and control system consisting of one main computer (FACOM 230-48), two minicomputers (PANAFACOM U-400S), and 90 terminals.

and more accurate dispatching activities. This system, which cost 1,850 million yen (7.8 million US dollars) to create, is operating smoothly.

One yet unsolved problem is control of the mass media in emergency situations. Our hope for the future is a gentleman's agreement between physicians and the press. We feel strongly that this agreement will come about, because everyone realizes that saving lives is the most important matter in a disaster situation.

Conclusion

After a tragic gas explosion in 1970 the Osaka Medical Association organized a committee to investigate the problems that arose during this disaster. From the results of questionnaires sent to the 71 hospitals where the disaster victims were received, the committee arrived at the conclusion that what was needed was a central headquarters, more ambulances and EMTs, the utilization of disaster tags, a special radio frequency, and a computer-aided command and control system. These needs have now all been accomplished.

Acknowledgement – The authors wish to thank the City Fire Department of Osaka for providing the necessary statistics and information.