Lessons from the Niigata Chuetsu Earthquake in Japan
—Experience of a small medical association in hilly and mountainous areas—

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Abstract
An Earthquake with a magnitude of 6.8 and a maximum seismic intensity of 7 hit the Chuetsu region of Niigata Prefecture in Japan on October 2004, causing tremendous impacts including the generation of about 100,000 evacuees, destruction of about 90,000 houses, and total damages exceeding 3 trillion yen (about US$27.6 billion) in the prefecture. In contrast to the Hanshin Awaji Earthquake of January 17, 1995, which mostly involved large cities on relatively flat land, the earthquake in Niigata affected hilly and mountainous areas with depopulation and aging of citizens. A lack of information, underdevelopment of communications media, and inequality in health care services emerged as significant problems, and caused confusion among rescue volunteers, who entered the disaster area in great numbers. The local medical association, without sufficient information, had to tackle the challenges of promoting cooperation with the medical teams from other areas and answering new problems peculiar to hilly and mountainous areas, such as death during overnight stays in cars. The experience from the 2 earthquakes, one in urban and the other in hilly and mountainous situations, should be utilized as typical reference information in future disaster measures not only in Japan, a country with frequent earthquakes, but also in other countries with the experience of earthquake disaster. This article does not intend to cover the details of all affected areas by this earthquake, but to outline the lessons learned from the activities of the Medical Association of Ojiya, Uonuma, and Kawaguchi following the earthquake.

Key words Disaster medicine, Earthquake, Medical team, Emergency medicine, Community medicine, Top-down, Line of command

Introduction
At 17:56, on October 23, 2004, an earthquake with a maximum seismic intensity of 7 occurred with its epicenter directly beneath the Chuetsu region, Niigata Prefecture. The areas under the coverage of our medical association (Ojiya City, Uonuma City, and Kawaguchi Town) were suddenly sent into a panic.

Niigata Prefecture is located near the middle of the coastline of Japan facing the Sea of Japan (land area 12,582 km², population 2.46 million). The inland region of the prefecture is surrounded by high mountains, and about a half of the total land area is classified as hilly and mountainous areas. The Chuetsu region, including the epicenter of this earthquake, consists mostly of hilly and mountainous areas. The damage from the earthquake in the whole of Niigata Prefecture is summarized in Table 1. Kawaguchi Town (land area 50 km², population 5,693) suffered disruption of roads, destruction of the 2 clinics, and a breakdown of lifelines, resulting in the loss of medical care and telecommunications functions. Shinkansen railway lines and expressways were
Fig. 1 Niigata-Chuetsu Earthquake in 2004
Main Shock (17:56, Oct. 23; Intensity 7) and Major Aftershocks
(Press Release, Japan Meteorological Agency)

Main Shock
17:56, Oct. 23
Max. intensity 7 (M6.8)

Major Aftershocks Immediately after the Main Shock
• 18:03, Oct. 23
  Max. intensity 5+ (M6.3)
• 18:11, Oct. 23
  Max. intensity 6+ (M6.0)
• 18:34, Oct. 23
  (largest aftershock)
  Max. intensity 6+ (M6.5)
• 19:46, Oct. 23
  Max. intensity 6− (M5.7)

Other Major Aftershocks
5+: 3 times
5−: twice

Major Aftershocks on the Next Day and Later
• 14:21, Oct. 24
  Max. intensity 5+ (M5.0)
• 00:28, Oct. 25
  Max. intensity 5− (M5.3)
• 06:04, Oct. 25
  Max. intensity 5+ (M5.8)
• 10:40, Oct. 27
  Max. intensity 6− (M6.1)
• 08:57, Nov. 4
  Max. intensity 5+ (M5.2)
• 11:15, Nov. 8
  Max. intensity 5+ (M5.9)

Map Legend
- Municipalities with fatality or complete or partial destruction of residence (23 municipalities)
- Municipalities with personal injury or damage to buildings (residence, non-residence) (27 municipalities)

Table 1 Damage from the Niigata-Chuetsu Earthquake in 2004
(Niigata Chuetsu Earthquake Disaster Response Headquarters)
As of 14:00, June 22, 2005

<table>
<thead>
<tr>
<th>Division</th>
<th>Death</th>
<th>Missing</th>
<th>Severe Injury</th>
<th>Slight Injury</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total in Niigata Prefecture</td>
<td>48 persons</td>
<td>0 persons</td>
<td>634 persons</td>
<td>4,160 persons</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Division</th>
<th>Complete Destruction</th>
<th>Severe Partial Destruction</th>
<th>Partial Destruction</th>
<th>Slight Destruction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit</td>
<td>Buildings</td>
<td>Households</td>
<td>Buildings</td>
<td>Households</td>
</tr>
<tr>
<td>Total in Niigata Prefecture</td>
<td>3,174</td>
<td>3,138</td>
<td>2,140</td>
<td>2,142</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Division</th>
<th>Non-residence Building</th>
<th>Other Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit</td>
<td>Public Facility</td>
<td>Road</td>
</tr>
<tr>
<td></td>
<td></td>
<td>River</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Landslide</td>
</tr>
<tr>
<td>Total of Niigata Prefecture</td>
<td>40,368</td>
<td>6,064</td>
</tr>
</tbody>
</table>
also destroyed, and many medical rescue teams experienced considerable delay in reaching the disaster area.

The prefectural government of Niigata has been conducting regional disaster prevention meetings every year, based on the experience of the large earthquake that hit Niigata 40 years ago in June 1964 and the lessons from the Hanshin Awaji Earthquake in the western part of Japan in 1995. However, the actual response to the present emergency revealed the presence of many problems. These problems were partly derived from the geographical difference in that the former 2 disasters occurred mainly in urban areas and the present earthquake affected a large expanse of mountainous regions. The fundamental cause, however, was the disruption of the line of command.

As part of the efforts to cope with the disaster, the local medical association requested support from various medical teams and also established its own “Emergency Medical Headquarters” to support the provision of medical care.

**Situations from Day 1 to Day 4**

**October 23**

Immediately after the first earthquake, the local medical association completely lost all its functions due to the breakdown of lifelines, disruption of traffic means, and interruption of telephone services. It was impossible to perform routine medical care, collection of information, and confirmation of damage.

Most of the mass of casualties were sent to hospitals and clinics during the period from 2 hours after the shock to midnight. Wounds were treated under small floodlight lamps and flashlights. While treatment was continued 24 hours a day, prescription of drugs was impossible and there was no way to confirm any information.

**October 24**

In Ojiya City, the medical rescue team of the Japanese Red Cross Society started independent rescue activities in the morning by setting up headquarters in a room of the city hall and opening first-aid stations in the municipal sports hall and elementary and junior high schools in the city. While the local government sent out public health nurses and other health personnel for rescue and information collection, the local medical association was not informed of this fact. During the 2 days, Ojiya General Hospital and Uonuma Hospital received as many as 340 and 154 emergency patients, respectively.

In the communities that had lost all lifelines, inhabitants filled refuge sites illuminated with emergency power generation.

**October 25**

I established the disaster countermeasures office of the local medical association in Niigata Prefectural Koide Hospital, which sustained relatively little damage, and contacted the members of the medical association, as well as the responsible persons of health centers and fire departments. Activities included information exchange concerning damage to medical facilities, decision to use local practitioners in place of hospital physicians who could not go to work, and decision to start visits to refuge sites.

In Kawaguchi Town, many patients with chronic diseases and those seeking referral letters visited the hospital. The Self-Defense Forces were deployed and medical teams arrived, but their arrival was not informed to local hospitals. I established the “Emergency Medical Headquarters” in the Ojiya Medical Association to take command of activities in Ojiya City, and focused my work on Kawaguchi and Horinouchi Towns.

As the medical team of Tokyo Medical Center (6 persons including 1 surgeon, 1 physician, 1 pharmacist, 1 nurse, and 2 clerks) arrived, I explained the situation of the disaster and asked them to support the medical care in Horinouchi Town. The National Hospital Organization contacted us, and I asked for their support in Kawaguchi Town.

**October 26**

The Kan-etsu Expressway was passable, but cars had to use all 4 lanes to go (both north- and south-bound), switching from one lane to another in a zigzag manner. Only emergency vehicles were allowed to use the expressway. From this day on, the medical association joined the voluntary meeting held by the Japanese Red Cross Society, and the meeting started to function practically as the “medical support headquarters.”
Problems in Current and Future Response to Disasters

1. Diseases and hygiene

Measures against food poisoning and other infections are required following the disaster. Because this earthquake occurred in winter, we placed emphasis on the control of influenza (Table 2). In view of the geographical features and climate of various locations throughout the world, a great variety of such measures are required according to the disaster situation. The large number of evacuees who stayed in their cars at night resulted in an epidemic of so-called economy-class syndrome, including cases of death. Response to this condition, as well as PTSD, will be required in future disasters.

As the earthquake occurred on a Saturday evening after the closing of local clinics, emergency patients mainly received treatment in hospitals. The 2 clinics in Kawaguchi Town treated casualties in an isolated situation, because road traffic was cut off.

While many patients visiting hospitals during the first 2 days following the disaster had external injuries, such as cuts from glass, burns, and fractures, the number of patients with the common cold and chronic diseases increased on later days. The action of JADP (Japanese Association of Dialysis Physicians) to patients requiring hemodialysis was particularly praiseworthy. The way of treatments to these patients will be a good reference for future disaster medicine.

2. Cooperation among medical teams

Saku Central Hospital in Nagano Prefecture sent medical teams nine times through the Japan Agricultural Co-operatives (JA). The relatively smooth continuation of medical care provided by these teams was supported by a number of facts. They brought 3 generators and many small floodlight lamps enabling emergency outpatient care at night from the very beginning. The medical teams also included nutrition staff and brought meals, canned food, water, LP gas, and portable cooking stoves to prepare food for 180 in-patients. This eliminated the need for transporting in-patients to other hospitals.

The Japan Red Cross team acted under an independent line of command separately from governmental agencies. Ten hours after the earth-

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Table 2 Medical care and relief activities

<table>
<thead>
<tr>
<th>Division</th>
<th>Persons Receiving Care from Medical Support Teams</th>
<th>Persons Receiving Examination or Consultation from Mental Care Teams</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>From October 26 to December 22, 2004</td>
<td>From October 26, 2004 to January 22, 2005</td>
</tr>
<tr>
<td>Ojiya City</td>
<td>11,782 persons</td>
<td>1,690 persons</td>
</tr>
<tr>
<td>Uonuma City</td>
<td>1,713 persons</td>
<td>935 persons</td>
</tr>
<tr>
<td>Kawaguchi Town</td>
<td>2,497 persons</td>
<td>265 persons</td>
</tr>
<tr>
<td>Total in Region</td>
<td>15,992 persons</td>
<td>2,890 persons</td>
</tr>
</tbody>
</table>

■ Vaccination against Influenza

<table>
<thead>
<tr>
<th>Division</th>
<th>Number of refuge sites at which vaccination was performed</th>
<th>Number of persons vaccinated at refuge sites</th>
<th>Number of persons vaccinated at medical institutions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>From November 4 to December 27, 2004</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ojiya City</td>
<td>9 locations</td>
<td>200 persons</td>
<td>5,487 persons</td>
</tr>
<tr>
<td>Uonuma City</td>
<td>—</td>
<td>—</td>
<td>4,206 persons</td>
</tr>
<tr>
<td>Kawaguchi Town</td>
<td>4 locations</td>
<td>92 persons</td>
<td>850 persons</td>
</tr>
<tr>
<td>Total in Region</td>
<td>13 locations</td>
<td>292 persons</td>
<td>5,906 persons</td>
</tr>
</tbody>
</table>
One problem recognized from this disaster was the lack of sharing information among different medical teams to facilitate the appropriate allocation of human and material resources. Although it is difficult to take control the situation of all refuge sites, which numbered at least 168 places in Ojiya City alone, the highest priority should be placed on cooperation between the medical teams from outside and the members of the local medical association, who understand the health conditions of inhabitants.

With regard to the time of withdrawal, Japan Red Cross first decided to provide support for 2 weeks, based on their initial on-site survey of damage (actually the support continued for 4 weeks). On the other hand, Saku Central Hospital started support without specifying the period. When AMDA (an NGO) decided to support earthquake victims in Kobe, it planned to provide support until such time that 50% of medical institutions were restored. In this regard, the cooperation of local governments and medical associations is important when external medical teams do not have information on which to base their decision to leave.

3. Cooperation with government agencies

The information concerning the disaster area is essential to “acute phase medical care,” and an indispensable prerequisite for providing this information is the close cooperation between the “Emergency Medical Headquarters” set by the medical association and the “Disaster Countermeasure Headquarters” set by the government. The lack of cooperation between both the headquarters caused several problems in the initial phase of the disaster. This experience revealed the importance of discussion and practice regarding the following matters:

(1) To secure means of communications and collect accurate information during emergency;
(2) To construct an information network using satellite telephones;
(3) To establish an organization in the role of headquarters to grasp the full picture of the disaster;
(4) To leave decision-making about disaster medicine to medical professionals;
(5) To ensure that the responsible officials of the Medical Headquarters of the medical association and those of the disaster countermeasure team of the government are stationed at the site of disaster;
(6) To handle the problems of allocation, lodging, etc. of many supporters from outside;
(7) To solve the problem of the cost of medical care given to victims; and
(8) To ask the mass media for prompt and appropriate response.

4. Proposals for disaster management

(1) To provide appropriate medical care to victims of disaster, it is necessary to estimate the human and material resources required and to ensure the appropriate allocation of medical resources. To this end, it is necessary to unify the flow of information and the line of command.
(2) As I experienced in the Great Niigata Earthquake in 1964, one of the most important issues was the management of water, including drinking water. In present-day Japan, we can expect to receive a sufficient supply of medical staff, drugs, water, food, etc. by the third day after the occurrence of disaster. However, situations differ in different parts of the world, and it is important to practice disaster management simulations including the supply of drinking water and utility water during normal times.
(3) There were cases where an outside medical team and a local hospital were working separately at a distance of less than 1 km from each other without mutual communication or sharing of disaster information. It is the responsibility of the Emergency Disaster Headquarters of the local government to assign appropriate locations to outside medical teams and to provide relevant information to both local hospitals and outside medical teams, but such activities were very difficult in the current situation of Japan, where the Emergency Disaster Headquarters did not include a medical professional. As shown in the statistics of medical workers and various organizations sent to the disaster area (Table 3), there were personnel and drugs in sufficient numbers, but they were not distributed to the areas where they were most needed during the “hyperacute phase.”
It is desirable that medical professionals are stationed at the Emergency Disaster Headquarters and issue appropriate orders. (4) The national government had already issued guidelines to strengthen medical care system at the time of disaster in 1986 (Table 4), but the opinions of physicians have not been reflected in these guidelines. As a result, local medical workers had to establish an independent support system based on the judgment of the president of the local medical association. A top-down approach is suitable for the provision of medical care in an emergency.

For example, the Tokyo Metropolitan Government has issued a new rule that all participants of disaster-related medical care following a large disaster must work under the control of the Tokyo Medical Association. This should provide a good model for system development in various localities.

**Conclusion**

Based on my experience of earthquakes, I as a physician would like to add some suggestions as outlined below. What is important at times of

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### Table 3 Medical teams and public health nurses sent to the disaster area

<table>
<thead>
<tr>
<th>Division</th>
<th>Medical Support Organizations and Total Operating Days</th>
<th>Nurses Sent from Japanese Nursing Association</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Organizations</td>
<td>Operating days</td>
</tr>
<tr>
<td>Ojiiya City</td>
<td>32</td>
<td>352</td>
</tr>
<tr>
<td>Uonuma City</td>
<td>16</td>
<td>71</td>
</tr>
<tr>
<td>Kawaguchi Town</td>
<td>10</td>
<td>116</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>58</strong></td>
<td><strong>539</strong></td>
</tr>
</tbody>
</table>

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### Table 4 Strengthening of early emergency medical care system at the time of disaster

1. Attendance at Regional Disaster Management Meetings
2. Conclusion of mutual disaster support agreements
3. Development of independent support systems
4. Development of key emergency hospitals
5. Strengthening of health center functions related to disaster medicine
6. Publicity, education, and training concerning disaster medicine
7. Development of disaster management manuals
8. Cooperation with fire-fighting organizations
9. System for identifying deceased disaster victims

(Health Policy Bureau, Ministry of Health and Welfare, May 1986)
disaster is, among others, the close relationships that exist between the people living in that area, regardless of how many advanced technologies they possess. The people living in these areas who have overcome the disadvantages from snow-drifts of over two meters in winter for years are kind and considerate in nature. I would say that it is this human nature that helps them surmount the various difficulties they humbly faced at the time of the big earthquake when otherwise great confusion could have occurred in society. The emergency system to cope with medical care and disasters can be technically and legally established. But the trustful relations among the people cannot be created by laws. It gives me much joy together with the other physicians involved in the rescue of the disaster victims to be able to live among the local inhabitants who exhibited the most beautiful aspects of the human spirit in helping each other while under the threat of subsequent and frequent aftershocks. While disasters almost always end in tragedy, they can also highlight the wonderful nature of people.

Although no one knows where and when, we can say a next big disaster will surely occur in the future. I really hope that the damages expected in future disasters will be minimized by the best and brightest human minds.