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# The Great East Japan Earthquake

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# Preparedness and resilience: the hallmarks of response and recovery

Jacob Kumaresan\*

The Great East Japan Earthquake struck the north-eastern coast of Honshu on 11 March 2011. With a magnitude of 9.0, it was the largest earthquake ever recorded in Japan. It triggered the largest recorded tsunami in Japan which devastated the lifelines, transportation and communication systems in the Tohoku region. The tsunami caused nuclear accidents and meltdowns of three reactors in Fukushima.

The impact on human life and health was massive. The death toll was 15 839 – second only to the Great Kanto Earthquake of 1923. As of 29 November, the missing individuals numbered 3632, while the injured totaled 5950.<sup>1</sup> Power, gas and water supplies were disrupted in many areas for several days and weeks. Roads, railways, airports and infrastructures were severely damaged. More than 930 000 buildings in the Tohoku region were either fully destroyed or partially damaged. Based on information from relevant prefectures and ministries, the economic damage was estimated around US\$ 219 billion.<sup>2</sup>

A total of 67 387 persons needed evacuation.<sup>1</sup> Due to the massive efforts on rehabilitation and construction of temporary housing by the nation, all evacuation centres were closed by the end of August. Safe drinking water and food were initial concerns due to the nuclear accident. During the early response stage, the major health concerns were hypothermia among the elderly, tsunami-associated pneumonia<sup>3</sup> and other respiratory ailments. During the recovery phase, a gradual increase in noncommunicable diseases was noted due to risk factors such as continued lack of exercise, poor diet and high stress levels. Mental health challenges are likely to emerge as a priority in the long term, requiring significant psychosocial support in the future.

A series of articles in this publication and elsewhere describe the health and public health concerns following

the Great East Japan Earthquake and tsunami, the response and management efforts undertaken, and the lessons learnt from this unprecedented experience. Several articles were written by authors who resided in affected areas and were directly involved in the response.<sup>4-6</sup> The need for a post-disaster surveillance system for developed country settings is proposed by Arima et al.<sup>7</sup> Beginning with an event-based surveillance approach in the acute response phase, the system needs to evolve to a syndromic approach during the recovery phase and eventually to enhanced sentinel surveillance during the reconstruction and development phases.<sup>7</sup>

Following the total destruction of the sole medical facility in Taro District, health care personnel responded to suffering citizens in the evacuation centres from a temporary clinic. Due to the active and regular visits by the health workers, all health care activities in the district were restored within six months.<sup>4</sup> The experiences of the Iwate Prefecture in providing public sanitation as well as medical and mental health care are valuable in ensuring better preparedness in future disasters.<sup>5</sup> Rapid responses following a quick needs assessment were critical for successful operations by the Ishinomaki Red Cross Hospital.<sup>6</sup> Providing adequate food, water and sanitation along with medical care ensured that there were no outbreaks of communicable diseases in this region.

The entire nation of Japan and the world rallied to help and support the victims affected by the devastating earthquake and tsunami. Among several heroic efforts, I highlight the support provided by Tono City as an outstanding example of solidarity and resilience. Tono City, located midway between the inland and coastal areas of the Iwate Prefecture, experienced widespread power outages, collapse of the main government building and lack of water supplies. Fortunately, none of the citizens were severely injured or displaced due to

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the earthquake. The mayor of the city, with the support of the community, started providing assistance to the worst-hit coastal areas. Responding to a desperate call from Otsuchi by a man who walked to Tono crossing two hills since all means of communications and transportation were disrupted, full-scale relief operations were instituted within 12 hours. Medical services were provided at homes and at the 50 evacuation centres in Tono city. Emergency supplies such as blankets, food, water and kerosene were procured and sent to several of the coastal towns within a few days. In addition to community support and voluntary donations, the private sector's donations such as powdered milk, diapers and sanitary products were mobilized. With the help of the Japan Postal Services and the Iwate Trucking Association, the city was able to make three return trips per day to the affected towns. These efforts were possible because the municipalities collaborated with each other rather than adhering to the country-prefecture-city structures. As a result, the donated items perfectly matched with the needs of the people in the affected areas.

Another crucially important factor in carrying out this rapid response was the preparedness measures taken by the city for the provision of both material and emotional support in the event of a large-scale disaster. The city had drafted a framework of support measures to be taken, which included emergency support teams, temporary support centres and utilization of sports facilities and parks as heliports. The city conducted two comprehensive emergency response drills for Iwate Prefecture which involved training in emergency triage, first aid, food preparation and distribution and the establishment and management of emergency communications networks. This degree of foresight

in preparedness as well as the resilience from the community to overcome the challenges resulted in rapid response and relief operations to the affected areas and the victims.

Making predictions about earthquakes and the extent of damage they may cause are difficult. However, the human toll and suffering and the economic costs associated with such disasters may be mitigated through better planning and preparedness measures. As witnessed during the Great East Japan Earthquake, the resilience of the community to support each other will accelerate relief and reconstruction efforts. With regard to health care and public health systems, the experience from the Tohoku region has provided a basis for post-disaster surveillance systems in developed nations.

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# The Great East Japan Earthquake: a need to plan for post-disaster surveillance in developed countries

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After a devastating earthquake and tsunami struck north-eastern Japan in March 2011, the public health system, including the infectious disease surveillance system, was severely compromised. While models for post-disaster surveillance exist, they focus predominantly on developing countries during the early recovery phase. Such models do not necessarily apply to developed countries, which differ considerably in their baseline surveillance systems. Furthermore, there is a need to consider the process by which a surveillance system recovers post-disaster. The event in Japan has highlighted a need to address these concerns surrounding post-disaster surveillance in developed countries.

In May 2011, the World Health Organization convened a meeting where post-disaster surveillance was discussed by experts and public health practitioners. In this paper, we describe a post-disaster surveillance approach that was discussed at the meeting, based on what had actually occurred and what may have been, or would be, ideal. Briefly, we describe the evolution of a surveillance system as it returns to the pre-existing system, starting from an event-based approach during the emergency relief phase, a syndromic approach during the early recovery phase, an enhanced sentinel approach during the late recovery phase and a return to baseline during the development phase. Our aim is not to recommend a specific model but to encourage other developed countries to initiate their own discussions on post-disaster surveillance and develop plans according to their needs and capacities. As natural disasters will continue to occur, we hope that developing such plans during the “inter-disaster” period will help mitigate the surveillance challenges that will arise post-disaster.

**A**fter the devastating magnitude 9.0 Great East Japan Earthquake and tsunami struck north-eastern Japan on 11 March 2011, the public health system was severely compromised in the affected areas. The destruction caused by the event was unprecedented since the Second World War; in addition to causing nearly 16 000 deaths with more than 3500 still missing,<sup>1</sup> the event destroyed the medical and public health buildings and the telecommunication systems vital to the public health system. The public health workforce was also severely affected; many public health workers were victims of the disaster, and those who could work did so under extremely difficult conditions. While no large infectious disease outbreaks occurred, systematic collection, collation, interpretation and reporting of infectious disease data faced numerous challenges, making needs and risk assessments difficult.

In May 2011, the World Health Organization (WHO) meeting, “Informal meeting on disaster recovery for the health sector,” was held at the WHO Kobe Centre in Japan, where post-disaster recovery of public health services, including infectious disease surveillance systems, was discussed by a group of experts and public health practitioners from affected areas. The approach described in this article is based on those preliminary discussions, which emerged from both observations and initial assessments from the field in addition to input from public health infectious disease surveillance experts. The authors hope that public health practitioners in other developed countries will find this information useful to initiate their own discussions and review or plan their post-disaster surveillance systems to better prepare in case a major disaster occurs.

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The existing infectious disease surveillance system in Japan is similar to those in many other developed countries, with components of laboratory confirmations and reporting based on both notifiable disease and sentinel surveillance.<sup>2</sup> Despite the occurrence of periodic natural disasters including earthquakes and tsunamis, the Japanese system lacked a comprehensive post-disaster surveillance plan. Furthermore, while there are existing models, frameworks and discussions of post disaster surveillance,<sup>3-8</sup> many focus on the developing country setting, and such models do not necessarily apply to developed countries. Developed countries differ considerably from developing countries in their baseline surveillance system, including the medical and laboratory facilities and the telecommunication services that support them.

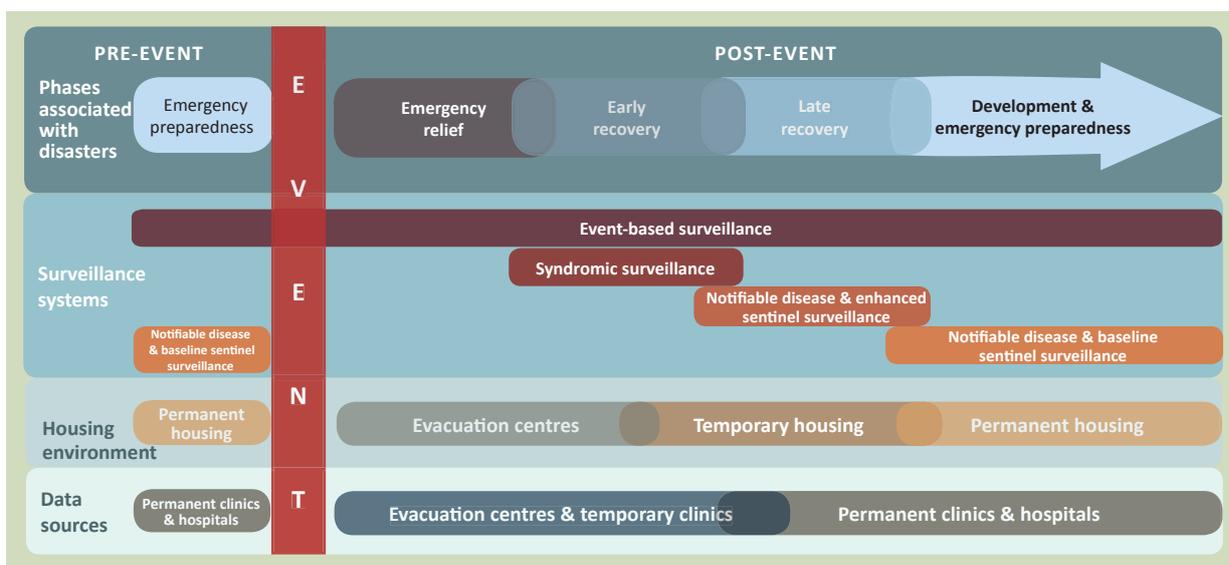
As in other major natural disasters, soon after the Great East Japan Earthquake, emergency relief focused on medical care for rescued survivors and implemented acute public health measures, such as sanitation and hygiene, to reduce occurrences of infectious diseases. During this period, there was very limited communication and coordination capacity, making systematic information collection difficult. Given that situation, event-based surveillance (EBS) (organized and rapid capture of information about events that are a potential risk to public health<sup>9</sup>) was used at many of the shelter sites by first responders and others working on site (Figure 1). Events, as clusters of syndromes,

could be rapidly detected and reported through ad hoc telecommunication systems (e.g. radio). EBS was believed to be the most efficient and effective way to collect and act on the information during the emergency response phase due to its practical and informal method.

During the early recovery phase of the Great East Japan Earthquake, workforce capacity, physical infrastructure and telecommunication infrastructure improved; frequent and routine (e.g. daily reporting) syndromic surveillance began to supplement ongoing EBS at the evacuation shelters where the majority of the displaced persons resided and at the temporary health clinics that were established. Such an intermediate step may be more feasible than attempting to return fully to the pre-existing, baseline indicator-based surveillance system (e.g. routine reporting of notifiable diseases, sentinel surveillance, and laboratory-based surveillance<sup>9</sup>), as a syndromic approach is less dependent on sophisticated medical and laboratory needs which may still be limited in capacity.

During the late recovery phase, when the displaced population has relocated to temporary or semi permanent residences, the concept of an “enhanced” sentinel surveillance system was discussed for diseases or syndromes that are usually followed through sentinel surveillance (e.g. influenza-like illness), with routine but less frequent (e.g. weekly) reporting. With mass

Figure 1. An example of a post-disaster surveillance framework for infectious disease surveillance systems\*



\* The surveillance system is dependent on the current relief/recovery/reconstruction phase, the housing environment of the affected population and the medical facilities present to capture the cases. Please note that this framework is based on preliminary discussions and has not been endorsed or recommended.

gathering conditions no longer present (e.g. high population density, challenges in sanitation/hygiene, poor nutrition, higher stress levels), the risk of infectious disease outbreaks would decline, making reporting on a more routine basis from all sites unnecessary. In addition, with the further recovery of medical, public health and laboratory capacities, implementing a system that existed pre-event would be possible. However, an “enhanced” system with proportionately more sentinel sites than normal from the catchment area/population may be useful given the vulnerability of the displaced and the altered geographic locations and demographics of the populations. In addition, with likely continued migration of persons over time, it is important to monitor trends in infectious diseases in an enhanced manner before returning completely to the baseline sentinel system. Lastly, at the development phase, when the displaced have moved to permanent homes and permanent clinics and hospitals have been re-established, surveillance can return to the baseline system.

The progression of the surveillance system described here, based on both actual occurrences and proposed ideas, can be viewed as the evolution of a surveillance system as it matures after a disaster event. Throughout this process, participants at the WHO meeting noted that surveillance professionals who are familiar with interpretation of surveillance data should be closely involved. As the surveillance system recovers, it was also emphasized that the post-disaster system should function within the existing surveillance system to the extent possible, so as not to become a competing ad hoc system that duplicates or burdens the baseline system. While baseline surveillance systems may be limited in scope and capacity in developing countries and the implementation of a post-disaster system may not greatly burden or conflict with the pre-existing systems, comprehensive surveillance systems often already exist in developed countries.

As different surveillance systems have their advantages and disadvantages and as surveillance systems are designed to meet particular needs at particular moments (e.g. differing priorities of sensitivity, specificity and timeliness), the meeting participants emphasized flexibility with consideration of the following:

1. current infrastructure and capacity of the public health system (e.g. laboratories);

2. current infrastructure and capacity of the medical system (e.g. location and type of facilities used as data sources); and
3. current relief, recovery and reconstruction status of the community (e.g. capturing populations residing in evacuation shelters versus temporary housing versus permanent housing).

Comprehensive risk assessment would assist in making decisions by taking these points into account. Thus, when planning for post-disaster surveillance systems, public health practitioners in developed countries should carefully balance the need to work within the existing system, adjusting the system to the current needs and capacities. As natural disasters will continue to occur, we hope that planning for post disaster surveillance during the “inter-disaster” period will help mitigate the numerous surveillance difficulties that would be faced in times of such occurrences.

### *Conflicts of interest*

None declared.

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# Public health response to the combined Great East Japan Earthquake, tsunami and nuclear power plant accident: perspective from the Ministry of Health, Labour and Welfare of Japan

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## GREAT EAST JAPAN EARTHQUAKE

At 14:46 on 11 March 2011, eastern Japan was struck by the largest earthquake in Japan's recorded history. With the epicentre off the Sanriku coast, the magnitude 9.0 quake triggered a tsunami, which together with the effects of the quake ignited a serious accident at a nuclear power plant. The damage was grave and widespread with the death toll as of 9 November 2011 at 15 835 and the number of missing and unaccounted for at 3664.<sup>1</sup> Immediately after the earthquake, the Japanese Government, local governments in the stricken areas, hospitals, external organizations and volunteers launched coordinated relief and recovery activities. The role of the Ministry of Health, Labour and Welfare (MHLW) in a disaster includes securing medical and nursing care, providing public health services and ensuring the safety of food and water supplies.

## FIRST RESPONSE BY THE MINISTRY OF HEALTH, LABOUR AND WELFARE

As a first response, the Japanese Government prioritized search and rescue and, working closely with local governments in the stricken areas, committed resources to assessing the damages, evacuating residents and providing first aid and relief to victims. However, understanding the medical needs in the affected area in a timely manner was not easy. MHLW set up a Disaster Response Headquarters a few minutes after the earthquake and established local headquarters

in Iwate, Miyagi and Fukushima prefectures on the following day to enhance communication between local and central governments. In the initial stages, from 11 to 22 March, approximately 380 Japan Disaster Medical Assistant Teams (DMATs) were dispatched to provide emergency medical assistance at the local hospitals and support for transporting patients across a wide area; for example, DMATs rescued more than 300 inpatients in hospitals isolated by the tsunami. The opportunities for medical assistance were mostly for chronic diseases, not for wound injuries, probably because most victims were killed by the tsunami. Hospitals and nursing facilities in other regions admitted victims in need; however, coordinating such a large-scale translocation was a challenge, especially for patients who required special care such as dialysis treatment. Almost 80% of hospitals and a third of medical/dental clinics in the three affected prefectures experienced different levels of damages, including total collapse of their facilities. Prolonged blackouts, water outages and fuel shortages also affected the continuity of hospital care. Following assessments of the medical needs of the stricken areas, several medical teams of doctors, nurses and other medical staff; mental health care teams; pharmacists; public health nurses and nutritionists were sent to provide medical and public health assistance to evacuees and backup for damaged hospitals. MHLW also provided medical information and secured medical supplies such as drugs. Additionally, MHLW ensured victims could seek medical care without health insurance cards and waived co-pays.

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## RESPONSE TO THE NUCLEAR POWER PLANT ACCIDENT

The earthquake and the following tsunami caused serious damage to the Tokyo Electric Power Company's Fukushima Daiichi Nuclear Power Plant; a considerable amount of radioactive material was discharged into the environment. Due to the potential effects from the accident at the power plant, many residents living nearby were forced to evacuate. MHLW assisted with the evacuation of about 1700 people from hospitals and nursing homes within a radius of 20 km to 30 km from the power plant where a "stay indoors" instruction was ordered. MHLW also dispatched medical teams to provide contamination screening and to address concerns about radiation exposure among residents. MHLW was primarily responsible for securing food and water safety by establishing a monitoring system for food, setting provisional regulation values of radioactive materials in food in accordance with the Food Sanitation Act, adopting the indices for limits on food and drink ingestion established by the Nuclear Safety Commission of Japan,<sup>2</sup> and regularly inspecting radioactivity levels in tap water to restrict the intake of contaminated water.<sup>3</sup> Several water-supply corporations asked users to refrain from using tap water for babies when the radiation level exceeded the regulation value for a few days in March. Some local governments provided bottled water for babies during that time.

MHLW also issued a leaflet on 7 April to address concerns about the child and maternal health effects of radiation.<sup>4</sup> However, step-by-step long-term efforts to explain the risks of radiological contamination are necessary. The Japanese Government has taken several measures to ensure the safety and security of residents such as radiation monitoring in the affected areas, decontamination of hot spots, health surveillance and monitoring of residents and risk communications on the health impacts of radioactive materials.

## INFORMATION SHARING WITH THE PUBLIC, THE WORLD HEALTH ORGANIZATION (WHO) AND ITS MEMBER STATES

Receiving accurate information on damages, evacuations, medical and logistic needs and supplies is crucial for residents, local governments, concerned

organizations and people across Japan so they can make proper decisions and take appropriate actions. MHLW began issuing a situation report on 11 March, the day the earthquake hit, both in Japanese and English.<sup>5</sup> In addition, MHLW was committed to sharing timely and accurate information on damages and radiation contamination with WHO and its Member States through the International Health Regulations (IHR).<sup>6</sup> MHLW regularly updated the information about radioactive materials, with a particular focus on water and food, on the IHR event information site until 31 May; MHLW also responded to inquiries.

## PREPAREDNESS FOR FUTURE PUBLIC HEALTH EMERGENCY: ADDRESSING A COMBINED DISASTER

The triple combined disaster of an earthquake, tsunami and nuclear power plant accident made the disaster relief operations more complex and difficult. The Basic Disaster Management Plan<sup>7</sup> for Japan included plans for four natural disasters and eight accidental disasters; however, a combined disaster plan was not included. Resources for and knowledge of radiation protection were very limited in those who responded to the natural disaster. On the other hand, expected resources such as electricity and lines of communication in the off-site centres were not available for responding to nuclear emergency. This unprecedented challenge raises new scenarios to be envisioned and prepared for, not only for Japan but also for the international community. MHLW remains committed to sharing the lessons learnt from this new category of emergency with the international community to strengthen global disaster preparedness.

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this crisis and play a role as a member of the international community.

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# Medical response to the Great East Japan Earthquake in Ishinomaki City

Tadashi Ishii\*

**Problem:** The Ishinomaki Red Cross Hospital is the only designated disaster hospital in the Ishinomaki Medical Zone, Japan that was undamaged from the Great East Japan Earthquake in March 2011. The tsunami completely destroyed a large part of the Ishinomaki Medical Zone.

**Context:** The Ishinomaki Red Cross Hospital was designed with the capability to respond to disasters. An instruction manual for responding to disasters had been developed and was exercised through drills.

**Action:** In accordance with the manual, the hospital disaster task force was established. The Ishinomaki Zone Joint Relief Team coordinated medical support from organizations such as physicians associations, dental associations, self-defence forces medical teams, pharmacists associations, the Japanese Red Cross and relief teams from hospitals all over the country. In three days, the joint relief team directly visited all emergency shelters to make an initial assessment and to collect information about the number and state of health of evacuees, provision of food and drinking water and the availability of electricity, water and sewerage.

**Outcome:** Initial assessment revealed that 35 emergency shelters lacked a sufficient food supply and that 100 shelters had unsanitary conditions. The joint relief team provided the Miyagi Prefecture government and the Ishinomaki municipal government with information about emergency shelters that did not have sufficient food supply. As of 30 September, the activities of the joint relief team were completed, and there was no outbreak of communicable diseases in the Ishinomaki Medical Zone. A total of 328 shelters with 46 480 evacuees were managed by the Ishinomaki Zone Joint Relief Team.

**Discussion:** Advanced preparation to quickly establish an initial response system, expertise, and decision-making ability and the ability to get things done are required for disaster response management.

## PROBLEM

Located in Ishinomaki City in Miyagi Prefecture, the Ishinomaki Red Cross Hospital is the only designated disaster hospital in the Ishinomaki Medical Zone consisting of Ishinomaki City, Onagawa-cho and Higashimatsushima City. In addition to emergency rescue, which is the basic mission of the Japanese Red Cross Society, the organization had been given the role of accepting and transporting the sick and injured in the disaster area. The applicable population is 220 000. The headquarters for Japan's Earthquake Research Promotion announced on 12 January 2010 (published only on their website) that there was a 99% probability of an earthquake occurring offshore from Miyagi Prefecture within the next 30 years.<sup>1</sup> The Great East Japan Earthquake struck on Friday, 11 March 2011 at 14:46.

## CONTEXT

In May 2006, because the building of the Ishinomaki Red Cross Hospital was aging, the hospital was moved from the Minato Ward on the coast further inland where the risk of tsunami damage would be minimal. At that time, measures were devised to better prepare the facilities for disasters, including earthquakes. The new hospital was provided with a seismically isolated structure and equipped with a ground heliport in case the elevator ceased to function and prevented access to the heliport on top of the building. The entrance was widened to accommodate a potentially large number of disaster victims, and oxygen outlets were provided at four locations along one wall for patients in need of oxygen.

At the end of 2007, the hospital disaster manual was revised to provide more specific information such as

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the name of the person in charge of each department. Based on the new manual, a tabletop exercise for dealing with a major disaster was conducted in January 2008, and an actual drill was conducted in July of that year. In June 2010, Miyagi Prefecture and Ishinomaki Red Cross Hospital jointly conducted a helicopter training exercise to test the response to a hypothetical disaster in Miyagi Prefecture. The exercise consisted of receiving and transporting simulated patients during a major disaster.

In January 2010, a network council of those in charge of disaster medical care in the Ishinomaki area was established. The council was formed to coordinate the efforts of pertinent institutions such as the fire, public health and police departments, self-defence forces, medical associations and nearby hospitals.

In September 2010, the hospital concluded an agreement of support with the telecommunications company NTT DoCoMo Shop Ishinomaki; Sekisui House, Ltd., a construction company; and the Shisuikai (a community of restaurants and drinking establishments in the city of Ishinomaki). According to the agreement, NTT DoCoMo Shop Ishinomaki would provide telecommunications equipment such as satellite-based mobile telephones, Sekisui House would provide tents, and the Shisuikai would prepare meals in the hospital.

## ACTION

### Initial hospital response according to the manual

The hospital switched to its own backup power generation several seconds after electrical power was interrupted immediately following the earthquake. In accordance with the hospital manual, a hospital disaster task force was immediately established, and a Level 3 emergency was declared. Level 3 is an in-house stipulation, whereby, if a large number of disaster victims are expected, all normal work at the hospital is cancelled and replaced by response to disaster victims. The conditions in the hospital related to the disaster and vital infrastructures were checked in accordance with the manual. Hearing that a tsunami had surged through the streets of Ishinomaki City; that there were thousands of fatalities; and that the city, including the municipal government buildings, was submerged, the operating premise was that the initial reaction function

of the Ishinomaki municipal government would be limited.

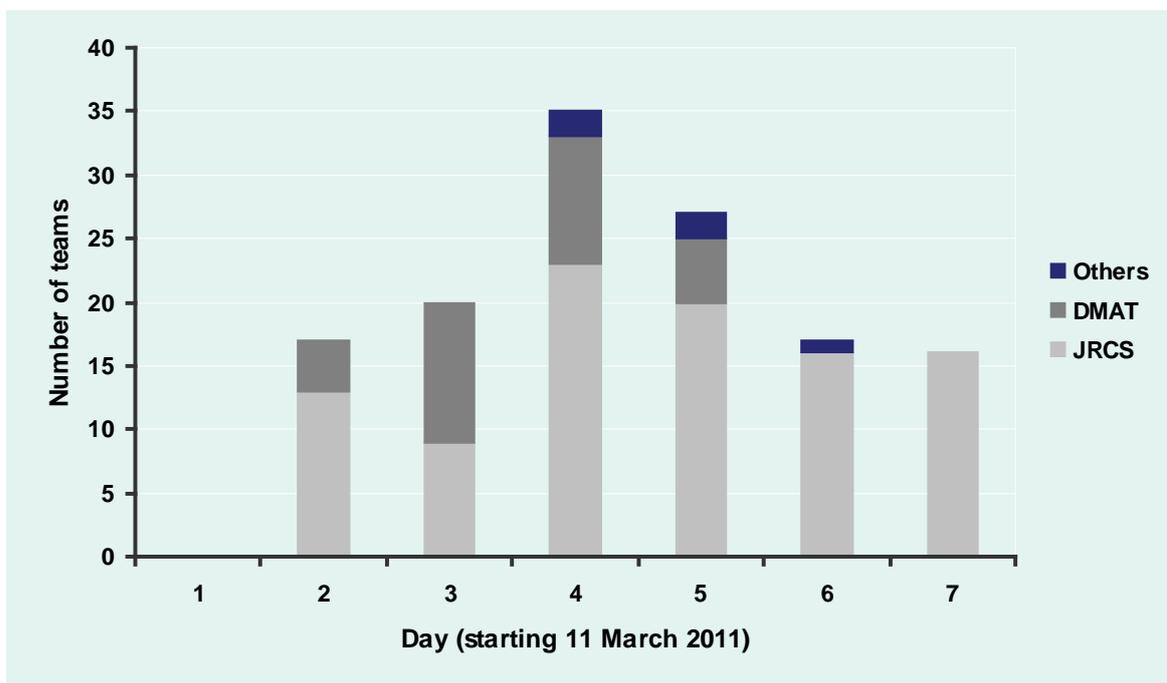
### Establishment of the Ishinomaki Zone Joint Relief Team and coordination of medical support

On 12 March, relief teams from outside the stricken area gathered at the hospital (13 Japanese Red Cross teams and four Disaster Medical Assistance Teams [DMATs]) (**Figure 1**). Because comprehensive disaster information was not initially available, the relief teams were sporadically sent to nearby emergency shelters or isolated areas by request of the self-defence forces and the fire brigade. On 13 March, Ogatsu, the southern portion of Higashimatsushima City and the south beach of Ishinomaki City were completely destroyed, as were Kitakami-cho and Oshika on 15 March. In order to efficiently and effectively utilize medical resources with a limited number of relief teams, on 18 March, it was decided to coordinate various pertinent institutions such as the Miyagi Prefecture government; the Ishinomaki municipal government; the Higashimatsushima municipal government; the Onagawa-cho government; the local medical association; the local dental association; the local pharmacists association; the Tohoku University Hospital; and Northeast, North and Central self-defence forces. The Ishinomaki Zone Joint Relief Team was established on 20 March. The joint relief team was organized so that all teams could work together in a coordinated effort. Teams included physicians associations, dental associations, self-defence forces, medical teams and pharmacists associations. Japanese Red Cross relief teams and relief teams from hospitals all over the country, primarily public hospitals such as prefectural hospitals via the Miyagi Prefecture government, also participated. The joint relief team decided the daily course of action and plotted the long-term course for future strategy by consulting with 22 experts from across Japan with a wealth of experience in disaster medical care and with knowledge of organization management.

### Assessment and support of emergency shelters

On 16 March, the water receded from the areas surrounding the government offices, making access possible, and a list of emergency shelters was received from the municipal government. There were about 300 emergency shelters in Ishinomaki City, Higashimatsushima City and Onagawa-cho. The

Figure 1. Relief teams dispatched in Ishinomaki in the first week of the response following the Great East Japan Earthquake



DMAT - Disaster Medical Assistant Team; JRCS - Japanese Red Cross Society

list gave the name of the shelter and the number of evacuees but did not provide details about the conditions at the shelters. Because DMATs’ activities were limited to 48 hours, they withdrew on 16 March, leaving only 16 Japanese Red Cross relief teams on hand on 17 March (3 more teams than on 12 March) (Figure 1). In order to get the most out of such limited medical resources, the relief teams split up and directly visited all emergency shelters to make initial assessments. After receiving the assessments, the Ishinomaki Zone Joint Relief Team task force determined the course of action for each relief team.

In addition to the number and state of health of evacuees (fever, cough, diarrhoea, vomiting, influenza, respiratory problems, etc.), the initial assessment contained information concerning provision of food and drinking water, availability of electricity and water/sewerage, access to means of keeping warm such as blankets and heaters and sanitation of toilet facilities. The relief teams collected this information from the emergency shelters each day, thus enabling the proper measures to be taken in coordination with local governments to the maximum degree possible. The assessment forms were designed to evaluate the 300 different shelters in

order to better aggregate their information. The shelters were graded using a four-tier coding system (excellent, good, bad, very bad). The grading was carried out by each relief team. It was necessary to collect information as quickly as possible, so the criteria for neutral and negative ratings were omitted from the manual to save time, leaving the subjective judgment to those in the field.

## OUTCOMES

### Initial hospital response according to the manual

All patients and employees in the hospital were unharmed. Physical damage to the hospital was minimal; with the exception of the gas supply, everything had escaped damage including testing equipment. There was a three-day supply of water including general service water. There was also a three-day supply of food for patients.

The triage area was set up as stipulated by the manual at 15:43, roughly an hour after the earthquake struck. Sekisui House came to the hospital immediately and set up tents in front of the entrance. Immediately following the earthquake, NTT DoCoMo

Shop Ishinomaki provided ten mobile telephones with priority connections and two satellite-based mobile telephones (one of which was provided prior to the disaster). Conventional mobile telephones, land lines, e-mail and Internet service became unavailable approximately two hours following the disaster. Until NTT DoCoMo Shop Ishinomaki set up a base station nearby on 17 March, the only telecommunications available were satellite-based mobile telephone and emergency wireless telecommunications.

The Ishinomaki Red Cross Hospital treated 3938 patients within the first seven days after the disaster. Forty-eight hours after the disaster, the hospital treated 115 patients, 26.1% of whom suffered from hypothermia, which was the most common ailment.

### **Establishment of the Ishinomaki Zone Joint Relief Team and coordination of medical support**

Revisions to mobilization criteria for the Japanese Red Cross relief teams in 2009 gave the directors of hospitals affiliated with relief teams the authority to send teams to the stricken area, enabling local Japanese Red Cross relief teams to go into action quickly. Japanese Red Cross and non-affiliated relief teams from all over the country that had gathered in the Ishinomaki area were registered for participation in the joint relief team beginning 20 March. The number of teams increased by as many as 59 teams on a single day on 26 March (100 physicians). It was truly an “all Japan” team. By 30 September, some 3633 relief teams participated in the joint relief team; the Japanese Red Cross relief team consisted of 1078 teams, and the remaining two-thirds were other than Japanese Red Cross.

Each relief team was active an average of four to five days. With this many relief teams, several teams were always coming and going. The cities of Ishinomaki, Higashimatsushima and Onagawa-cho were divided into 14 areas based on the distribution of emergency shelters. Relief teams were allocated to each area as needed; one of the teams was designated as the managing team to decide the next day’s activities in the area, thus providing the teams with autonomy of activities. A “line” was established whereby multiple teams were coordinated at the site into team 1, team 2, team 3 and so forth in order to have participating

relief teams continuously performing activities. One line operated as one team, not simultaneously as individual teams. The line teams were given instructions and then deployed to affected areas by a co-ordinating headquarters which was set up at the Ishinomaki Red Cross Hospital on 28 March. Elsewhere, general meetings were held each day by the task force to determine the needs of each area, get opinions, coordinate activities and decide the overall course of activities. In addition to daily assessment data and meetings, reports on each area were heard, emergency medical needs were assessed and the number of lines required for each area was revised each day. Medical needs for emergency shelters gradually decreased as infrastructure such as water and sewerage was restored and private-practice physicians began working again. The activities of the joint relief team were completed by the end of September 2011.

A total of 328 shelters with 46 480 evacuees were managed by the Ishinomaki Zone Joint Relief Team, and 53 696 people were seen at evacuation centres during the relief teams’ visits until activities ended.

The fire department dispatched resident liaisons to emergency centres and heliports to take charge of ambulances and helicopter control. The police department provided public security information. The Ishinomaki municipal government sent representatives to the relief team meetings to work with them. The self-defence forces took the lead in patrolling areas that were dangerous to access and provided helicopters to cover isolated islands. Some 2334 pharmacists from the Miyagi Prefecture Pharmacists Association provided assistance. The emergency department of the hospital accepted patients from emergency shelters and first aid stations without restriction and required no letter of referral.

### **Assessment and support of emergency shelters**

Initial assessments started on 17 March and were completed in three days. During this time, there were 93 emergency transports from emergency shelters (overall total of 313) in Ishinomaki City, Higashimatsushima City and Onagawa-cho, which accounted for 29.7% of the total number of transports. Assessments of emergency shelters were subsequently updated each time the rounds were made, and the data were recorded and kept in chronological order to get a good understanding of the

Figure 2. Wrap-type toilet used in evacuation centres



variation in the number of patients with symptoms and various tendencies. Initial assessments revealed that 35 emergency shelters lacked a sufficient food supply and that 100 shelters were contaminated by sludge and dust and had unsanitary conditions such as toilets that could not flush because of damage to the water and sewerage systems.

The Miyagi Prefecture government and the Ishinomaki municipal government was provided with information about insufficient food supplies in emergency shelters, and the Miyagi Prefecture government addressed the problem.

The joint relief task force enlisted the cooperation of contractors to provide 90 wrap-type portable toilets that were stored in Higashimatsushima City and distributed to emergency shelters in the Ishinomaki area that needed them. These toilets, primarily for the elderly who have a hard time getting about, can be set indoors. The western style, wrap-type toilets (waste is solidified by chemicals for sanitary disposal) put minimal stress on the knees (Figure 2).

Two contamination-control certified nurses at the hospital visited each emergency shelter where conditions were deemed unsanitary to provide guidance to improve sanitation. Assessment data of the number of patients with symptoms were updated and monitored daily, and contamination-control certified nurses were sent to the shelters where there was an increase in the number of patients with symptoms. Comments of the contamination-control certified nurses such as it being important not only to sterilize the fingers with quick drying

Figure 3. Water supply system



alcohol disinfectant but to wash with running water were applied. With the total cooperation of the international relief department of the Japanese Red Cross Medical Treatment Center, simple hand-washing facilities were set up at 11 shelters selected from assessment results. These consisted of cloth storage tanks filled with water and connected to a pipe with a spigot (Figure 3). As of 30 September, there had been no outbreak of contamination or proliferation of communicable disease in the Ishinomaki medical district.

## DISCUSSION

A detailed manual that outlines initial response procedures inside the hospital in specific terms was helpful and was clearly connected with the comparatively smooth initial response. The manual included such information as the person and procedure by which critical infrastructure and damage would be checked following the disaster, the chain-of-command structure and contact system, staff actions, each department's responsibilities, where and how much of the necessary materials would be stored, how and by whom they would be deployed, training based on the manual, disaster assistance agreements and enhanced linkage among facilities and pertinent institutions for preservation of hardware and critical infrastructure. These guidelines, however, are only effective for the initial impact of the disaster. It is difficult to foresee all the circumstances that may occur subsequently, and it is therefore impossible to create a manual that covers the entire response to a disaster. Although the details will be omitted here, application issues continued subsequent to the initial impact. As difficulties appeared

one after the other, an optimal plan was devised on the spot and adjustments were made as problems occurred.

Coordination of medical activities and support for emergency shelters required the cooperation of all medical institutions, Tohoku University, the administration (Miyagi Prefecture government, Ishinomaki municipal government, Higashimatsushima municipal government and Onagawa-cho government), the self-defence forces, the fire department, the police department, businesses and so forth. In order to maintain the logistics function of the Ishinomaki Zone Joint Relief Team task force, which was handling an overwhelming workload, the Japanese Red Cross Society provided the hospital with significant support, dispatching some 1173 people to supplement the task force staff and some 3929 medical personnel between 12 March and 14 August 2011.

There was significant collaboration with the private sector providing support to emergency shelters. In addition to the previously mentioned companies, a huge amount of support was provided by Google, which created software that compiled information about the emergency shelters and the number of people examined based on assessment data. AEON provided medical treatment support buses to visit emergency shelters and first-aid stations, and Nihon Kohden provided Automated External Defibrillators and various test kits and equipment. Other companies such as Medical Expert, Seimens, Shigadry With Earth, and M-Cube and Associates provided other simple test equipment, mats, beds and so forth.

Requirements for disaster response management are: (1) advanced preparation to quickly establish an initial response system; (2) expertise and decision-making ability; (3) willingness to stay the course; and (4) the ability to get things done. Achieving (1) above, requires knowledge of the type of damage expected in major disasters, evaluation of responses to past disasters, a realistic manual that hypothesizes the worst possible scenario, training and collaboration with pertinent institutions on a routine basis. Often, individuals do not have enough power to act on their own, so (2) requires the help of experts, superiors, staff and counterparts at pertinent institutions. Number (3) means not being self limiting, not compromising and recognizing that the usual logic does not always prevail in times of emergency. Managers must work tirelessly to inspire trust in others to insure that decisions are accepted and implemented.

Like (2), number (4) suggests that one person cannot do everything, and it is necessary to get a consensus with affiliated and other organizations and create a system of support and collaboration.

There were several problems in standardizing the activities of the Ishinomaki Zone Joint Relief Team, which could possibly become a model case for future major disaster relief activities.

1. The relief team task force was established in a Japanese Red Cross hospital, allowing for an enormous amount of clerical support to maintain a huge clerical processing capacity. A hospital other than a Red Cross hospital that becomes the headquarters for a major disaster in the future may not be able to provide equivalent functions. Some public means of training clerical staff will probably be necessary.
2. Collaboration among the 22 members of the task force relied somewhat on personal connections. Developing a means to standardize establishment of integrated collaboration that does not rely on personal connections requires consideration.
3. Accurate damage information was not centralized and shared quickly, limiting the self-defence forces' rescue efforts. Review of the information conveyance system on the national level is highly recommended.
4. Because management and/or understanding of the situation in each area depended on the chain of command for each area, there were differences in perception of the situation in different areas. If the task force had monitored the affected sites more closely, they would have been able to address this problem. Also, because the activities of the chain of command were not standardized, there was disparity in management of each area. An area management manual must be prepared without delay.
5. Collaboration with DMATs did not proceed smoothly. Because DMATs respond to trauma in the initial stage of a disaster, they were not equipped to respond to a disaster

demanding long term rescue activities, whereby the majority of the patients were suffering from endogenous disease. The DMAT activities outline needs to be reviewed.

### *Conflicts of interest*

None declared.

### *Funding:*

None.

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# Health care response to the tsunami in Taro District, Miyako City, Iwate Prefecture

Hitoshi Kuroda\*

**Problem:** In the Taro District (population: 4434), the great tsunami of 11 March 2011 destroyed the central region including the clinic, the sole medical facility (one physician, 13 nurses and other staff) in the district, and many citizens were forced to live in evacuation centres.

**Context:** The Taro District experienced massive damage during the tsunamis of 1896 and 1933. Since then countermeasures to tsunamis have been implemented. The great tsunami on 11 March 2011 caused catastrophic damage to the low-lying areas where approximately 2500 people lived; 1609 buildings were completely destroyed, and approximately 200 people died or were missing across the district.

**Action:** The Taro National Health Insurance Clinic, the sole medical facility in the Taro District, was required to play a central role in a variety of activities to care for residents in severely affected areas. First of all, evacuees needed to move to neighbouring hospitals or safer evacuation centres because lifeline services were cut off to the first evacuation centre. Then, the clinic staff worked in a temporary clinic; they visited the evacuation centres to assess the public health and medical situation, cared for wounded residents, managed infection control and encouraged a normal lifestyle where possible. Additional medical, pharmaceutical and logistical support was received from outside the district.

**Outcome:** There was no noticeably severe damage to health, although there was manifestation of and deterioration in lifestyle-related diseases (e.g. diabetes, hypertension, obesity). Health care activities gradually returned to their pre-disaster levels. At the end of July 2011, the evacuation centres closed, and all evacuees moved to temporary accommodations.

**Discussion:** Isolated rural health practitioners were required to be involved in a wide variety of activities related to the disaster in addition to their routine work: e.g. preventive health (public health and safety activities), routine medical care, acute medical care, psychological care, post-mortems and recovery of medical facilities. Although the whole health care system returned to near-normal six months after the disaster, it is important to plan how to develop more resilient medical systems to respond to disasters, especially in rural areas. This article describes my experience and lessons learnt in responding to this disaster.

## PROBLEM

Compared to the rest of Japan, the coastal region of Iwate Prefecture has a shortage of medical services.<sup>1</sup> The Taro District (**Figure 1**), Miyako City, Iwate Prefecture is no exception. The sole medical facility in the district was for some time the Taro Municipal Hospital (established in 1948); the district hospital was restructured into a municipal clinic with inpatient facilities (19 beds) in 2010. Since 2007, I have been the only doctor in the district. In addition, there are 13 nurses, one clinical laboratory technician and one radiation technician in the clinic. Before the earthquake, there was a daily average of 57.5 outpatients and 9.6 inpatients; home visits were made to approximately 30 people per month (as of FY 2009).<sup>2</sup>

As the only doctor, I was responsible for (1) primary/internal medical care for outpatients/

inpatients; (2) public health activities; (3) school-based medical care at day care centres, elementary schools, junior high schools, high schools; (4) visiting medical care at elder homes; (5) various immunizations; (6) health checkups and (7) health seminars.

The tsunami that struck on 11 March 2011 destroyed much of the central region including the clinic (**Figure 2**). Many local citizens were forced to move to the evacuation zones due to the extent of the destruction in the affected area (**Figure 3**).

In the context of a shortage of medical services and the destruction of the only medical facility, this paper describes the lessons learnt on the evacuation, maintenance of people's health, continuation of medical activities and support received from inside and outside the district.

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Figure 1. **Map of Taro District\***



\* Taro District, Miyako City is located near the centre of the coastal region of Iwate Prefecture, facing the Pacific Ocean. Shimonoseki City, the most western of Honsyu island, dispatched health care workers to Miyako City, the most eastern city. Ryukyu National Hospital stands on Okinawa.

Figure 2. **Photograph of tsunami\***



\* A giant wave overcame the 10-metre high embankment and destroyed the central region including the clinic on 11 March 2011. Our clinic is seen in the left of this photo (marked with an arrow), which was taken from the 3rd floor of a building overlooking the north-west direction. Reproduced with permissions from Mr M Hatakeyama..

Figure 3. Taro District clinic after the tsunami\*



\* By 12 November 2011, almost all destroyed buildings and rubble have been removed. Our clinic is seen in the middle of this photo (marked with an arrow), which was taken by the author from a 10-metre high countermeasure embankment.

## CONTEXT

The Taro District, Miyako City, Iwate Prefecture encompasses an area of 101 km<sup>2</sup> with a population of 4434 people (as of 1 March 2011).<sup>3</sup> It is located near the centre of the coastal region of the Iwate Prefecture; its main industries are fishing and tourism, and it is characterized by a declining population, falling birth rates and an aging population.<sup>3</sup>

The Taro District experienced massive damage in the tsunami of 1896 (wave height: 15 m; fatalities: 1859 people; survivors: 36 people) and that of 1933 (wave height: 10 m; fatalities: 911 people; survivors: 1828 people).<sup>4,5</sup> Countermeasures against tsunamis have since been implemented including setting up of an embankment with a total length of 2.4 km and a height of 10 m (Figure 3), flood protection forests, remote control floodgates, deployment of illuminating lights using solar panels, deployment of public address radio networks for disaster control to each household, tsunami observation systems, annual tsunami evacuation drills and educational activities undertaken by people who had experienced the tsunami of 1933.<sup>4,5</sup> In March 2003, a municipal proclamation on tsunami disaster control was announced by the authorities.

On 11 March 2011, the great tsunami, following a magnitude 9.0 earthquake, struck the Pacific coast of eastern Japan. Approximately 20 000 people were dead or missing, and about 120 000 buildings completely destroyed.<sup>6</sup> Approximately 330 000 people remained refugees as of November 2011.<sup>7</sup> In the Taro District, the waves reached over 30 m in height.<sup>8</sup> Taro was one of the regions with the highest waves and the most damage.

The 11 March 2011 tsunami and earthquake overwhelmed the engineering countermeasures. Most of the low-lying areas (approximately 2500 residents) were affected by the tsunami and 1609 buildings were completely destroyed. Approximately 200 people were dead or missing across the Taro District.

## ACTIONS

### Emergency evaluation and setting up medical functions

The Taro National Health Insurance Clinic was completely destroyed by the tsunami, but all five inpatients and staff in the clinic were successfully evacuated to a hill 500 m from the clinic. Within a day, we set up a

temporary outpatient clinic in the General Affairs Office, which is located in a less affected area. We set up inpatient care functions in a meeting room of the nursing care facility on the following day.

In the centre of the town, which was severely damaged, approximately 800 residents evacuated to the three temporary evacuation facilities. The evacuation facilities were surrounded by rubble, tsunami seawater and a fire on the night of 11 March. I started triage on the morning of 12 March to identify the evacuees with health problems who required nursing care. Almost all the vulnerable people (approximately 20 in number) with health problems were transported to nearby hospitals and nursing care facilities on 12 March. In addition, I undertook post-mortems in the district at the request of the local police force.

### Procurement and prescription of medicine

The majority of evacuees did not have their regular prescriptions with them in the evacuation centres and needed them as quickly as possible. However, the clinic, which was the only pharmacy in the district, was destroyed by the tsunami. Evacuees including clinic staff were left with no lines of communication.

On 12 March, the nurses at the clinic went through the wreckage of the clinic and salvaged important medical products (antihypertensives, aspirin, acid suppressions, antimicrobials, antipyretic-analgesics, anti-anxiety agents and laxatives). Since the printed medical records had all been lost in the disaster, filling prescriptions for regular medicines was done by my memory following requests from patients. A computer server that stored prescription details at the clinic was later recovered.

On 15 March, the clinic was moved to a location with better access for delivery of miscellaneous medicines. From 25 March, pharmacists from outside the district helped to manage medicines. On 4 July, external prescription dispensing began at a pharmacy.

### Health management in evacuation centres

Medical and nursing staff were concerned that infection<sup>9</sup> and thromboembolism<sup>10</sup> would become problems for the evacuees and implemented prevention measures such as hand-washing, gargling, cleaning, periodic ventilation, encouragement of “radio gymnastic exercises” (a

common national exercise in Japan) and drinking ample water.

Neighbourhood resident groups, who were not affected by tsunami, volunteered to serve rice balls beginning on the first day of the disaster. Safe drinking-water was available, including stocked bottled water, at the evacuation centres.

My clinic staff visited several evacuation centres to assess the situation, respond to suffering people and manage contagious diseases. As insomnia, constipation and acute upper respiratory tract inflammations had become significant issues among the evacuees, staff at the evacuation centres prescribed anti-anxiety agents, laxatives and cold remedies.

On 1 April, 800 people from eight evacuation centres in the district moved to the gymnasium of the Greenpia Hotel, which had not been damaged by the tsunami. On 2 April, families with family members who required nursing care were moved to guest rooms in the hotel (total 250 people). Evacuation facilities at the Greenpia gymnasium were closed on 20 June when temporary accommodation became available.

In the district prior to the disaster, people were concerned about their blood pressure and many measured their blood pressure at home. Therefore automated sphygmomanometers were installed at the Greenpia evacuation centre. Evacuees with high blood pressure presented for health consultation at the clinic for blood pressure management.

### External medical and health care support and necessary materials procurement

From 14 March to 26 August, one to three doctors aided the medical management efforts of our clinic per my instructions: (1) one doctor was originally from this area (14 March to 27 March); and (2) physicians belonging to organizations such as Médecins Sans Frontières (MSF) (21 March to 27 May), the Japanese Association of Cardiovascular Intervention and Therapeutics and the Japanese Circulation Society assisted on a rotational basis (18 April to 26 August).

Health care workers from Shimonoseki (Figure 1) were dispatched from 1 April to the end of

Table 1. Principal diseases and number of patients from day 10 to day 70 after the disasters in Taro\*

Principal diseases	Number of patients with diseases						
	Day 10–20	Day 21–30	Day 31–40	Day 41–50	Day 51–60	Day 61–70	Day 10–70
Upper respiratory tract diseases	199	107	100	56	53	71	586
Lower respiratory tract diseases	0	1	0	0	0	0	1
Hypertension	69	207	353	211	73	193	1106
Gastritis	3	69	168	109	28	82	459
Diabetes	9	29	58	35	12	31	174
Musculoskeletal diseases	7	45	175	93	43	96	459
Trauma	17	2	3	5	7	6	40
Total number of patients checked	304	459	857	509	216	479	2825

\* The day of the disaster is day 0 (e.g. day 10 is 21 March). After day 21 (1 April), almost all evacuees lived in the large evacuation centre. One patient might contract several diseases.

July. They undertook the health management of evacuees at the evacuation centres and temporary housing facilities. Psychological care was provided by other teams.

Many medical goods requested by the clinic were sent from within and outside the country. In particular, MSF donated medical products, equipment and resources (logisticians and an architect) for the new temporary clinic.

By 19 April, post-mortems had been carried out on 140 bodies in the Taro District. The identities of all the bodies found were confirmed, except one person who died in a fire. I undertook post-mortems on 100 of the 140 bodies and considered the cause of death in almost all cases to be from crushing and/or drowning.

### Health management in evacuation centres

No gastrointestinal or respiratory infection clusters were observed while the evacuation centres were open, nor were there any reports of thromboembolism. No emergency appeals were made to the evacuation centres after the medical evaluation on 13 May.

**Table 1** identifies the major diseases that our clinic and the MSF medical team detected from day 10 to day 70 after the earthquake. Data from day 10 (21 March) to day 20 (31 March) reflected the number of cases treated by the MSF medical team who visited each evacuation centre. From day 21 (1 April) the number of

cases who visited the temporary clinic at Greenpia is shown.

After people transferred from the small evacuation centres to larger ones with higher ceilings on 1 April, the incidence of sporadic upper respiratory tract diseases cases appeared to fall (**Table 1**). However, it appeared that several lifestyle-related diseases (e.g. hypertension, diabetes) cases increased after transfer to the larger evacuation centre.

The situation remained stable as more people moved into temporary housing in mid-May. By the end of July the evacuation centres closed and all evacuees (an estimated total of 1200 people) had moved to temporary houses. Following this, health management could be undertaken based on the personal responsibility of individuals, as it had been before the disaster.

### Psychological care

From late March to mid-May 2011, 130 support personnel, more than 80% of the total, received psychological interviews, which contributed to the psychological stability of those individuals. Following this, there were continued consultations with persons wishing to have them and continuous management of at-risk persons.

There were reports of suicides among staff at the City Office at the nearby disaster area, but in the Taro District there were no such instances. As of

November 2011 there had been no cases of attempted suicide or deaths of people living alone, but with many people having emotional trauma, continuing psychological care is being undertaken.

## DISCUSSION

As the only physician in the sole municipal health facility in a rural area under disaster setting, I performed: (1) safe evacuation; (2) disease prevention activities in evacuation centres; (3) psychosocial care for evacuees and relief workers; (4) setting up a temporary clinic, including procurement of medical equipment; (5) medical care at evacuation centres/temporary clinics; (6) staff management, including medical/mental care; (7) liaison with local government and external organizations; and (8) post-mortems. I have described my disaster-related experiences to highlight three relevant factors from World Health Organization documents regarding disaster preparedness and response:<sup>11</sup> disaster-resilient health facilities, community capacity and advocacy/awareness.

### Disaster-hit area with limited medical care capacity

In Japan the official average number of physicians is 22.5 per 10 000 people, while in Iwate Prefecture it is 19.2 and in Miyako City it is 12.0.<sup>1</sup> Our area has fewer physicians compared with Japan's average, and I am the only physician working with a population of 4434 in the Taro District. Limited medical capacity in a rural area had both advantages and disadvantages in the disaster scenario.

The staff of the clinic knew all the patients and their families very well. This made it easier to maintain relationships with patients and to respond promptly to their needs (e.g. triage, emergency prescription without medical records). This close relationship was also helpful for continuous medical care and preventative measures to be carried out in the evacuation phase.

The disadvantage of limited medical capacity is that staff can become overwhelmed as a result of the sudden increased workload when they themselves are also victims of disaster. There was a clear need for backup medical support. Management of medical products and goods and communication with the district government or media was time consuming given the limited capacity.

Maintenance of health and medical activities will not occur through medical personnel alone, but also requires mutual aid between citizens, officers, logisticians and the cooperation of people.

Backup systems for medical charts or prescription histories which are resilient to massive damage are very important to maintain continuity of medical care. We were able to recover partial information that was stored in a non-affected computer server. A backup system should be part of a package of disaster-resilient medical information technology systems in the future. In addition, clinics should be located away from tsunami areas, balancing location with the convenience of patients.

Various medical organizations came to inspect and evaluate the disaster zone after the earthquake. It would perhaps have been better if a disaster support personnel dispatch centre had been set up immediately to coordinate the deployment of support personnel. In addition, the medical teams from outside the district were not familiar with the local medical care. External support staff should be briefed on the local situation in advance of providing medical support. Nonetheless, the support personnel who were active in the district for this event had a valuable learning experience and can contribute expertise in responding to future disasters.

### Community cooperation

Since I started working in Taro 10 years ago, our clinic has emphasized the importance of blood pressure control given the high prevalence of hypertension in the local population, and we have been working to implement automatic blood pressure measurement at home. In the evacuation centres, evacuees frequently used the automated sphygmomanometers installed. Evacuees with high blood pressure came for health consultations or attended the clinic; blood pressure management thus proved to be a springboard for enabling further health management.

It is also believed that the active participation of evacuees in radio gymnastic exercises was one of the preventive measures against disease including thromboembolism. People cooperated with infection prevention measures and infectious diseases did not become prevalent. This illustrated the mutual trust that existed between health care personnel and citizens

After people left the larger evacuation centre, the incidence of upper respiratory tract diseases appeared to decline. Given that most respiratory tract infections are spread via droplet transmission, additional space in the temporary accommodation may have reduced the opportunity for transmission and contributed to this decline. In addition, the diffusion and dilution of the pathogens would likely be more dispersed as result of better humidity and ventilation management in the temporary accommodation compared to the evacuation centres. Furthermore, the fact that the evacuees were 10 km from the disaster zone meant that the frequency of contact with rubble and polluted sludge decreased.

It appeared that the number of hypertension and diabetes patients increased after people relocated to Greenpia. One possible reason for this increase was that people visited the clinic for prescriptions of routine medications, including those used to treat hypertension and diabetes. In addition, during this period, more people received routine medical care than before and so existing diseases were more often identified. Stress and imbalance of calorie intake and exercise may worsen these diseases.

At the evacuation centre, it is possible that the manifestation of and/or deterioration in lifestyle-related diseases such as diabetes, hypertension and obesity, was the result of diet and lack of exercise. Meals were provided by the government and were not specific to individual needs. Insufficient exercise during day-to-day life, which might have been exacerbated by most people losing their jobs, also may have been a factor. In addition to addressing infection control in evacuation centres, it may be beneficial to manage the diet and exercise routines of evacuees to maintain health condition.

The neighbourhood associations that existed before the disaster should be re-established as soon as possible to ensure a mutual assistance framework among citizens (e.g. encouraging appropriate exercise or food intake, voluntary supportive mechanisms for the elderly).

There are many populated regions in the world where earthquakes can occur and disasters are likely to result. It is crucial to think carefully about what should be done when disaster strikes. Evacuation drills are important as are evaluating post-disaster needs of securing lifeline services and means of communication,

the maintenance of people's day-to-day lives in the evacuation centres, the assessment of the whereabouts of citizens and the means for the continued provision of medical services.

### Advocacy and awareness

It is believed that approximately 30 to 40 minutes passed between the earthquake and the tsunami. There were few survivors of the tsunami in the Taro District.

I am proud to have contributed to post-mortems as an important process of grief care for family members of the deceased. However, I want to emphasize again the importance of immediate evacuation after such an earthquake to limit the number of tsunami-related deaths.

### Limitations

This report is a descriptive study with the inherent limitations based on personal experience. However, I hope that this experience will be used for disaster-resilient health system development.

### Conflicts of interest

None declared.

### Funding

None.

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# Impact of the Great East Japan Earthquake and tsunami on health, medical care and public health systems in Iwate Prefecture, Japan, 2011

Masaru Nohara\*

**Problem:** The Great East Japan Earthquake was one of the largest earthquakes ever recorded in global history. The damage was spread over a wide area, with the worst-hit areas being Iwate, Miyagi and Fukushima prefectures. In this paper we report on the damage and the impact of the damage to describe the health consequences among disaster victims in Iwate Prefecture.

**Context:** In Iwate Prefecture the tsunami claimed 4659 lives, with 1633 people missing. In addition to electricity, water and gas being cut off following the disaster, communication functions were paralysed and there was a lack of gasoline.

**Action:** Medical and public health teams from Iwate Prefecture and around the country, including many different specialists, engaged in a variety of public health activities mainly at evacuation centres, including medical and mental health care and activities to prevent infectious diseases.

**Outcome:** Given the many fatalities, there were relatively few patients who required medical treatment for major injuries. However, there were significant medical needs in the subacute and chronic phases of care in evacuation centres, with great demand for medical treatment and public health assistance, measures to counteract infection and mental health care.

**Discussion:** By referring to past experiences of national and international large-scale disasters, it was possible to respond effectively to the health-related challenges. However, there are still challenges concerning how to share information and coordinate overall activities among multiple public health response teams. Further examination will be required to ensure better preparedness in response to future disasters.

## PROBLEM

The Great East Japan Earthquake struck Japan on 11 March 2011, with an epicentre off the Sanriku coast (latitude 38°6.2', longitude 142°51.6', depth 24 km).<sup>1</sup> It was one of the largest earthquakes ever recorded in global history (magnitude 9.0) and was compounded by the further disasters of an enormous tsunami, fires and an accident at a nuclear power station in Fukushima Prefecture. The damage was spread over a wide area, with the worst-hit areas being Iwate, Miyagi and Fukushima prefectures. While the impact of the damage from the earthquake in terms of human cost and destroyed structures was relatively light, the tsunami almost entirely obliterated the coastal regions (**Figure 1**).

In this paper we report on the damage and its impact to describe the health consequences among

disaster victims in Iwate Prefecture who were subject to damage from the tsunami. We also detail the public health and sanitation activities that were implemented by the Iwate prefectural government and various other health-related organizations.

## CONTEXT

### Overview of the disaster-affected areas

Although the severity of the impact of the earthquake itself varied from region to region, it affected an extremely large area of eastern Japan. The subsequent tsunami brought about catastrophic damage to the three prefectures of Fukushima, Miyagi and Iwate and in particular the area from the southern part of Miyagi Prefecture to the coastal regions of Iwate Prefecture. This is because of the geographical characteristics of

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Figure 1. Rikuzen-takata City before and after the disaster\*



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the region which has a series of peninsulas and deep bays and inlets that are referred to in geographical terms as a “ria” coast. The structure of this coastline means that when a tsunami strikes it tends to increase greatly in height once it reaches the coast. Due to the “ria” coast characteristics of the Iwate Prefecture coastline, at its highest point the tsunami reached a height of approximately 38 m, and damage was spread along a 600 km stretch of the coast.

Due to these geographical characteristics, the Tohoku region has had previous experience with large-scale tsunami damage, and it was perhaps the best-prepared region in the world for tsunami countermeasures, including the presence of large-scale coastal levees and breakwaters and the implementation of evacuation training for residents. However, this massive natural disaster, said to be a once-in-a-thousand-year event, inflicted a tremendous human cost in this region.

Iwate Prefecture is situated in the north-east of Honshu, the main island of Japan, and is the second largest prefecture after northernmost Hokkaido, accounting for 4% of Japan’s total land mass (Figure 2). It has a population of 1.33 million. The people of the coastal regions of Iwate that were hardest hit are predominantly engaged in the fisheries industry. The proportion of the population over 65 years of age stands at 30%, greater than the national average of 20%, with the aging of the population continuing to progress. In comparison to other regions the Iwate Prefecture has relatively few human resources

in terms of health and welfare practitioners, including doctors.<sup>2,3</sup>

### Casualties and missing

As of 21 September 2011, six months after the disaster struck, the official number of victims in Japan was 15 799 dead and 4041 missing.<sup>4</sup> The fatalities were approximately three times the number claimed by the Great Hanshin-Awaji Earthquake (1995), which was the largest natural disaster in recent times until 2011. The number of casualties in Iwate Prefecture alone stands at 4659 dead and 1633 missing.<sup>5</sup>

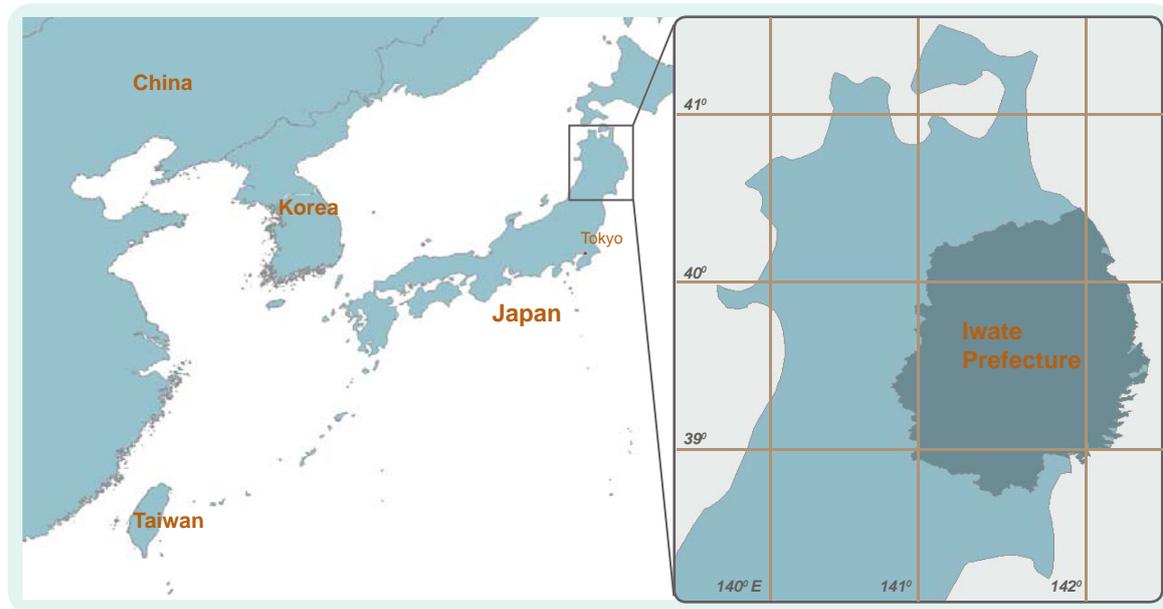
### Impact of damage

#### Utilities

Electricity, water and gas were all cut off in the disaster. Although these were restored in two or three days to inland areas that escaped tsunami damage, in the coastal areas it took approximately one-and-a-half months for electricity to be restored and four months for the water supply.

All normal means of communication were also lost in the disaster and in the initial aftermath (approximately two weeks) only satellite mobile phones functioned (and these did not always work effectively). It was for this reason that in the initial post-disaster period local governments were severely restricted in their attempt to assess and evaluate the status of the damage.

Figure 2. Map of Iwate Prefecture



### *Transportation*

There was no public transportation in the coastal areas. Although most of the local residents had used vehicles to go about their daily lives, many of these were washed away in the tsunami. In addition, roads were damaged or blocked, meaning that access to and travel within the disaster regions were very difficult.

The inland cities that were expected to provide backup functions in times of emergency almost exclusively relied on vehicular transportation for assistance activities (excluding air transport); following the disaster, travel between the inland and the coast took between two and three hours. In addition, there was an initial lack of gasoline, and health and welfare workers experienced difficulties in procuring gasoline for their vehicles to go about their health and medical support activities.

### *Health care facilities*

In the coastal areas of Iwate Prefecture, three hospitals were entirely destroyed by the tsunami, and approximately half of all clinics and other health facilities were damaged in some way. Many local government personnel, including public health personnel, were affected by the disaster also, resulting in local government functions, which are expected to play a central role in post-disaster response, being entirely paralysed or severely restricted.

## **ACTION**

### **Medical activities**

In the coastal areas of Iwate Prefecture, there are four hospitals designated as disaster base hospitals that are expected to perform a central role in the provision of medical care following a disaster. Fortunately, these hospitals escaped major damage and were able to provide emergency medical care following the disaster, including initial patient triage, emergency response and transportation of patients to inland areas.

A total of 128 Disaster Medical Assistance Teams (DMATs), consisting of one to two physicians, one to two nurses and one administrator, came to the assistance of Iwate Prefecture for a nine-day period beginning 11 March 2011, engaging in emergency medical care and patient transportation activities and other duties. These teams provided transportation via helicopter to inland areas and established a wide-area distribution centre and staging care unit (a temporary medical facility for emergency medical evaluation outside of affected areas), at Hanamaki Airport further inland from where they provided wide-area transportation and distribution services via aircraft to medical facilities both inside and outside Iwate Prefecture.

Taking on the work of medical activities performed by DMATs in the post-disaster acute phase, medical

assistance teams (Japanese Red Cross Society, Japan Medical Association, etc.) provided medical care mainly at evacuation centres from the subacute through to the chronic phases of operations. In early April, a maximum of 58 teams were engaged in activities in Iwate Prefecture. Their number gradually decreased as local medical facilities reopened and evacuation centres were closed. Medical assistance from outside the prefecture was ultimately concluded at the end of July 2011.

### Evacuation centres

At the peak period there were a total of 399 evacuation centres in Iwate Prefecture and a total of 54 429 evacuees. Following the completion of temporary accommodations, all the evacuation centres were closed by mid-August 2011.

### Public health and sanitation-related activities

In addition to medical teams, many public health and sanitation teams engaged in activities in the disaster areas. These included health maintenance activities by public health nurses, mental care from psychiatrists and clinical psychologists, oral care by dentists, as well as support from pharmacists, certified nurses, occupational therapists and physiotherapists.

In areas where damage was relatively slight, as of September 2011, the public health and sanitation systems were gradually recovering and accordingly assistance from outside the prefecture was being reduced.

Current public health and sanitation assistance activities shifted from evacuation centres to home-based care by mid-August 2011, both for residents living in their own homes and also those in temporary accommodation.

There are many residents who continue to require assistance in the form of mental health care, and as there are few local human resources who can provide mental health care, it is expected that external assistance will be required in the long term.

### Measures against infectious diseases

Since many of the evacuation centres had lost basic infrastructures, resulting in no power or water for drinking

and sanitation purposes, there was a marked downturn in the state of sanitation. Iwate Prefecture provided sufficient bottled water for drinking. However, clean water for hand washing and water for toilets was insufficient. In addition, there was damage to the sewage system.

In the largest evacuation centres, almost 1000 evacuees were living together, and they were joined by many volunteers coming and going. In addition, since the disaster struck during the season for influenza and infectious gastroenteritis, there was an extremely high risk of outbreaks of infectious diseases becoming epidemic. It was necessary to implement a strategy whereby the signs of an infectious outbreak could be detected at an early stage and swift intervention measures implemented. Infection control assistance teams organized by experts in infectious diseases from within the prefecture were launched. They implemented Daily Surveillance for Outbreak Detection using mobile terminals in 40 large-scale evacuation centres. These teams also provided assistance with improving the disease-resistant environments in evacuation centres and providing infection control measures. These measures included evaluation of sanitary condition of evacuation centres, training for hand hygiene for public health workers/evacuees, instruction for infection control (e.g. isolation and prophylaxis for infectious disease cases), information-sharing about infectious disease and prevention and procurement of disinfectants.

## OUTCOMES

In contrast to the 1995 Great Hanshin-Awaji Earthquake, in which there were 6434 fatalities and 43 792 people injured, in Iwate Prefecture following the Great East Japan Earthquake there was a remarkably small number of individuals injured compared to those that died. There were 6322 fatalities (4659 dead and 1633 missing) and only 188 people reported injured<sup>5</sup> (based on reports from municipal governments).

These figures clearly show the characteristics of tsunami damage: relatively few casualties caused by falling structures in the earthquake, and approximately 90% of the deaths caused by drowning.<sup>6</sup>

Through 18 March 2011, a total of 191 patients were airlifted to Hanamaki Airport in Iwate Prefecture, and 16 were transferred to medical facilities outside the prefecture. The patient breakdown was 101 females

and 90 males, with an average age of 54.4 years (0–100 years). In addition to conditions caused directly by the disaster, such as broken bones, external injuries, water inhalation and hypothermia, there were other medical needs including care for pregnant women and dialysis patients.

Given the many fatalities, there were relatively few patients who required medical treatment for external injuries caused by the disaster, particularly in view of the scale of the disaster itself. However, there were significant medical needs in the subacute and chronic phases of care in evacuation centres, with great demand for medical treatment and public health, sanitation assistance for general disorders, measures to counteract infection and mental health care.

The conditions and health status in the disaster-affected areas that should be mentioned in particular are as follows:

- **Hypertension:** There were many reports of hypertension, due largely to people being unable to take their medication, high levels of stress due to the disaster, lack of exercise, and the high salt content of food served at evacuation centres.
- **Deep vein thrombosis (DVT):** From the experience of previous disasters, there were concerns about an increase in DVT caused by lack of exercise and lack of fluid intake, but there were few serious cases reported that required preventive intervention. However, in examinations performed in several evacuation centres, there were reports of increased D-dimer levels.
- **Respiratory problems:** Many patients reported respiratory problems, which is likely to be as a result of the disaster coinciding with the hay fever season, as well as the impact of dust in the air and respiratory infections such as colds and influenza.
- **Mental and psychosocial health:** In comparison with the national average, Iwate has a high prevalence of psychiatric disorders and also a high suicide rate.<sup>7</sup> In addition, it has been pointed out that people living in the Tohoku region tend to keep their feelings

internalized and avoid relying too greatly on other people. Many residents in the disaster-hit areas lost family, friends, homes, possessions and their jobs in this disaster and the psychological impact has been immense. Six months after the disaster there were reports that suggested cases of post-traumatic stress disorder. Although there has been no significant increase in the number of suicides, this will require monitoring in the future.<sup>8</sup>

- **Infectious diseases:** Although sporadic outbreaks of influenza and infectious gastroenteritis were seen in evacuation centres, there were no widespread epidemics. There were concerns that the prevalence of flies and mosquitoes in the summer season could cause further infectious disease epidemics, but as of September 2011 no outbreaks were reported. With the closure of evacuation centres and the transfer of residents to temporary accommodation, the risk of infectious diseases decreased.

## DISCUSSION

Local municipalities with detailed knowledge of the local situation are usually expected to devise a disaster prevention plan and play a central role in disaster response with the assistance of the prefectural government. However, in this disaster, many local officials including public health personnel lost their lives, and those who survived engaged in disaster response in a situation in which they themselves were disaster victims. Although it is local government personnel who are expected to take the lead in formulating plans for the reconstruction of towns and ensuring the restoration of the public health sector, it is likely that long term sustained assistance from external sources will be required in terms of human resources, and financial and technological assistance.

As Iwate Prefecture had experienced large earthquakes over the course of several years, the initial disaster medical response was well prepared in the form of manuals and implementation of training. Preparations among the relevant organizations and institutions were also in place to respond to earthquake and tsunami disasters. Although the recent disaster exceeded assumed scenarios, the response to it ran

smoothly overall, including the mobilization of DMAT, transportation of patients and establishment of a staging care unit according to the pre-designed emergency plan, although several individual issues and challenges remain.

Challenges for the initial medical response to disaster include: (1) difficulty in transmitting information quickly and accurately due to the disruption of means of communication, (2) securing medical and food supplies at medical facilities, and (3) securing fuel for electricity generators and gasoline for vehicular transport.

The damage caused by the disaster covered a wide area, and evaluation of the public health and sanitation aspects of many evacuation centres was also required. Although assistance was provided by many health experts for the maintenance of medical care and ensuring the health of evacuees and residents, further examination will be required to ensure better preparedness in response to a future disaster. This includes the sharing of information among various teams, overall coordination of functions on the ground, and information-sharing and liaison with a central command. Furthermore, most of the disaster-designated hospitals in Iwate Prefecture had a three-day stockpile of medicines, foods and fuel for their own generators. Advance agreements to have prioritized procurement with suppliers are important to prepare for long-term interruption of basic services.

The psychological and physical burdens of living for a long period of time as evacuees were extremely large. As of September 2011, there had not been a reported rise in the number of severe conditions such as stroke or heart failure, but these aspects will require careful monitoring in the future.

There were no large-scale epidemics of infectious diseases in the evacuation centres. The enhanced knowledge and awareness of public health and medical practitioners is thought to have contributed to this outcome. Ad hoc surveillance (daily surveillance for outbreak detection) was helpful to monitor infectious disease status in large-scale evaluation centres.

The lessons from previous disasters such as the great Hanshin-Awaji and the Niigata-Chuetsu earthquakes tell us that the psychological impact of the disaster will require careful, attentive and systematic

assistance over the long term.<sup>9-12</sup> In addition, it will be essential to provide sustained assistance to bereaved children and orphans on whom the psychological impact will be especially great, as well as on-the-ground medical activities and technical advice to local support staff. These include health care workers, local government officials, fire and police service personnel and teachers who were, despite engaging in assistance activities, disaster victims themselves.

By referring to past experiences of national and international large-scale disasters,<sup>13</sup> there was an effective response to several health-related challenges pertaining to medical and public health and sanitation. However, there were many issues that exceeded initial expectations or scenarios for a large-scale disaster, and a specific response needs to be made to tsunami disasters. There are many outstanding challenges that cannot be resolved by resorting to a response based on a disaster manual.

Furthermore, it is a fact that the health and welfare systems of each country are different. There are various laws and health insurance plans relating to medical qualifications and systems that vary from country to country. There are cases in which a response made in one country may not be applicable in another. Therefore, a response is required that is based on the particular systems and local characteristics of the country in question.

Six months after the disaster, the evacuation centres were closed, the acute phase of the disaster response ended and the full-fledged recovery and restoration of the public health system, including maternal care or immunization activities for children, was re-started. Public health systems are essential for overall recovery as they form a safety net for residents. However, such systems cannot stand alone in society, as they are all closely related to other factors, including industry and employment, the living environment, social capital and administrative systems. This interdependence is also something that will require action in the long term to achieve cooperation among the various sectors of society.

### *Conflicts of interest*

None declared.

## Funding

None.

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I would like to take this opportunity to mention the tremendous and diverse assistance Japan received from around the world following the disaster. This assistance has been a great help in reconstruction efforts by residents in the disaster-affected areas and the knowledge that the world was providing such support was also a great comfort. I would like to offer my heartfelt appreciation.

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# Western Pacific Surveillance and Response

## Instructions to Authors

### Aim of Western Pacific Surveillance and Response

To create a platform for sharing information to improve surveillance of and response to public health events in the Western Pacific Region.

### Objectives

- To produce a web-based publication on surveillance and response activities in the region that has high exposure and is freely accessible.
- To promote information sharing on experiences and lessons learnt in surveillance and response for public health events in the Western Pacific Region and globally.
- To build capacity in communicating epidemiological findings in the Western Pacific Region.
- To highlight new and relevant technical or guidance documents and meeting reports published by the World Health Organization, Western Pacific Regional Office.

### Audience

Western Pacific Surveillance and Response (WPSAR) is aimed at people studying, conducting research or working in surveillance of and response to public health events both within the region and globally.

### Scope

WPSAR covers all activities related to the surveillance of and response to public health events. Such activities may be implementation or evaluation of surveillance systems, investigations of public health events, risk assessments both in rapid responses and policy development, outbreak investigations and research on routine public health activities. Public health events may be in any of the following areas: communicable diseases, natural disasters, bioterrorism and chemical and radiological events.

### Frequency

Journal articles will be published an article at a time building up to an issue every quarter. This means that articles will be uploaded onto the website after the review and editing process therefore allowing timely dissemination. Printed copies of the journal are available for areas with limited internet access on request after the end of each quarter.

### Instructions to authors for manuscript writing and submission

WPSAR follows the guidelines from the Uniform Requirements for Manuscripts Submitted to Biomedical Journals by the International Committee for Medical Journal Editors (ICMJE, <http://www.icmje.org>).

### Format for Manuscripts

Please submit all articles in double spaced 12 point Arial font in a Microsoft® Office Word file or a compatible file in English.

The format of the article will depend on the type. There are letters to the editor, perspectives, case reports/case series, lessons from the field, surveillance reports, surveillance system implementation/evaluation, risk assessments, original research, news items and meeting/conference reports.

### Letters to the Editor

A letter commenting on a previously published article OR a letter commenting on the theme of the issue.

- Word limit: ≤500 words
- ≤5 references
- ≤1 illustration

### Perspectives

An unstructured article discussing an issue regarding surveillance of and response to public health events. The scope of the discussion must be clearly defined.

- Word limit: ≤1000 words
- ≤10 references
- ≤1 illustration

### Case Report/Case Series

An unstructured article describing an unusual case or series of cases of public health significance. Sub-headings may be used to increase the readability of the article.

- Unstructured abstract of ≤250 words
- Word limit: ≤2000 words
- ≤15 references
- ≤3 figures/graphs/pictures

### Lessons from the Field

An article describing an issue faced in field epidemiology and the experience in trying to overcome the issue.

- Structured article with an abstract of ≤250 words and sections for problem, context, action, outcome and discussion
- The abstract should also be structured with problem, context, action, outcome, and discussion
- Word limit: ≤2000 words
- ≤15 references
- ≤3 figures/graphs/pictures

### Surveillance Reports

An article of a summary and interpretation of surveillance data for a given period of time. A description of the surveillance system and the limitations of the data collected must be included.

- Unstructured abstract of ≤250 words
- Word limit: ≤2000 words
- ≤15 references
- ≤10 figures/graphs/pictures

### Surveillance System Implementation/Evaluation

An article describing the implementation of a new surveillance system or an evaluation of an existing surveillance system used to detect public health events.

- Unstructured abstract of ≤250 words
- Word limit: ≤2000 words
- ≤15 references
- ≤3 figures/graphs/pictures

### Risk Assessments

An article detailing a risk assessment of a public health threat or event. The risk assessment may be planned and formal or rapid and informal. The scope and methods of the risk assessment must be clearly defined.

- Structured article with an abstract of ≤250 words, introduction, methods, results and discussion
- The abstract should also be structured with objective, methods, results, and discussion
- Word limit: ≤2000 words
- ≤15 references
- ≤3 figures/graphs/pictures

### Original Research

Original research articles may include epidemiological studies including outbreak investigations.

- Structured article with an abstract of ≤250 words, introduction, methods, results and discussion
- The abstract should also be structured with introduction, methods, results, discussion
- Word limit: ≤3000 words
- ≤40 references
- ≤5 figures/graphs/pictures

### News, Meeting and Conference Reports

News items and meeting and conference reports will not undergo peer review. Please contact the Editor at WPSAR@wpro.who.int if you intend on submitting such an article.

### Illustrations

Refer to the article type for the limit on illustrations (graphs, tables or diagrams). Please insert all illustrations at the end of the manuscript with a title. The illustration must be referred to in the text and must be able to be understood on its own. Use Microsoft® Office Excel for graphs and Microsoft® Office Word for tables and diagrams. Additionally, please provide a Microsoft® Office Excel spreadsheet of the data used to create a graph. Footnotes for illustrations should have superscript letters assigned and an explanation provided below the illustration.

### References

Reference the most recent and relevant publications. Please use Vancouver style referencing. Sample references can be viewed online: [http://www.nlm.nih.gov/bsd/uniform\\_requirements.html](http://www.nlm.nih.gov/bsd/uniform_requirements.html).

Place the bibliography at the end of the article text and not as footnotes. Write journal names in full. Use superscript sequential numbering in the text. Place the number after any punctuation. For example:

These results are consistent with the original study.<sup>11</sup>

Reference personal communication in the text only and include the person's full name and institution.

### Peer Review Process

Every article will be reviewed firstly by the editorial team to ensure the article is within the scope of WPSAR and the quality is sufficient for undergoing peer review. All articles with the exception of news items and meeting and conference reports will undergo external peer review by two reviewers. This will be a blinded peer review process where the reviewer does not know the identity of the author(s) and the author(s) do not know the identity of the reviewer. Author(s) may be asked to revise the manuscript as a result of the peer review. After satisfactory revision, accepted manuscripts will be edited and sent to the author(s) for final approval before publication.

### Authorship

All authors should have contributed significantly to the article through one or more of the following in each category A, B and C:

#### A

- Study design
- Data collection
- Data analysis
- Data interpretation
- Writing the article

#### B

- Drafting the manuscript
- Critically revising the manuscript

#### C

- Final approval of the manuscript for submission

Any other contributors may be listed in the Acknowledgements section.

### Acknowledgements

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- A cover letter describing the article and why it should be published
- A title page with the article title, short title, brief description of the article of ≤ 50 words, ≤ 7 keywords, full names of all authors and institutions and full contact details of the corresponding author. This must be a separate file to the article to ensure a blind review
- A Microsoft® Office Word file of the article
- Scanned copy of the licence for publication provided during the submission process signed by all authors

### Corrections

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