

Dengue Fever Epidemic in Tainan, 2007

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Abstract

In Jun 15, 2007, the first probable case of Dengue fever was reported by Chi Mei Hospital. The health officials from Tainan City Health Bureau performed case investigation and expanded screening of the population and found there had been several cases of Dengue fever in An-Nan Li Borough of An-Nan District. The laboratory finding on Jun 24 proved that this patient, without travel history, was the first case of Dengue Fever in summer 2007. Afterward a large number of cases were found in Tainan County as well as the northern, eastern and southern areas of Tainan City, which became the most serious epidemic in the Tainan area in history. There were 2690 reported cases of dengue fever, including 1821 patients who were confirmed cases, 369 patients who were negative, and 501 patients who were diagnosed as uncertain cases. According to the date of disease onset, the epidemic peaked at the 45th week of the year with 269

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cases recorded that week.

This study reviewed the 2007 Dengue Fever epidemic in Tainan, which consisted of an analysis of the demographic characteristics and geographic distribution of cases, a description of the action of the mobile disease control team, as well as results from monitoring of vector sources. It also discussed the control measures implemented in a veterans' home and during the National Athletic Games that overlapped with the epidemic. Finally, it gave a summary of the Dengue Fever epidemic in 2007 and made recommendations accordingly.

Keywords: Tainan County and City, dengue fever, elimination of mosquito breeding sites

Introduction

Dengue fever is one of the most common viral diseases in humans. In the past fifty years, the global incidence of dengue has grown dramatically. The rapid rise of populations worldwide, urbanization of tropical and subtropical countries, and the expanding distribution of the mosquito vectors made the control of this disease a real challenge, which has subsequently attracted much attention from health organizations all over the world.

Dengue fever goes by other names, including “breakbone fever” or “dandy fever”. It is transmitted by *Aedes aegypti* and *A. albopictus*, and the disease manifests itself through high fever, headache, myalgia, arthralgia, pain behind the eyes, and skin rash. Dengue is endemic in tropical and subtropical countries which have a population of *A. aegypti* and *A. albopictus*, and the disease is especially widespread in countries

with *A. aegypti*, including places in Asia, South America, Africa, northern Australia, and part of the West Pacific. In high prevalence areas of Thailand, reported cases with symptoms were a tip of the iceberg of the infected population, as approximately 50-90% of the patients did not have any symptoms [1-2]. In the past 30 years, the case number of dengue has persistently increased. WHO has reported that more than half of the world's population are living in endemic areas and there are one hundred million dengue infections worldwide every year. Among them, nearly 250,000-500,000 patients had Dengue Hemorrhagic Fever. Only less than 10% of symptomatic patients were reported [3].

There are four distinct serotypes of virus that cause dengue. People who get re-infected with a different serotype of virus will exhibit various degrees of manifestations, from mild symptoms to Dengue Hemorrhagic Fever or Dengue Shock Syndrome. Previous research has indicated repeated infections by different serotypes of virus constitute one of the most important risk factors of DHF/DSS [2,4-5].

In 2007, a surge in dengue fever cases had been reported throughout Southeast Asia. Thailand reported nearly 60,000 cases; Indonesia reported about 130,000 cases; and Vietnam reported 60,000 cases. In addition, Malaysia, Myanmar, the Philippines, Singapore, and India also experienced outbreaks of dengue fever [6]. Taiwan was located in a subtropical area, and the warm and humid climate, as well as the high population density, are favorable for mosquito breeding. In Jun 2007, the first case of dengue fever was reported in Tainan City, and an epidemic soon followed.



Materials and Methods

- A. Targets and the period of investigation: The targets were the reported and confirmed cases from the Nationally Notifiable Infectious Disease reporting system in Taiwan, excluding the imported cases. The collection and analysis was based on the date of symptom onset for all cases, which occurred between May 20, 2007, and Feb 25, 2008.
- B. Case Definition: Fever ($\geq 38^{\circ}\text{C}$) combined with two or more of the following symptoms: headache, retroorbital pain, myalgia, arthralgia, skin rash, hemorrhagic manifestations, and leucopenia.
- C. Definition of Confirmed Case: Patients who met any one of the following criteria was defined as a positive case: 1) Isolation of dengue virus in serum; 2) Detection of dengue viral RNA in serum; and 3) Positive IgM and IgG, or a fourfold or greater rise in titer of IgM or IgG in paired serum, with negative anti-JBE IgM.

Description of the cases

A. History of Outbreak

a. Tainan City

The first confirmed case in June 2007 was in reported in An-Nan Li Borough of An-Nan District, Tainan City. This patient had visited three different clinics after symptom onset on June, 9 and was reported on June 15 when going to hospital. Without having a travel history, this patient was documented as the first domestic case of Dengue Fever in that summer. The case investigation and expanded surveillance were performed by the local health bureau on June 18, and they revealed several positive cases were in the same borough. Although these cases had sought medical

advice, they were not diagnosed as Dengue by the doctors in local clinics. This resulted in an extended period of Dengue spread in the community.

The first case in Northern area was confirmed on July 2. The workplace of this case was An-He Borough. The next reported cases were a grandfather and his grandson in Yu-Huang Borough. The father was also confirmed as a positive case by expanded screening. We speculated that there might be some undetected cases in these two areas. After a period of transmission in the communities, the outbreak finally became explosive. In the beginning of July, there were cases one after another reported in Yu-Huang, Gong-Yuan, and Guo-Xing Boroughs.

On July 20, a case was reported in Eastern area. Because the control measures were focused on the eastern area, the cases in Da-Lin Borough and Da-Zhong Borough in southern area had not been detected till early August. When the case number rose in both eastern and southern areas, an outbreak occurred in a veterans' home in Zhong-Xiao Borough in the eastern area. A resident started to have symptoms and was reported by the hospital on August 8. On Aug 13, three cases were reported from Yongkang Veterans Hospital. The expanded screening was performed by the local health bureau. Among 441 blood specimens, the number of confirmed cases was up to 84 by Sep 15. A total of 22 in 78 confirmed cases did not have symptoms (28.2%). The major manifestations of the other 56 cases were fever and poor appetite. The percentages of headache, skin rash, and arthralgia were all less than 40%. Most of these residents were between 70 and 80 years old. On the basis of investigation, the index case was a cook living in Zhong-Xiao Borough. He started to have symptoms on July 26 and continued to work in viremic stage. Since there



were confirmed cases in this area, and vector control was hard to implement in the veterans' home, as well as the inconspicuous manifestations in the elderly, this outbreak evolved into the largest outbreak in Taiwan in recent years. Afterward, the mobile disease control team of the Taiwan Centers for Disease Control (Taiwan CDC) went to supervise vector control activities several times, and the Fourth Branch of Taiwan CDC assigned a staff member to conduct case monitoring and implement control measures. The outbreak in the veterans' home was eventually brought under control.

The epidemic continued for about four months and overlapped with the National Athletic Games held in Tainan City from Oct 20 to Oct 25. The team from Taiwan CDC was assigned to implement intensive vector control measures on site, and to monitor the health status of every worker in this area. Consequently, no contestants in the National Athletic Games had become infected with dengue fever.

After the National Athletic Games, even with the arrival of November, the preceding typhoons had increased the number of water storage containers. Consequently, cases of Dengue fever were reported all over the six areas during this time, especially in northern, eastern and central-western areas. The mobile disease control team was on duty everyday in the most popular places for public congregation (markets, parks, and temples) identified through epidemiological investigation reports. The number of reported cases began to decline in the middle of December, but a few cases were still reported every day. By late December 2008, no confirmed cases were detected, and after monitoring for 28 days, the end of the epidemic was announced on Feb 25, 2008.

b. Tainan County

The first case in Tainan County was living in Yan-Xing Borough of Yong-Kang City with initial symptom onset on July 2. Given that the workplace of this case was in An-Ping District, Tainan City, the infection source might have been located in Tainan City. Among 151 confirmed cases in Yong-Kang City, 83 were typable. A total of 81 of the confirmed cases belonged to type 1, and most of them were related to Tainan City by investigation. Two of the confirmed cases were type 2 and were related to Gui-Ren Township. Since the outbreak in Gui-Ren and Guan-Miao Townships started on Oct 18 and some of the contacts screened had positive blood tests, this was likely not the first wave of transmission. The cases in Xiang-Yang Village, Nan-Hua Village, Song-Jiao Village, Guan-Miao Township were type 2, which were different from type 1 in Tainan City, showing that there had been another infection source. Finally, we found a foreign spouse who visited her relatives in Vietnam in July. She came back to Taiwan on July 23 and had symptoms on the following day. Because she was not detected, we lost the golden time for implementing preventive measures. Besides, the Gui-Ren market was better so people living in Guan-Miao Township preferred to shop there. As a result, the outbreak was extended to Gui-Ren market, and a total of 113 cases were reported. By the efforts of Tainan County Health Bureau and township officers, extensive mosquito control and expanded screening activities were implemented, and health education was also given to the public. The outbreak in Guan-Miao and Gui-Ren Townships eventually stopped.

B. Analysis of the Outbreak

a. Status of outbreak: The local outbreak of dengue in 2007 was the most serious one in Tainan recently. There were 2690 reported cases, including 1821 confirmed cases, 369 negative cases, and 501 uncertain cases. The outbreak peaked in the 45th week of the year, with 269 cases confirmed during that week (figure 1).

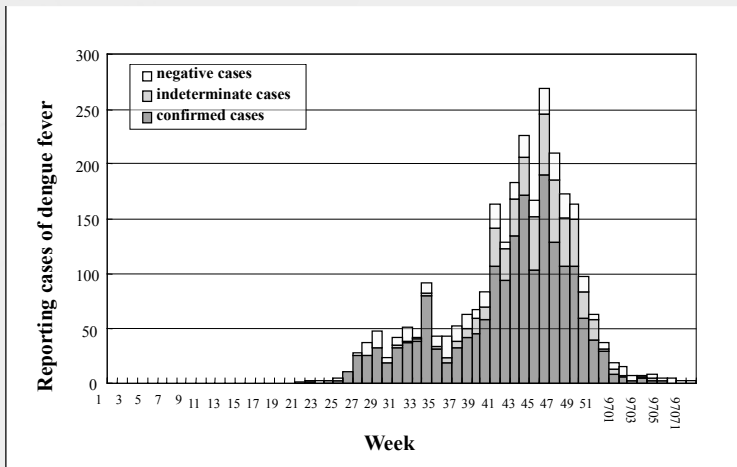


Figure 1. Weekly domestic dengue cases in Southern Taiwan, 2007

b Distribution of cases: A total of 1474 cases were in Tainan City (471 in eastern area, 466 in northern area, 192 in central-western area, 170 in An-Nan district, 148 in southern area, and 27 in An-Ping District), 345 cases in Tainan County (mostly in Yong-Kang City:151 cases, secondly in Gui-Ren Township: 113 cases), and one case in Yunlin County (this patient studied in Tainan City and only came back to Yunlin on holidays). (figure 2).

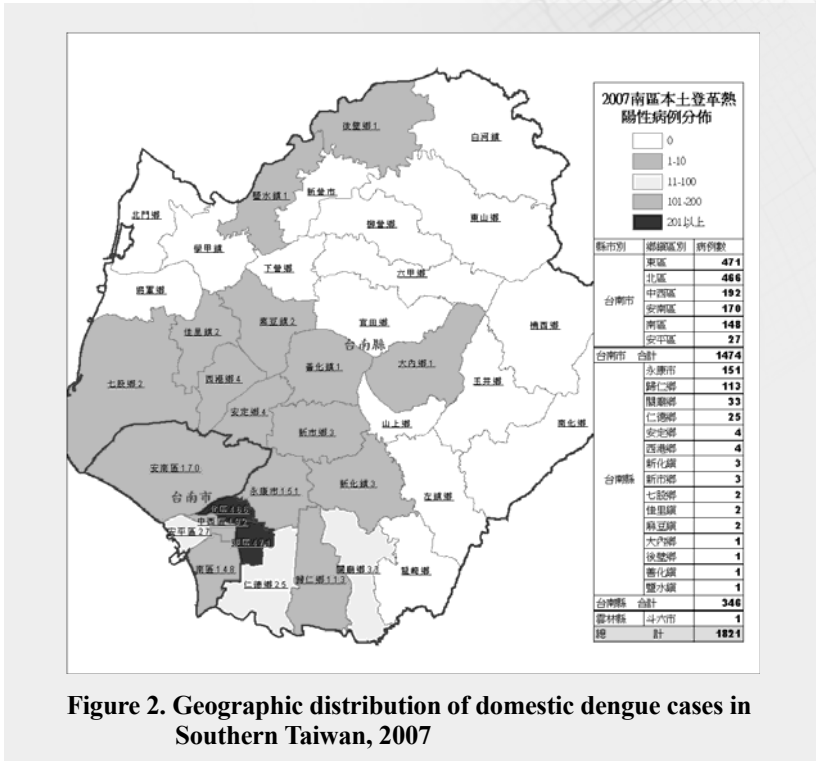


Figure 2. Geographic distribution of domestic dengue cases in Southern Taiwan, 2007

- c. The sources of case reports: There were 1599 cases reported by hospitals or clinics, and 222 cases from screening of contacts with positive blood tests.
- d. The demographic characteristics of cases: A total of 944 confirmed cases were male, and 877 were female. The range of age was between 0 and 98 years (mean: 43.7 years, mode: 48 years) (figure 3). The mean age of male patient was 43.8 years, and the mean age of female was 43.6 years. There was no significant age difference between males and females. When comparing the sex difference in each age group, the incidence was higher in men younger than 44 years or older than 65 years of age,

while the incidence was higher in women aged between 45 and 64 years. The ratio of males to females was 1:0.93. As the confirmed cases in the veterans' home were mostly males, this made the proportion of male patients higher in 2007.

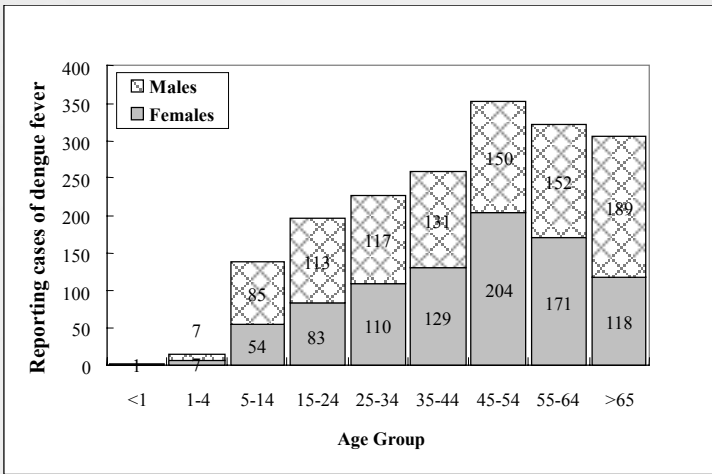


Figure 3. The sex and age distribution of confirmed cases of dengue in Southern Taiwan

- e. The serotypes of dengue virus: a total of 1036 cases were serotype 1 (934 cases in Tainan City, and 102 cases in Tainan County), and 76 cases were serotype 2 (8 cases in Tainan City and 68 in Tainan County). There were 709 cases who were non-typable. (Table 1).

Table 1. The serotypes of dengue virus

District	DENV-1	DENV-2	Total
Tainan City	934	8	942
Tainan County	102	68	170
Total	1036	76	1112

C. Control and preventive measures

a. Regional health offices:

In order to prevent the transmission of dengue, about 200 staff members, volunteers and residents from the local health bureau, department of environmental protection, department of civil affairs, An-Nan district office formed six teams to carry out community-based interventions. The deputy mayor Hong held a meeting for the dengue control taskforce every day, and a “Dengue Operation Center” was set up on July 15 in accordance with the Disaster Prevention and Relief Act. A project was launched for the dengue outbreak in veterans’ home in August. On Sep 3, the director of the health bureau declared that the range for screening and control of dengue virus and using insect repellent should be expanded to a radius of 100 meters. Because the National Athletic Games were going to be held in Tainan City, the vector control was carried out in the whole area and athletes’ villages since Oct 1. The local health bureau simultaneously monitored the mosquito density and provided all participants with “Dengue Fever Personal Prevention Kit” (including information about dengue control, insect repellent and mosquito repellent patches in a hand bag). Mosquito coil incense was provided for the athletes’ villages to prevent insect bite. The health service center was in charge of managing and making a record of participants with fever or any other discomfort. The officials from Kaohsiung County and Kaohsiung City assisted in surveillance of mosquito. A “Clean-up Week” and “Clean-up Days” have been designated to eliminate mosquito breeding sites and to use insecticides at hotspots. Through the teamwork of the city government, full-scale efforts were implemented to improve environment sanitation and hygiene as well as to manage open space and vacant houses.



The clean-up and elimination of breeding sites was supervised by the city's Planning Office and double-checked by the local health bureau within one week. After efforts to sanitize the environment and to decrease the availability of water trapping containers by the public as well as efforts to regularly monitor mosquito activity and to implement health education to the communities by the local health bureau, the outbreak was finally contained.

Since confirmed cases were found in Tainan City, the Tainan County government had mobilized its residents and volunteers to engage in dengue control. All town mayors asked village chiefs to implement mosquito control measures, such as surveillance of mosquitoes and teaching the residents how to eliminate the breeding sites.

b. Central Government

Since suspected case of dengue was reported, the government supervised the local health bureau in preventive measures, including sampling and transport of specimens, and assistance in the follow up of the laboratory findings. The administration also asked the local health bureau to supervise the reporting systems in hospitals and social mobilization. The local health bureau was told to summon people to clean up the neighborhood and visit hospitals. The staff in the branch was divided into four groups, such as (1) investigation: to be responsible for monitoring of the case reporting system, analyzing the development of the outbreak, collecting outbreak information, and predicting the hotspot areas (2) the mobile disease control team: to be in charge of the survey of mosquito density, double-checks for elimination of breeding sites, and assessing the spray of insecticides (3) administration: to manage the backup resources, assignment of cars, and dispatch of supplies (4) evaluation: to be in charge

of collecting information about public sentiments, contact with local health bureaus, follow-ups on meeting records and working diaries, and setting up the southern command center of dengue and holding daily meetings. The mobile disease control team started assistance in supervision of all control measures on Jun 28, and gave suggestions. On July 6, the director of the fourth branch of Taiwan CDC visited the mayor of Tainan City and helped to establish the command center. The National Games Dengue Fever Prevention Task Force was established by the instruction of Executive Yuan on Oct 3, resulting in prevention of dengue outbreak in the National Athletic Games. Forty health officials were assigned as onsite dengue control officers and were in charge of the preventive measures in the area of the National Athletic Games from Oct 16 to Oct 25. After the activity, the mobile disease prevention team divided Tainan City into four areas, including northern, eastern, southern and central-western areas, and continued to assess the outbreak situation and implement preventive measures according to the geographic classifications, for the purpose of efficient mosquito control. Other branches of Taiwan CDC also dispatched manpower to assist, and the personnel of each branch returned after completing certain short-term missions.

Personnel from the Center for Research and Diagnostics had studied the insecticide susceptibility and detection of dengue virus from mosquitoes many times and went to Tainan to demonstrate how to use mosquito spray. During the National Athletic Games, 1575 vector mosquitoes of dengue fever were caught and tested, but no dengue virus was isolated. Workshops on “mosquito spray and dengue control,” “the use of aerosol spray,” and “the surveillance of mosquito with dengue virus” were given to first line



disease control officers to enhance their knowledge and skills.

From Jun 15, 2007 to Feb 15, 2008, the Fourth branch (including backup manpower) provided 3774 persons-days, and the mobile disease control team has been sent out 1153 times to inspect a total of 245 boroughs and made 78 inspection records. The disease control supplies made available consisted of (1) 2,221 bottles of insecticide for special environment; (2) 19,280 cans of aerosol spray; (3) 38,925 packs of insecticide for larva; (4) 7,044 bottles of insecticide for special environment; (5) 71 thermal foggers; and (6) 10,000 "Dengue Fever Personal Prevention Kits" distributed during the National Athletic Games. This outbreak control was conducted by Tainan City Government and assisted by the central government in terms of dispatching additional manpower, medications, equipment and financial aids in order to prevent the outbreak from spreading into another city and help the proceeding of the National Athletic Games.

Discussion and Suggestions

A. Community participation and attitudes

Because of the public's insufficient understanding of disease transmission patterns and dengue vector ecology, and the habits of keeping water in containers for watering the flowers, it makes the mosquitoes breed easily. Some people were still found keeping water storing containers after the government's inspection and persuasion efforts, and this showed that people tend to overlook the severity and have little knowledge about dengue outbreaks. In addition, the dengue control measures were often mistaken for neighborhood clean-up efforts due to insufficient understanding of the vector mosquitoes, hence the health

officials need more expertise and patience when communicating to the public.

***Suggestions:**

1. Strengthen public education about the importance of eliminating breeding sites of vector mosquitoes for dengue control, and teach the public the necessity of insecticide spray for eliminating vector mosquitoes.
2. Mark the residences which had been checked for the elimination of breeding sites in order to prevent disturbing the residents inside frequently.
3. Convince and guide people to cooperate with the preventive and control measures, and report the offenders who refuse to cooperate, or act to interfere with disease control work according to the Disease Prevention and Control Act.

B. The behavior of seeking medical advice and the reporting systems of hospitals

Some people are used to buying medicine in the drug stores without going to a doctor when they are sick. Others may go to a doctor in the beginning, but case reporting might still be delayed due to atypical symptoms in the early stages. These people might spread the virus in the viremic stage, which would in turn defer the control measures of dengue.

***Suggestions:**

1. Educate people to go to a doctor if they have any suspected symptoms, and tell the doctor about travel history and mosquito bites. People can go to a local medical office for blood test if dengue was suspected.
2. Increase the frequency of visiting hospitals and provide information



about outbreaks, ask hospitals to report if a probable case was found.

3. Conduct the training courses of clinical diagnosis for doctors, and request the medical association and local health bureaus to inform hospitals and clinics that probable cases should be reported immediately.

C. The insufficiency of experiences with and supplies of preventive measures

In the beginning of the outbreak, the insufficiency of experiences made the timing of insecticide spray, drug distribution, elimination of breeding sites, schedule planning, and notification of residents not able to have a great effect. Without having developed specialists in vector control, there was a shortage of manpower in elimination of mosquito breeding sites, follow-ups and double-checks of breeding sites. Although people from multi-employment development plan were hired, but it took long time to develop expertise.

The insufficiency of experiences and supplies not only results in the difficulty in dengue control, but also makes information hard to collect. Outbreak investigations can provide epidemiological analyses of outbreaks, identification of probable infection sources, and information about hotspots for preventive measures in the future, which would prevent health workers from working blindly.

***Suggestions:**

1. Set up a collaborative disease control mechanism at the border between County and City, for the purpose of preventing dengue spreading and coordinating the work of dengue control in the border.

2. The development of the ability to manage outbreaks and the cultivation of people with vocational skills need time. Only by combining training and long term cultivation with the experiences of dengue control, which would in turn facilitate communication and coordination between departments, that an integrated and experienced rapid-response team of dengue control can be built.
3. Arrange training courses for the leaders of mosquito spray, and improve the efficacy of insecticide spray and communication with the public. In addition, visits to the residences and elimination of the breeding sites should take place before spray, as this would facilitate the process of insecticide spray.

D. Old districts, vacant houses or lots, and other geographic issues:

There are a lot of historic spots and temples in Tainan City. As time went by, some districts became dilapidated without management. After people moved out to other areas, there were more and more vacant houses and open space. A lot of water containers were found there and became the breeding sites of mosquito, which was a blind spot for dengue control.

***Suggestions:**

1. Continue educating people to implement preventive measures, and request the chief of each village to keep the environment clean. Compose a voluntary team for mosquito control, and mobilize the communities to summon the residents to participate in the team.
2. The committee of each community should be responsible for the management of that community, including keep basements clean without water and coordinate neighborhood clean-up regularly.



3. Ask the city government to take over the vacant houses and open space, and request the owners to clean regularly. The owners should be requested to improve within a limited time if the environment is not clean.
4. Each city and county government can make their own regulations about the management of vacant houses and open space in order to increase the efficiency of management and ensure thorough implementation.

Dengue outbreak is a big challenge and a threat to public health, and keeping the environment clean and the elimination of mosquito breeding sites are the best policy of dengue control. Communities should use volunteers to recruit more people in eliminating mosquito breeding sites and abandoned containers. Community mobilization is also needed to implement dengue control.

Owing to international activities and tourism, it is common for Taiwanese people travel to South East Asia. Therefore, preventing dengue transmission from imported cases (visitors, foreign laborers, and foreign spouses) is one of the important control measures. The infection sources for imported cases are usually Indonesia, Vietnam and Thailand. As a result, if travelers have fever and relevant travel history, the quarantine officers in the airport will collect specimens for a blood test. The control measures will initiate if dengue is confirmed. From July 1, 2008 on, NS1 has been integrated into the airport rapid screening test by Taiwan CDC. We want to avoid the transmission of dengue by early diagnosis and prevention. In order to prevent outbreaks from being triggered by imported cases, regular vector monitoring and elimination of mosquito breeding

sites should be the routine. When the mosquito density is higher than usual, preventive measures should be started.

Conclusion

After the experience of dengue control in 2007, the health workers in southern area have gradually developed the ability to mobilize and expertise about the disease. The chief of city government has also paid more attention to the preventive measures and established the divisions and channels of team work, which are expected to be beneficial to the response to future outbreaks. Moreover, it is possible for dengue transmission to spread across different cities so setting up a collaborative mechanism in the border is one of the future targets.

Most of the cases in this outbreak were type 1, but some areas had type 2 cases simultaneously. This led to the possibility of dengue hemorrhagic fever. It is necessary to increase the effect of quarantine. Prevention of imported cases requires the cooperation between central and local health workers as well as the utilization of community resources and efforts to make dengue control part of people's everyday lives.

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