

A Case Study of Volcano Eruption
Health and Emergency Medical Response
to Unzen-Fugendake Eruption

Hisamichi Baba, MD, PhD*

Shigeyoshi Teramoto, MD, PhD**

Vice President* and President**
National Nagasaki Chuo Hospital,
Nagasaki, Japan

Introduction

Since ancient times, volcanic events had been considered as the most destructive natural phenomenon. Also, it may be said that we are well aware of Japan's existence along the intersection of four tectonic plate around the Pacific Ocean where more than 60% of the recorded earthquakes have occurred.

Although these are not be compared with such an enormous large-scale calamity as **the Hanshin-Awaji Great Earthquake** in Jan.1995, Nagasaki Prefecture, located in the north-west part of the most western island of Kyushu, Japan and has a population size of 1.5 million has experienced a series of mid to large-scale disasters in last decade, such as **the Nagasaki Great Flood Disaster, the Shimabara Railroad Accident, the Unzen-Fugendake Eruption and Consequent Pyroclastic Flow Disaster**, etc.

Therefore, establishment of an emergency health/medical care system for such disasters including sustenance of life-line service, such as safe drinking water provision, electricity and gas as energy resource and sewage service, is now well recognized essential and significant. Also, it is well accepted, that such emergency relief and aid system should be maintained as routine countermeasure

Generally, large scale disasters are classified into two categories, namely, disasters caused by natural phenomena and man-made disasters. The disaster caused by pyroclastic flows due to the eruption of Mt.Unzen-Fugendake, Nagasaki, Japan in June 1991 is classified as a typical natural disaster and can be positioned as a series of disasters involving pyroclastic flows, an avalanche of earth and rocks, falling ashes, etc.

Background of Mt. Unzen-Fugendake

It is well known in Japan that some of 28 National Parks are located near live or dormant volcanoes and provides amusement of hot spa which is also known relating to volcano activities.

Unzen is one of popular resort area due to its interesting scenery relates to volcanic activities and various kinds of hot springs.

Mt Fugendake has been known as one of volcano, as some documents have inform us its last eruption 200 years ago with a consequent massive Pyroclastic Flow Disaster and Tsunami which brought more than 15,000 toll.

Before its recent eruption, although it is highest peak among modest hills in the Unzen-Amakusa National Park, Kyushu, Japan. So, except local community people, not many visitors could recognize Fugendake could keep

such a destructive potential.

Volcanic activity does not continue long and manifests in different fashion. The bundle of minor earthquakes starting in November 1989, and small tremor appeared on recorder might be its aura signs.

However, until May 20 1991, much attention was not paid when a running flow of significant amount of lava was recognized first.

Within a few months, new lava-dome was generated over original peak of 1,359 m high with frequent flows of ash, lapilli or other ejecta

The tragedy of disastrous Pyroclastic Flow happened on June 3 1992. The flow run down 4 Km East to nearest village and attacked people at observation, rescue and report.

Casualties

Casualties caused by Pyroclastic Flows following the Unzen Fugendake Eruption is shown in table 1. It reveals number of casualties caused by pyroclastic flows as a consequent of the Unzen Fugendake Eruption in June 1991.

Table 1 Casualties due to Pyroclastic Flow

Human Casualties	Injured 52
	Dead 43
	Death at site 27
	Missing 4
Material Casualties	Death at Hospital 12
	Building 1,079
	Residence 452
Estimated Amount of Damage	Non-residence 627
	¥ 136,597million
	US\$ 130million

Concerning with the human casualties, number of the injured was 52. Total death cases due to pyroclastic flow were 43 including 27 identified immediate death at the site, 4 missing, and 12 death at hospitals

Physical damage includes 1,079 units of the buildings and houses collapsed and/or burnt down, including 452 residential and 627 other buildings such as storage or animal houses. The financial loss is estimated up to total amount of 136,597 million Japanese Yen or 130 US dollar equivalent

Response and Triage

Response and *Triage* taken by the Prefectural Shimabara Onsen(hot spa) Hospital, the most nearest public health facility, at the time of emergency in the disaster region were following.

The patients with severe burn were treated mainly in the Shimabara Onsen Hospital whereas the mild cases were examined at the other primary or secondary medical facilities nearby. The number of burn case were 17, including 13 people suffering complications from inhaling of heated erogenous gas or substances.

Four out of 17 have shown non-life threatening injury, such as burn below body surface of 25%. These people were not referred to the other health facilities for intensive care and could discharge shortly after necessary treatment. One person with mild inhalation injury and some others with moderate inhalation with burn over body surface of 40% were referred to National Nagasaki Chuo Hospital, one of the tertiary care hospital in Nagasaki Prefecture, for necessary intensive care.

Prognosis of the injured people in the hospital were not bad, however, as the longest, a patient needed for 6 months of treatment before discharge in December 1991. Other 8 persons, some suffered from mild inhalation injury and with burn of over 50% of his/her body surface, or burn over 80% were referred to the Nagasaki University Hospital, another tertiary care facility or the National Nagasaki Chuo Hospital, etc.. Transportation of the patients was done with particular attention by attending emergency care physicians and nurses in ambulances. Three persons were not referred, although they were suffered from extremely serious burn, but provided a maximum treatment at Shimabara Onsen Hospital

From our experience of treating these people, we are aware of some how the distinction of each individual. As the possibility of survival was not directly correlate to the level of injury from inhalation

Response of the National Nagasaki Chuo Hospital

In order to respond to possible request for relief and medical care for visiting and admitting patients, " the National Nagasaki Chuo Hospital Headquarters for Disaster Relief to Unzen Fugendake Eruption" was set up immediately after the information of the eruption in May 1991

As a preparatory arrangement, 2 emergency relief squad were built, each of which consisted of 6 members, 2 physicians, 2 nurses, 1 administration officer and a driver, and stood for emergent requests of dispatch any time to the disaster area.

Responding to requests of reference of injured person(s) for consultation or admission, under the Vice president as the Coordinator, a comprehensive intensive care team was organized, which consisted with total of 40 members, plastic surgeons, respiratory specialists, anesthesiologists and intensive care nurses for an assumed cases of massive burns in addition to the inhalation injury. Preparing for the case of an outbreak of an avalanche of earth and rocks, assuming a large number of the traumatic patients, another team of total 40 stuff consisting of general surgeons, orthopedists, anesthesiologists and nurses was also organized under the supervision of the Vice President. Also for the nursing department, a supporting system for in-patients, including night-duties was reinforce.

Response of the Prefectural Level

The officers of Department of Health/Environment, Nagasaki Prefecture, the members of Medical Association of Nagasaki Prefecture and the Medical Association of Shimabara City, and health/medical professionals from tertiary care facilities in the prefecture, such as Nagasaki University Hospital and National Nagasaki Chuo Hospital, and Prefectural Shimabara Onsen Hospital, etc. convinced for the Emergency Measure Meeting for Unzen Fugendake Eruption, on June 25 1991 and exchanged opinion and discussed the possibilities including following issues:

1 Communication Hot Lines

As communication measure by telephone was almost paralyzed in the affected area due to the event, the information exchange between the area and tertiary care hospitals was not exist. As a countermeasure to such situation, a tentative emergent hot lines was constructed between Prefectural Shimabara Onsen Hospital and Nagasaki University Hospital, and between Abeam National Hospital and National Nagasaki Chuo Hospital. So, communications system in order to respond to any request of relief or support and refer of the injured person(s) was confirmed.

2 Transportation System

Although the main road was shut off or blocked by piled ash and mud flow, for transportation by road, it was possible to take ambulances, however, helicopters were not utilized as air transportation measure and, by sea, any kind of hospital ship was also not taken into action.

3. Referral System

Depending on the size and extent of the pyroclastic flow or an avalanche of earth and rocks, transportation by road might be completely cut off, therefore, a difficulty of referral of a severely injured patient was anticipated. To cope with such situation, a referral system of injured person(s) within the prefecture and to the other area cross the border by helicopters of the Self-Defense Forces, and boats of the Marine Safety Agency was also established.

A medical collaboration network, among hospitals and other health/medical facilities and emergency medical centers in the neighboring prefectures, such as Fukuoka, Kumamoto, Saga, etc., was also developed in order to keep a capability of treating many severe burns. Anticipating the disastrous event, hospitals in Nagasaki Prefecture had to maintain a certain space for emergent visit or admission.

In case, patients were referred by helicopters to the remote hospitals or emergency medical centers in the other prefectures, care to the family members should also keep in mind.

As for helicopter transportation, at the time of emergency, some local authorities, such as Hokkaido, Tokyo Metropolitan Government, Nagasaki and Okinawa Prefecture, have requested operations to one of official agencies such as Self-defense Force, Marine Safety Agency, Police Department, etc. Although, frequent use of helicopter transportation may need extra maintenance and operational cost, as other massive casualty may be anticipated any place not only in Japan but globally, an extra provision will be highly appreciated.

4 Current Situation of Emergency Medical Care in Nagasaki.

An information of possible space for admission for disaster casualty in Nagasaki Prefecture shows a capacity of

100 beds	for serious trauma,
200 beds	for moderate trauma,
35 beds	for serious burns(over 30% of body surface with inhalation injury),
140 beds	for mild burns

5. Number of Injured Persons and Health Care

Initially, the number of the injured persons in Shimabara City, where Fugendake

is existing, was about 4,200, and 500 in Town of Fukae, next to Shimabara. Later, it went up to 11,000. Local people living around Mt. Fugendake have been forced to move to 10 evacuation centers provided somewhere nearby areas by the local government, such as gymnasiums for citizens in the city or towns, public halls, gymnasiums of primary and junior high schools, hotels, etc

Four weeks after the forced evacuation, the Nagasaki Hospital of Japan Red Cross, Kumamoto Postal life Insurance Hospital and the Medical Association of Shimabara City assigned one or two physicians to each evacuation center in order to maintain and improve public health and primary care services of the displaced people. Until that time, members of the Medical Association of Shimabara City were in charge of health and medical care of the people

6. Surveillance on Health Conditions of Displaced People

A surveillance on the health condition of the people, including the development, mental condition and physical growth of primary and junior high school students in the disaster area was conducted by Dr. Takemoto, Professor of Public Health Science, Nagasaki University.

It has pointed following,

Primary and junior high school students showed deterioration in physical ability and body weight gain. Also, PTSD(Post Traumatic Stress Disorders) were recognized among roughly 60% of school children who forced to move to temporally dwelled small houses, complaining as

"I dream a dreadful one and can not sleep!",

"I am easy to get angry at trifling matters...",

"I don't want to do anything", etc.

On the other hand, such signs were observed only 30% of the children living in their original house.

Among grown up, major complaints were respiratory diseases and skin or mucous membrane disorders, probably caused by pyroclastic flows or ashes in air, etc.

It is, now after the Great Hanshin -Awaji Earthquake, well recognized among public, to pay attention to the mental care of the affected people together with physical care in a longer time scale. a care and support system to the senior people should, also, be carefully arranged.

7. Emergency Medical Care at Great(Natural) Disaster

Primary, Secondary and Tertiary Emergency Care Systems have been established in Nagasaki Prefecture in the existing emergency medical service system

- 1) Medical Information System was established in order to respond at the time of devastated natural disaster and provide necessary emergency care.
 - (1) Establishment of communication system among health facilities, Prefectural Government and other local public agents or authorities.
 - (2) Expansion and/or provision of communication appliances, such as wireless system, mobile telephones, etc.
 - (3) Establishment of teleradiology system
 - (4) others

- 2) Referral System for respond to emergency at particular natural disaster was established.
 - (1) Improvement, supervision, management and maintenance
 - (2) Provision of intensive care ambulances
 - (3) Mobilization of emergency helicopters
 - (2) Use of hospital ships

- 3) Planning of Disaster Mitigation
- 4) Development self-defense fire fighters for disaster relief activities and volunteer organizations
- 5) Training and Education of emergency medical care
- 6) Health Care Management for disaster victims
- 7) Others

Among above, establishment of medical information system and referral system were recognized most essential. Namely, as recognized at the time of Great Hanshin-Awaji Earthquake, communication and information in emergency should be the most critical issue to provide appropriate, effective and practical rescue, relief and health/medical care. It may never be too exaggerated at the time of catastrophic disaster. Therefore, physical provision of communication net-work or provision of such a apparatus like wireless exclusive telephone lines or mobile telephones, etc.

Referral System is another indispensable issue.

Large sized and equipped with intensive care materials ambulances might be implemented. It is applicable for routine emergency transportation of the patients and can provide a small surgery, if necessary. At the time of catastrophic disaster covering broad areas, emergency operation of helicopter transportation is required. In case, there is no place for constructing temporal evacuation centers or first aid unit, a hospital ship may be considered.

Needless to say, a plan of mitigation should not be neglected in order to reduce physical damage and sacrifice of human and animal lives. Voluntary fire fighter team must be set up and trained regularly. Any kind of citizen's voluntary groups can be trained for basic health care for disaster victims. Among health and medical professionals, practice of emergency medical care maybe incorporated into annual postgraduate training.