

Overview of NDMS Infrastructure in Taiwan

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Abstract

Since 921 Chi-Chi earthquake, our government has been engaged in establishment of a disaster response system and gained much achievement. These include the improvement of infrastructure of National Disaster Medical System (NDMS) such as the development of Disaster Medical Assistance Team (DMAT), the establishment Taipei Emergency Operations Center (EOC), and the integration of disaster response planning (DRP). However, there are still many weak points for the development of a well-established disaster response system. The infrastructure of our NDMS also needs more improvements, either hardware or software. In this article, we tried to analyze the present NDMS in Taiwan by using the SWOT analysis model. The overall performance will be:

Strengths: The government has been consistently engaged in the development of a good NDMS system.

Weaknesses: There is still no professional authority or organization that is responsible overall education and training, integration of planning, incorporation into standard operations planning, and constant monitoring.

Opportunities: The international communications promote understanding and modification of the policies. The persistent stimuli from various kinds of disasters keep the government high alerting in disaster response in Taiwan.

Threats: The progress in NDMS may be still lower than the real demand of disaster response.

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Key words: Disaster Response; SWOT; NDMS; DRP; EOC

Introduction

National Disaster Medical System (NDMS) is an overall system of medical response to disaster, either natural or artificial such as technical disaster, major transportation accidents and acts of terrorism in a country. In the United States, it belongs to the former Federal Emergency Medical Agency (FEMA), or the present Department of Homeland Security. According

to the definition from NDMS in the U.S., this system is responsible for medical response to a disaster area in the form of teams, supplies and equipment; patient movement from a disaster site to unaffected areas of the nation; and definitive medical care at participating hospitals in unaffected areas. Taiwan has been engaged to incorporate its NDMS since 1999 and may have initial progress recently.

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Disaster Medical Assistance Team

Taiwan is an island country with a high population density. Located in the junction of Philippines and the Euro-Asia tectonic plates, Taiwan is prone to natural disasters such as earthquake, typhoon, floods and landslides. For examples, the average number of earthquake is more than two thousands events per year and 200 of them are perceptible.¹ Chi-chi earthquake, one of the most deliberating earthquakes in 20th century, hit Taiwan at 1:47 AM on September 21, 1999.² After that, the government has hurried up to be engaged in the establishment of a good disaster response system. Disaster Medical Assistance Team (DMAT) set-up was one of the most important links and has been begun since July 2000. Two National DMATs have been established in Taipei and Tainan, corresponding to Northern and Southern National DMAT. With powerful assistances from the Department of Health and National Fire Administration, local DMAT program has also been promoted. However, the adequacy in the distribution of all the DMAT resources has not been verified yet.

Because some natural disasters such as earthquake and landslide may be unpredictable, appropriate emergency medical services and DMAT support may be the key points to reduce mortality and morbidity.³ Response time is critical in the administration of emergency medical care and special field hospitals established one week later might be too late to prevent early mortality. Many previous epidemiological data confirmed the role of DMATs in disaster response.⁴⁻⁸ It is therefore logical for us to consider implementing more DMAT personnel and resources in the high-risk areas.

According to the definition from National Disaster Medical Team (NDMS) in the United States,⁹ The central government should be responsible for Disaster Medical Assistance Teams (DMATs) as prearranged sources of support. ADMAT consists of a volunteer group affiliated with NDMS. Although a DMAT consists of approximately 35 individuals in each deployable unit, each particular team may consist of more than three times the number to avoid any possible unavailability of a key person at the time of deployment. Each DMAT is composed of members with a variety of health or medical skills and many other support personnel such as communications, logistics, maintenance and security. Many teams also include a Critical Incident Stress Management subunit.

DMATs are categorized according to their ability to respond. A Level-1 DMAT can be ready to deploy within 8 hours of notification and then remain self-sufficient for 72 hours with enough food, water, shelter and medical supplies to treat about 250 patients per day. Level-2 DMATs lack enough equipment to make them self-sufficient but are able to deploy and replace a Level-1 team utilizing and supplementing their equipment which is left on site. Level-3 DMATs consist of teams in various stages of development.

Some of the DMAT functions include triage of victims at the disaster site.^{10,11} Providing sophisticated medical care in austere conditions and maintaining casualty clearing or staging locations just outside the site of the disaster.^{9,10} DMATs can also provide care at a reception area when the patient evacuation part of NDMS is activated. They can receive victims of the disaster in areas across the country that were unaffected and thus can handle the large quantity

of injured people.

In order to be ready to respond to a disaster, DMATs undergo specialized training both at the team level and during local and national level exercises. Along with this training and exercise, DMAT members provide medical care at special events and attend annual training conferences. Each team develops and maintains plans for deployment to various disasters. Supplies and equipment are provided through DOD excess property sources, federal budget requests, local donations and funding and other sources.

To investigate the appropriateness of the distribution of Disaster Medical Assistance Team (DMAT) in Taiwan, we ever analyzed the personnel data registered in Disaster Response HOspital and PErsoneel registry (Dr. Hope registry) database and correlated them with the frequencies and severities of the earthquakes (from January 2001 to December 2001),¹⁴ one of the most possible devastating events in Taiwan. The relative risk of perceptive earthquake is highest in Hualien county and lowest in Taoyuan county, Taipei city, and Kaohsiung city. The DMAT personnel is highest in Taipei city (total 1,042 persons) and lowest in Keelung city, Taipei county, Ilan county, Hsinchu county, Miaoli county, Yunlin county and Taitung county. A linear regression model revealed that poor correlation between the relative risk of the earthquakes and DMAT personnel ($R^2=0.018$). The covariance value was -2.75 . The linear regression model also demonstrated that poor correlation between the population density at risk and the distribution of DMATs ($R^2=0.024$). The covariance value was -913.39 . In conclusion, we find that the distribution of DMAT personnel is not correlated with the

relative risk and damage of earthquakes in each geographic area at present in Taiwan. Detailed reevaluation and redistribution of DMAT resources may be vital in good preparedness of disasters nowadays.

In addition, we also attempt to find out the adequacy of DMAT composition and to help further modification of DMAT set-up.¹³ With the preliminary data in this registry, we tried to analyze the composition of these DMAT personnel and make comparisons between them and the available data from nine DMATs in United States. A multivariate analysis model revealed that: total DMAT members (in USA) = $0.74 \times$ (Number of Physicians) - $21.15 \times$ (Number of Nurses) - $21.04 \times$ (Number of Paramedics) - $8.96 \times$ (Number of EMT) - $101.67 \times$ (Number of Pharmacists) + $346.92 \times$ (Number of Respiratory Therapists) + $58.03 \times$ (Number of Psychological Consultants) + $13.94 \times$ (Number of Other Categories) - 33.09 . The variations of the other two teams are less than 170. In contrast, the multivariate analysis model revealed: total DMAT members (in Taiwan) = $44.07 \times$ (Number of Physicians) - $6.28 \times$ (Number of Nurses) + $3.66 \times$ (Number of EMT) + $1.72 \times$ (Others) - 1425.6 . The variations of other teams ranged from -375.1 to -1075.86 . The paramedics or EMT account for more than 50% of DMAT personnel in USA whereas they comprise only 6.4% in Taiwan ($p < 0.001$). In conclusion, there are no consistencies in the compositions among different DMAT personnel in Taiwan. The establishment of uniform policies and overall planning may be the only method resolving this problem.

According to the SWOT analysis, we considered that our DMAT system as:
Strengths: The government has been consistently

engaged in the establishment of DMAT, either national or local.

Weaknesses:

1. There is still no professional authority or organization that is responsible overall DMAT education and training.
2. There is still lack of uniform training programs.
3. The financial funding for local DMAT is not sufficient.
4. The distribution of DMAT is not adequate.
5. Most of the DMAT members are not professional.

Opportunities:

1. The international communications promote understanding and modification of the policies.
2. The persistent stimuli from various kinds of disasters keep the government high alerting in disaster response in Taiwan.

Threats:

1. The progress in DMAT set-up and training may be still lower than the real demand of disaster response.
2. There are still no specialized DMATs such as DMORT, VMAT, FCC, NPRT and NNRT in Taiwan.

Emergency Operation Center

The emergency operations center (EOC) is the essential part of disaster response system. The function of EOC includes providing a central point of contact, initial notification, gathering critical information, requests for resources, informing key managers of status, contacting managers for information, media questions, and EOC operations log.¹⁴ In Taiwan, the disaster response system has been limited in the dispatch centers and emergency response centers

that were composed and supported mainly by the Fire Administration. The fully-functioned EOC has not been still well established in Taiwan. However, according to the concept of general management system, an emergency response center under the supervision of the Fire Administration can not afford all of the emergency functions such as medication, food and nutrition and communication. It is therefore so urgent for us to set up an EOC in our disaster response system.

Taipei City government has established an EOC under the supervision of the Bureau of Health on December 29th, 2003. Its structure and operations seem different from the EOCs in the United States. We also tried to analyze the possible differences and possible advantages / disadvantages between them.¹⁵

The EOC has placed its role in dual functions, that is, providing command and assistance in disaster and communicating inter-hospital cooperation at the usual time. We assessed the infrastructure of the EOC by applying the guidance of the Department of Homeland Security in the United States to understand if the EOC has fulfilled the criteria of EOC set-up. Initial evaluation discloses that two major problems exist, that is, the limited space and incomplete documents (including emergency operation plan). On the other hand, the EOC in Taipei City has dual functions. One is preparing disaster response, and another is inter-hospital communication in transfer patients into those where beds are available. It provides 24-hour inter-hospital communication and information gathering. Within two months after operation, they have collected data from 481 mass casualties. The success rate of inter-hospital transfer is reported to increase from 10%

to 38% and that of intensive care units even 100%. In summary, Taipei EOC has initial achievements and may lead Taipei City to better disaster response.¹⁵

According to the SWOT analysis, we considered that our EOCs as:

Strengths:

1. The development of EOC had been the first priority in Taiwan.
2. The establishment of EOC has accomplished initial achievements.
3. Taipei EOC has dual functions.

Weaknesses:

1. There is still no consistency in the policy of EOC setting.
2. There is still no uniform guidelines in EOC setting.
3. There is still only one EOC in Taiwan.

Opportunities: The international communications promote understanding and modification of the policies.

1. The persistent stimuli from various kinds of disasters keep the government high alerting in disaster response in Taiwan.

Threats:

1. The role of EOC should be elucidated and differentiated from dispatch center of fire department / other disaster response center.
2. There is still no well-established inter-agency cooperation policies between EOC and other agencies.

Disaster Response Plan

Disaster response plans play a critical role in overall performance of disaster response. However, it remains still the major problem in Taiwan. In the United States, the former FEMA has implemented many disaster response plans

and modified according to the real need persistently. The Department of Homeland Security has continued the task force and has gained great achievements. Their planning has become a golden standard of disaster response all over the world. Besides, they also emphasized inter-agency cooperation and have implemented the policies and standard operation plan among different agencies. The harmonious interactions among different agencies has assisted them good response for 911 terrorist attack.

In addition, many other specialized agencies such as the Center for Disease Control (CDC) also develop associated response plan and standard operation plans for each specific problems. For example, health officials should be health authorities who assert good leadership to exercise and maintain medical resources for public health during a pandemic. To accomplish such an objective, all of the healthcarers ought to be familiar with pandemics response planning, exercise of incident command system, estimation of surge capacity, and inter-agency cooperation and communication. ASTHO thus designed a checklist for health officials to elucidate if the response planning was well-prepared. In addition, ASTHO demonstrated that limited funds have been made available for pandemic planning. And the United States are in various stages of readiness for a public health crisis that could potentially last more than a year. They then suggested that preparedness for bioterrorism be a good opportunity for health agencies to initiate or continue development of a well-established pandemic response plan.

To investigate the preparedness in avian influenza and its relation with psychological stress, we assessed the staffs in a university-teaching hospital in January 2004.¹⁶ The study

population included medical physicians, nursing staffs, administrative staffs, and medical technicians. The questionnaire for avian influenza preparedness was modified from ASTHO checklist. There were 53 items to be investigated. The main categories include (1) legal and policy issues; (2) authority; (3) vaccination/antivirals; (4) surge capacity; (5) communications and education; (6) laboratory and surveillance. In addition, the emotional stress was assessed by a stress test that ranges from 0 points to 110 points. The psychological background was set if the avian influenza is coming in the near future. The overall average scoring for ASTHO checklist was 19 ± 6 points (95% CI 13-24). The scoring was 20 ± 7 points (95% CI 13-26) for nursing staffs, 19 ± 7 points (95% CI 12-26) for medical physicians, and 21 ± 6 points (95% CI 14-27) for administrative staffs. There was no significant difference among three groups. The correlation between emotional stress and preparedness is moderate ($r^2=0.59$, $P<0.0001$). For each group, the similar findings were confirmed (data not shown). This study demonstrated that a substantial portion of health care staffs still did not know well the pandemic plans and thus had psychological barrier in management of avian influenza pandemics.¹⁶

In Taiwan, National Health Research Institute and National Science Council have provided many grants and financial funding for disaster investigations. These investigations have also provided good references for policy-making. Taiwan Society of Disaster Medicine has been engaged in evaluation of cost-effectiveness of funding for disaster planning in the past 5 years. The final data are still collected. However, there are great challenges in integrat-

ing disaster planning and in incorporating into standard operation planning in Taiwan. In summary, according to the SWOT analysis, we considered that our DRPs as:

Strengths:

1. The National Health Research Institute has been engaged in integration of all disaster planning.
2. The trends of disaster response modeling are towards the major trends developed by Euro-American countries such as those designed by FEMA or DHS.

Weaknesses:

1. There is still no formal or official organization or authority responsible for the integration of DRP and the creation of SOP.
2. The cost-effectiveness analysis can be drawn in the past 5 years' survey as yet.
3. The possibility of "paper plan syndrome" still exists.

Opportunities:

1. The NHRI and NSC should combine all the existing disaster investigations to make a well-established disaster response plan which can work in a real disaster of any type under a ALL-HAZARD RESPONSE model at present.
2. The linkage between planning and the practice of SOP should be evaluated in detail.

Threats:

1. The roles of NHRI and NSC may be limited to academic research only.
2. The lack of a specified organization such as that like FEMA in the U.S. may weaken the fulfillment of DRP.

Overall Response System and Future Development

As describe above, Taiwan has been engaged in research in disaster medicine for more than two years since 921 Chi-Chi earthquake. Although there are many outstanding results after 5 years' efforts and many standard operating procedure (SOP) are also on drafting, there are still three MAJOR problems. First, the structure of the entire research program is under the principles of PATHWAY OF HAZARD-SPECIFIC MANAGEMENT instead of PATHWAY OF ALL - HAZARD MANAGEMENT. For example, the nuclear conflicts are under the supervision of the Atomic Energy Council whereas landslide under the control of the Council of Agriculture. However, many emergency functions such as food supply and health services cannot be provide by these agencies only. It is contrary to the most efficient disaster management system of United States and may make the inter-agency integration more difficult. Second, the generalization and education for specific personnel (such as those involved in DMAT and Mitigation Team) and for the public will also be a difficult task if there is no specific organization responsible for it. The establishment of a Hazard Research and Application Center, which is specified and designated as the integrated research agency, is the only resolution to these problems. Third, there are no constant disaster research and application academies, and only few integrated scientific papers and SOPs have been published. The efficiency may be inadequate in consideration of the research budget in the past two years. The set-up of a permanent ALL-HAZARD academic research center that includes integrated surveys provided by experienced specialists may be a good resolution to this dilemma.

The task is therefore to create the integration of all research programs under the guidance of ALL-HAZARD RESPONSE SYSTEM and to provide continuous education for the professionals and the laypersons in the most efficient way. A specific database that includes all available international and Taiwan evidence-based disaster surveys will be established. The center will also, from the viewpoints of academics, become one of the important consultation organizations for disaster policy and management.

Based upon the above specific aims, the mission of a professional Hazard Research and Application Center" is to integrate all research programs and develop ALL-HAZARD RESPONSE SYSTEM (role as "wisdom bank") and to provide regular education and training for the professionals and the public (role as "disaster school"). And the center will provide available information of evidence-based disaster medicine and management and furthermore become an academic consulting organizations for disaster policy and management. To resolve the dilemma concerning inadequate efficiencies in the use of research budget, the set-up of a permanent ALL-HAZARD academic research center that includes integrated surveys provided by experienced specialists can achieve more conclusions including integrated scientific papers and SOPs in the most efficient way.

The IMMEDIATE benefit of "the Hazard Research and Application Center" is the foundation of ALL-HAZARD RESPONSE SYSTEM. In the viewpoint of ALL-HAZARD PATHWAY, the first priority of emergency operation plan (EOP) or SOP format should be that a planning team's chief concern will be to include all essential information and instructions

in the EOP. There are generally the same emergency functions no matter what kind of disaster or hazards take place. In the United States, Federal Emergency Functions consist of 12 major functions: (1) Transportation: via Department of Transportation; (2) Communication: via National Communication Service; (3) Public Works: via Department of Defense; Firefighting: via United States Fire Administration; (4) Information and Planning; via Federal Emergency Management Agency (FEMA); (6) Mass Care: via American Red Cross; (7) Resource Support: via General Service Agency; (8) Health and Medical: via Human Health Services; (9) Urban Search and Rescue: via FEMA; (10) Hazardous Materials: via Environment Protection Agency; (11) Food: via United States Fire Administration; (12) Energy: via Department of Energy. FBI will be another additional commander or coordinator if man-made disasters such as terrorist attack occur. In other words, no matter what kind of natural or man-made disasters happen, the representatives of the 12 agencies with authorities would gather together to do direct interactions and assistances. It has been proved to be the most efficient system for every kind of disaster because the demands of disaster response are all included in these 12 emergency functions and NOT dependent upon the types of the disasters. In Taiwan, however, various agencies are responsible for initial survey and management of different disasters. For example, the Council of Agriculture is responsible for landslide and the Agency of Economy for floods. NO uniform response model has been established in our country and inter-agency co-operation and interaction are indeed NOT good. The efficacy and efficiency of disaster response are also declined. Nowadays do

National Program for Hazard Mitigation has provided many individual conclusions of disaster investigations. It is the critical time for us to utilize and integrate these available resources into a good disaster response system under the principle of ALL-HAZARD MANAGEMENT.

On the other hand, it is essential to generalize the present available resources of disaster management into public education, including for both the professionals (such as DMAT, rescue team and mitigation teams) and the laypersons. In my survey, DMAT personnel, as an example, are distributed unevenly and NOT correlated with the frequency and the severity of past or ongoing disasters. The education and training of local, and even national, DMAT also individualized. No uniform regulations or guidelines can be found among these so-called trainings. And no specific organization is authorized to be the training agency for these personnel. In other words, the public in the society have completely no ideas about the present disaster response system, let alone the essential knowledge and skills when the disasters occur. According to the previous disaster survey such as Tong-Shan Earthquake, more than 80% of the survivors rescued themselves or others. It reveals that the necessity of layperson to have adequate knowledge and skills in disaster rescue and relief. Although Taiwan Society of Disaster Medicine and two National DMAT leaders have been engaged in the education, there is still a long way for us to reach the goal of "public generalization". The same situation is also met for those professionals. The training of National DMAT and of several local DMATs are individualized with no uniform guidelines. One of the LONG-TERM benefits

of "Hazard Research and Application Center" will be the key role in unification of training and education.

Summary

Taiwan has been engaged in the investigations concerning disaster response for 5 years. When 921 Chi-Chi earthquake occurred, Dr. Flores¹⁷ ever recommended as follows.

1. "The experience from the 921 earthquake has hopefully raised the awareness of government officials and the general public of the social and economic impacts that large earthquakes can cause. Certainly, there is more concern now for a similar damaging earthquake that could impact Taipei. There is a great need for all levels of government in Taiwan to institutionalize earthquake preparedness and mitigation programs. The development of emergency response plans and disaster assistance programs needs to be given high priority.
2. The application of real-time seismic information and the utilization of new technologies such as loss estimation and GIS was already being pursued by universities, the National Center for Research on Earthquake Engineering, the National Science and Technology Program for Hazards Mitigation and other institutions. These efforts need to be accelerated and further research in the loss estimation should be high priority.
3. The almost nonexistent insurance coverage of residential and commercial properties has put most of the recovery financing burden on the government and lending institutions. The government needs to seriously look into expanding the role of

insurance in disaster financing. Research on this issue should be given very high priority.

4. Financing the rebuilding of commercial and residential properties poses the greatest challenge to the government and lending institutions. Financing programs will need to be well thought out since these will most likely serve as the basis for the government disaster assistance programs that will need to be institutionalized as part of an overall disaster preparedness program."¹⁸

Of course, our government has made much achievement in related construction of disaster response system. However, there are still many weak points for the development of a well-established disaster response system. The infrastructure of our NDMS also needs more improvements, either hardware or software. The outbreak of severe acute respiratory syndrome has taught us another lesson. A good all-hazard response system with specific modifications for each special pattern of disaster may be the best response model. Immediate integration of all disaster planning and standardization of education and training programs is the current priority.

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