

Original Article

Review of Dengue Fever Epidemic in Tainan City, 2012

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Abstract

With global warming and frequent human activity, dengue fever (DF) has become a very important epidemic disease in Tainan City in recent years. The first confirmed indigenous DF case occurred on April 28, 2012 in Tainan City. Due to the increasing rainfall after summer and the infected case appeared earlier than previous years, both factors might induce many unfavorable influence on the DF control for Tainan City Government in 2012. With the cooperative effort of each government unit, the dengue epidemic declined gradually after reached the highest peak in the 38th week of 2012 and ended on February 20, 2013. The dengue epidemic had lasted for 43 weeks, 1,286 cases were reported, including 751 indigenous positive cases, 526 negative cases and 5 unknown cases.

The purpose of this article is to review the epidemic of indigenous DF started from the summer of 2012 in Tainan and analyze the distribution of DF cases, effectiveness of notification, inspecting efficiency of “Mobile Task Force of Southern Regional Center of Taiwan CDC” and illustrates the control operations of central and local governments to provide suggestions for the future.

Key words: dengue fever, Tainan City, Command Center of Epidemics, Mobile Task Force

Preface

Dengue fever (DF) is transmitted by *Aedes* and would affect the most populations in the world that has become the fastest spreading viral disease. The geographic distributions have increased 30 times and expanded to new countries gradually during the past 50 years. It is estimated that about 50 million people globally were infected every year, furthermore, there were 2.5 billion people living in the countries which are DF epidemic [1]. Among these 2.5 billion people, there were about 70 % of the population living in Southeast Asia and the Western Pacific areas. In the Western Pacific region, DF has become the most severe health

problem of residents [2] especially after the DF pandemic in 1998. In addition, human activity, population growth, urban-rural flows and the rise of consumption capacity would accelerate the speed of DF spread and virus evolution. Dengue virus (DV) with more severe pathogenicity would also transmit from South and Southeast Asia to the Pacific and the Americas region [3,4].

Taiwan is located in the Pacific Ocean area and is suitable for reproduction of dengue vectors with high temperature and humidity. Taiwan is divided into two zones by the Tropic of Cancer, and the climate, environment, mosquito species and population density are significantly different [5, 6]. Since the ecological environments between these two regions are different, Southern Taiwan usually has more severe dengue epidemics, especially in 1987 and 1988, including Kaohsiung City, Tainan City and Pingtung County; but there were only few small scales of outbreaks in Northern and Central Taiwan [7]. The most serious dengue outbreak was in 2002, there were 5,336 indigenous positive cases in Taiwan and most of them were at the southern side of Tropic of Cancer, and Kaohsiung City alone has 4,811 cases in total. For the last 10 years, the ranges of indigenous dengue epidemics in Tainan City were varied every year. Most of these epidemics were not severe, for example, there were 2, 4, 60, and 8 indigenous cases from 2003 to 2006, respectively. Nevertheless, dengue epidemics became more and more serious since 2007; there were 1,821 cases that year and 490 cases in 2010. Besides, in recent years, the types of DV become various in Tainan City; 2007 had type I and II and 2010 had type I and IV. Therefore, the risk of dengue hemorrhagic fever (DHF) increased gradually in Tainan City. In 2007 and 2010, there were both 11 indigenous DHF cases confirmed and became a major threat to the health of residents [8]; DF has become a major public health issue for the Tainan City Government which affects the quality of life and the health of residents.

According to the study of molecular epidemiology of DV during 1987 to 2010, the gene sequence showed that each indigenous outbreak was caused by a single imported DV strain and it vanished at the end of each outbreak. The virus strains of each indigenous outbreak were different but similar to countries from Southeast Asia or South American. Thus the dengue epidemics in Taiwan were considered imported [9, 10]. Recent years, Taiwan people have frequent contacts with Southeast Asia countries which having severe dengue epidemics and it results the increasing risk of DF importation. Moreover, the duration of dengue epidemic has been extended gradually in the recent years. Take Tainan City for example, indigenous dengue epidemic in 2010 extends to February 2011, it implied that the rising risk for dengue epidemic to across winter. In 2012, the dengue epidemic occurred in the previous year and also ended on January 26, 2012. We illustrate indigenous dengue outbreak from the summer of 2012 in Tainan City and analyze the scale and development of epidemics, integrate operations of control conducted by central and local governments, maintain good experiences to compensate the deficiency and to provide suggestions for DF control in the future.

Materials and Methods

I. Subjects and survey duration

The subjects are the indigenous positive cases of DF in Tainan City from the Communicable Disease Reporting System. Data were collected from April 28, 2012 to February 20, 2013, according to onset date.

II. Definitions of DF positive cases

Laboratory result provides either positive or negative. Result with either one listed below is defined as test positive and judged as positive DF case.

1. DVs are isolated and identified from clinical specimen (blood).
2. Clinical specimen is positive according to the molecular biological nucleic acid detection.
3. DV specific IgM or IgG antibodies positive or titer rise \geq 4-fold in paired sera (convalescent and acute phase).

III. Definitions of DHF positive cases

Positive cases of DHF should have all 3 symptoms listed below :

1. Tendencies of bleeding (one or more of the following situations) :
 - Positive tourniquet test
 - Petechia, ecchymoses or purpura
 - Bleeding from mucosa, gastrointestinal tracts, injection sites or other sites.
 - Hematemesis or black feces.
2. Decreasing of platelets (number of platelets \leq 100,000/mm³)
3. Appearing evidences of increasing vascular permeability (one of the following situations) :
 - Hematocrit rises more than 20 % above normal
 - Hematocrit drops more than 20 % above normal after replacement fluid therapy
 - Plasma leakage, such as pleural effusion, ascites or hypoproteinemia

IV. Map of geographic distribution of indigenous positive cases of DF :

With the Infectious Disease Warehouse System of Taiwan Centers for Disease Control (CDC), Ministry of Health and Welfare and QGIS software to construct the geographic distribution of indigenous positive cases of DF in Tainan City after the summer of 2012.

Overview of the dengue epidemic

I. Descriptions of the dengue epidemic

1. Scale of the dengue epidemic

Indigenous dengue epidemics were occurred in Tainan City from the summer of 2012 to the spring of 2013, 1,286 cases were reported in total, including 751 positive cases, 526 negative cases and 5 unknown cases (no second specimen collection or lost contact). The onset date of the first indigenous positive case of DF was April 28, 2012, the last case occurred on February 20, 2013. The epidemic curve showed that the peak was on 38th week with 96 indigenous positive cases in 2012. The epidemic graph and

the districts of epidemic were shown in Figures 1 and 2. The geographic distribution of indigenous positive DF cases was shown in Figure 3.

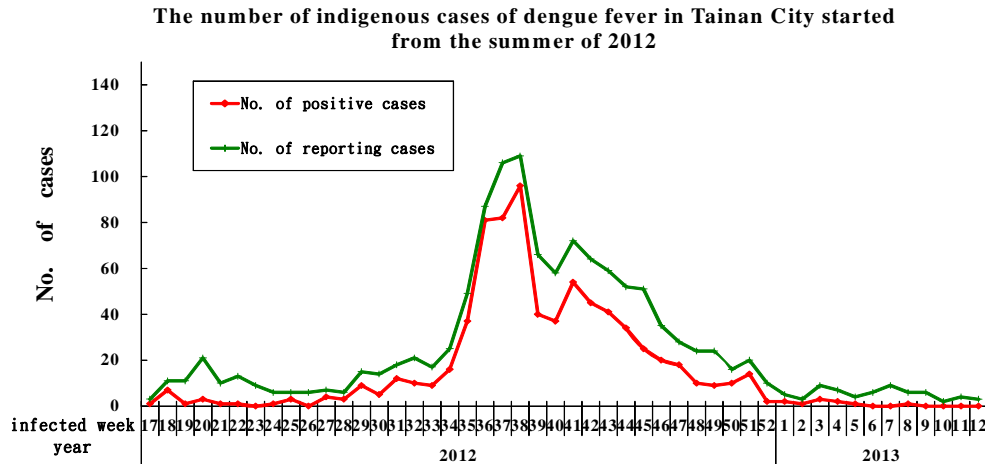


Figure 1. Epidemic curve of indigenous positive DF cases in Tainan City started from summer 2012.

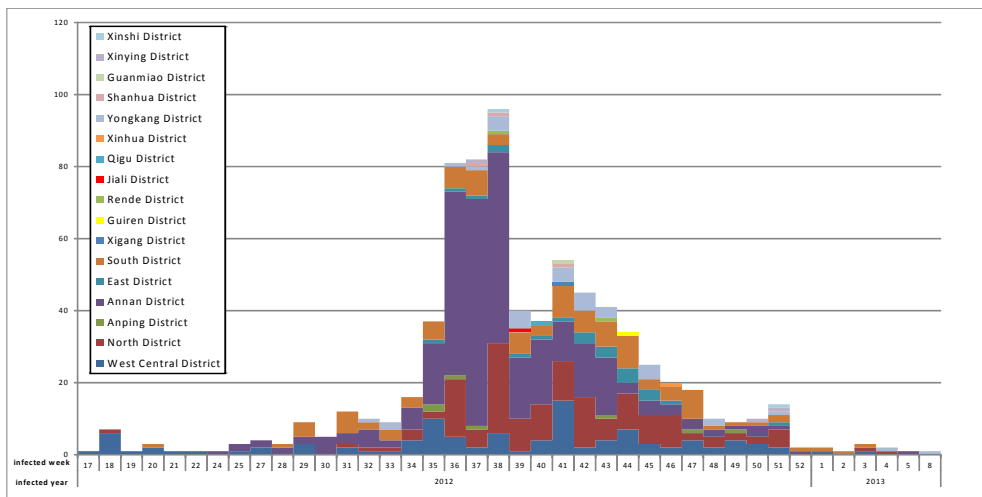


Figure 2. The distribution of indigenous positive DF cases in Tainan City started from summer 2012.

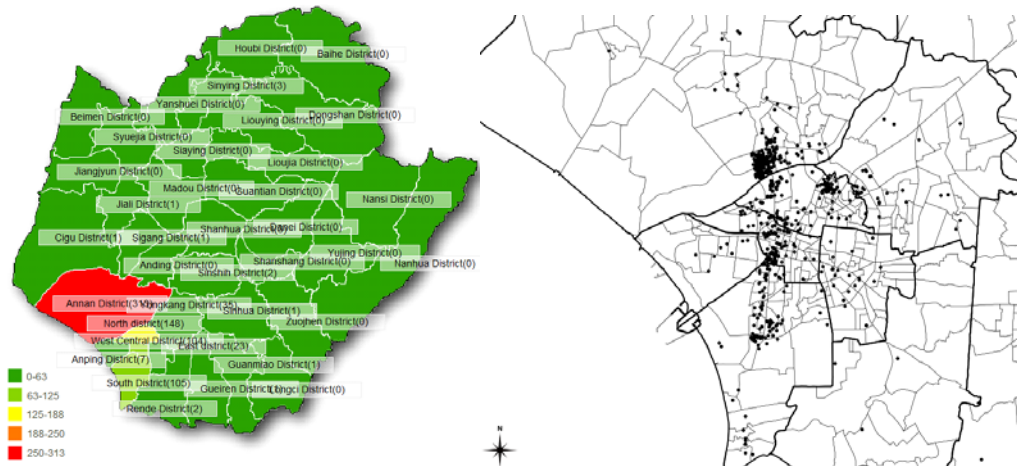


Figure 3. Left: The geographic distribution of indigenous positive DF cases in Tainan City started from summer 2012. Right: The dot distribution map of indigenous positive DF cases in Tainan City.

2. Development of the dengue epidemic

The first indigenous positive DF case was reported on April 28, 2012. It was the year which had the earliest reported indigenous DF cases in recent years. Moreover, it had the highest rainfall in April at Tainan City since 2006. According to the record of the Central Weather Bureau, the monthly rainfall in April reached to 141.5 mm in 2012. These unfavorable factors caused a great challenge to the control operations of dengue epidemic in the early summer of 2012. Dengue epidemic started from the end of April in the West Central district and gradually spread to Annan district and others. The dengue epidemic can be divided into 3 stages in Tainan City after the summer of 2012:

- (1) The first stage was between the 17th and 35th week (from the end of April to the end of August) in 2012, there were 86 indigenous positive cases in total. The major dengue epidemics area was in the West Central district in the beginning and gradually spread into Annan and South district later. The first indigenous positive DF case was living in the Minzhu village, West Central district. This case was detected by expanding blood collection of the residents with suspected dengue symptoms around the working place of the first confirmed case in the Dagang village, North district. After that, several cases were found by epidemiological investigations and blood collections in Minzhu village and adjacent villages successively. Although these cases had dengue symptoms and had gone to the hospitals but they were not reported in time by doctors to the local health department. Therefore, the dengue epidemic might have been spread for a while in the community before detected. The first indigenous positive DF case was found in the 18th, 20th and 24th week of 2012 in North, South and Annan district respectively. The dengue epidemics in West Central district remained steadily soon afterwards but increased gradually in Annan and South district.
- (2) The second stage was between the 35th and 40th week in 2012 (from the end of August to the end of September), there were 373 indigenous positive DF cases in total. This stage was the most severe period and the highest peak was in the 38th week due to the impact of outbreak in Annan district (219 cases). In addition, other districts with cases reported were spread out gradually, Annan district had the most cases and North district (67 cases) came second. The dengue epidemic in Annan district was mainly occurred in Haidian, Xingfu, Anfu, Guoan and Hainan villages. The first indigenous positive DF case was reported in the 24th week in Anfu village, Annan district. There were nearly 100 abandoned empty houses stacked with a lot of garbage and mosquitoes breeding sources in Anfu village during the control period. The junction of Haidian and Guo'an village also had found a large construction site with many breeding sources. Dengue epidemic gradually spread out in the villages mentioned above and the adjacent villages also since the 35th week in 2012. With 28 confirmed cases in one single week, Haidian village had the most cases in Tainan City. The positive DF cases were mainly in Xiaokang, Zhengjue and Shijian village of North district.

(3) The third stage was between the 41st week, 2012 and 8th week, 2013 (from the early of October in 2012 to February in 2013); there were 292 indigenous positive DF cases in total. After the first peak of the dengue epidemic in this stage, there was another smaller peak in week 41st. The epidemic was declined in Annan district while others were still in high prevalence at the same time, such as West Central, North and South district and new cases were reported successively in the other districts. However, the dengue epidemic was still restricted in the urban area of old Tainan City. The epidemic was gradually declined after a small peak in the 41st week and below 10 cases per week after the 48th week. Because of the sporadic cases in the South, North, Yongkang and West Central district, the epidemic extended to year 2013. The last case was reported in the 8th week, 2013 at Yongkang district but its infection site should be at South district.

II. Dengue epidemiological analysis:

1. Distribution of indigenous cases of DF

There were totally 751 indigenous DF cases in Tainan City after the summer of 2012, 313 cases were in Annan district, 148 cases in North district, 105 cases in South district, 104 cases in West Central district, 35 cases in Yongkang district, 23 cases in East district, 7 cases in Anping district, 3 cases in Shanhua district, 3 cases in Xinying district, 2 cases in Rende district, 2 cases in Xinshi district and 1 case each in Qigu, Xigang, Jiali, Xinhua, Guiren and Guanmiao district, respectively. The number of indigenous DF cases in each district and the incidence per 100,000 people was shown in Table 1. Indigenous DF cases were occurred in 17 districts, 151 villages in total and most of them were in old Tainan City. Among these areas, Annan district had the most cases (313 cases) and South district had the most infected villages (29 villages).

Table 1. The number of indigenous DF cases in each district and the incidence per 100,000 people in Tainan City

City	cases	the incidence per 100,000 people(cases/10 thousand people)
Annan District	313	172.7
North District	148	112.0
South District	105	83.3
West Central District	104	132.1
Yongkang District	35	15.7
East District	23	11.9
Anping District	7	10.9
Shanhua District	3	6.8
Xinying District	3	3.8
Rende District	2	2.8
Xinshi District	2	5.7
Qigu District	1	4.1
Guiren District	1	1.5
Jiali District	1	1.7
Xigang District	1	4.0
Xinhua District	1	2.3
Guanmiao District	1	2.8
Total	751	40.0

2. Demographic characteristics

There were 387 males and 364 females of the indigenous DF cases in Tainan City. The incidence rate for male and female was 41 and 39 per 100,000 people separately; the age ranged from 0 to 86 years (the mean was 44.6 years old, median was 47 years old, mode was 57 years old). The average age of males was 44.1 years old and female was 45.1 years old. The average ages of males and females did not have significant difference in statistics. The most affected people were 50-64 years old, 45-54 years old came second, while the group under 4 years old came in last. The number of indigenous DF cases generally increased with age yet declined slightly in the group over 65 years old. Males had more infected cases than females in each age group generally and the male-female ratio of total indigenous DF cases was 1:0.94. The age and gender distribution of indigenous positive DF cases was shown in Figure 4.

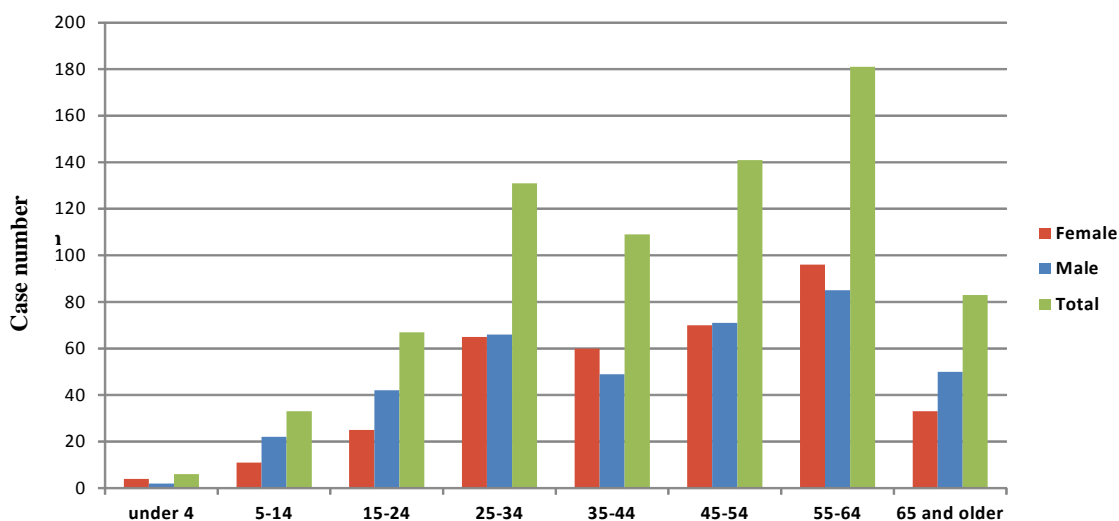


Figure 4. The age and gender distribution of indigenous DF positive cases in Tainan City

The occupation distribution of indigenous positive DF cases was analyzed; housewife had the highest percentage (11.5 %), followed by student (7.9 %) and service personnel (3.6 %). In addition, percentage of educator was 1.3 % and with student together was up to 9.2 %. Therefore, except for housewife, educator and student were also under the high risks of DF infection. Percentage of unemployment was 36.8 % and the other was 29.2 % separately. The distribution of occupation ratios of indigenous positive DF cases was shown in Figure 5.

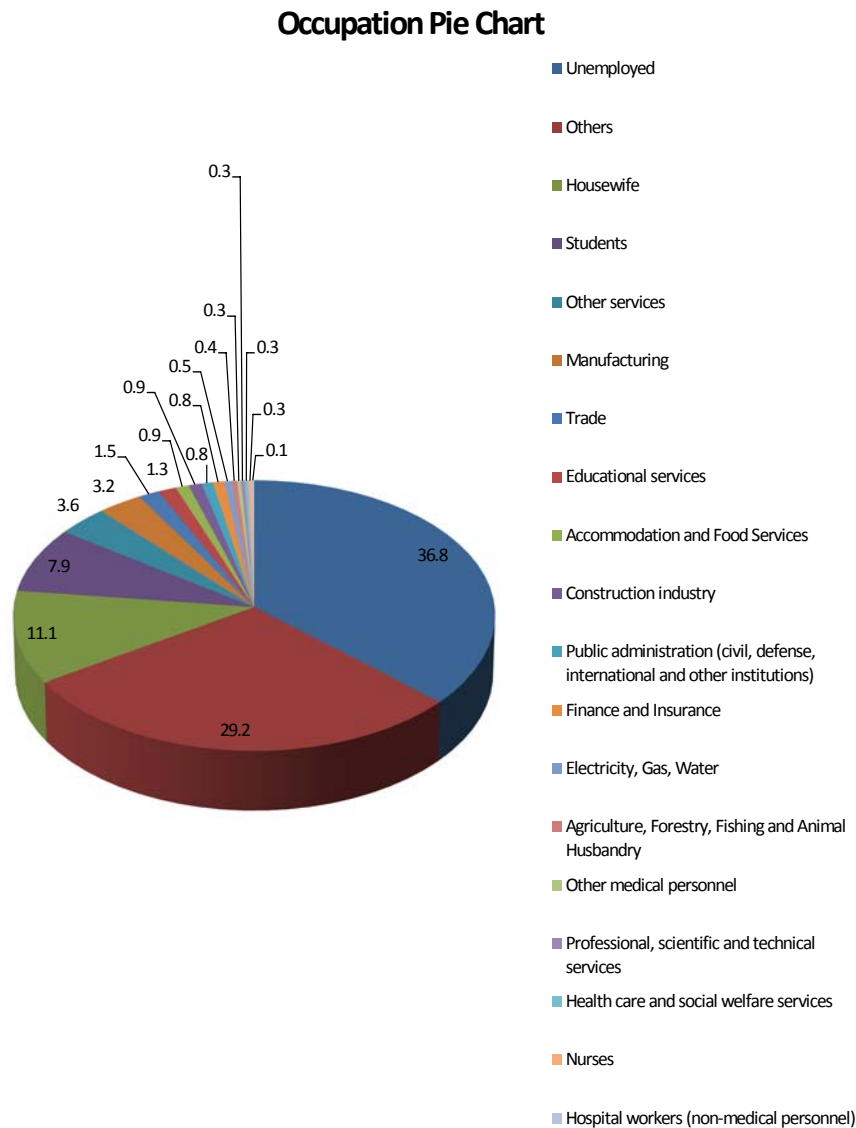


Figure 5. The occupation ratio (%) of indigenous positive DF cases.

2. Types and genetic sequences analysis of DV :

There were 560 specimens among the 751 indigenous positive DF cases in Tainan City could be used for virus genotyping. Twenty two cases were DV type I. The similarity between this virus strain and Dominican virus strain in 2007 was > 99 %. It indicated that the virus strain was first isolated from the Dominican imported case in 2007. This virus strain was identical to the indigenous virus strain causing outbreak at Tainan City in 2011. It implied that this virus strain might have been imported into Taiwan after outbreak and it might continue to spread from year 2011 to 2012 in Tainan City. Although the genotype of imported case was not similar to the 2007 Dominican virus strain but it still might be imported again due to the undetected imported cases in the early 2012.

One case of the indigenous positive DF cases was type II and was 100 % identical with Thailand strain in 2011. The 2011 Thailand strain was first isolated from Thailand imported case in 2011. This virus strain was the same as the virus strain isolated from Fengshan district, Kaohsiung in 2012. The case was living in the Shanhua district of Tainan City but went to Kaohsiung City on holidays, so it might indicate that the infected site was in Kaohsiung City. Other 537 cases had not done virus genotyping yet.

3. Indigenous positive cases notification and hospital visit analysis :

(1) Reporting sources

Among the 751 indigenous positive DF cases, the most cases (482) were notified from hospitals (64.2 %), followed by 185 cases (24.6 %) from clinics and 84 cases (11.2 %) from public health centers. The notified cases from public health centers included expanding collection of contacts, and voluntary report from resident.

(2) Duration between onset and notification date

The average duration time between onset and notification date for the 751 DF cases was 3.6 days. The statistics of the duration time in Tainan City was shown in Figure 6. The longest duration time (12.5 days) appeared in April 2012 when the outbreak had just begun. Along with the epidemic developed, the average duration time declined slightly and the shortest duration time was 2.8 days in September 2012. However, the duration time extended again in 2013. The percentage of the indigenous positive DF cases with the average duration time that longer than 6 days was 19.3 %, it meant that about one fifth of the cases were reported after viremic period and the duration time increased with the epidemic declined.

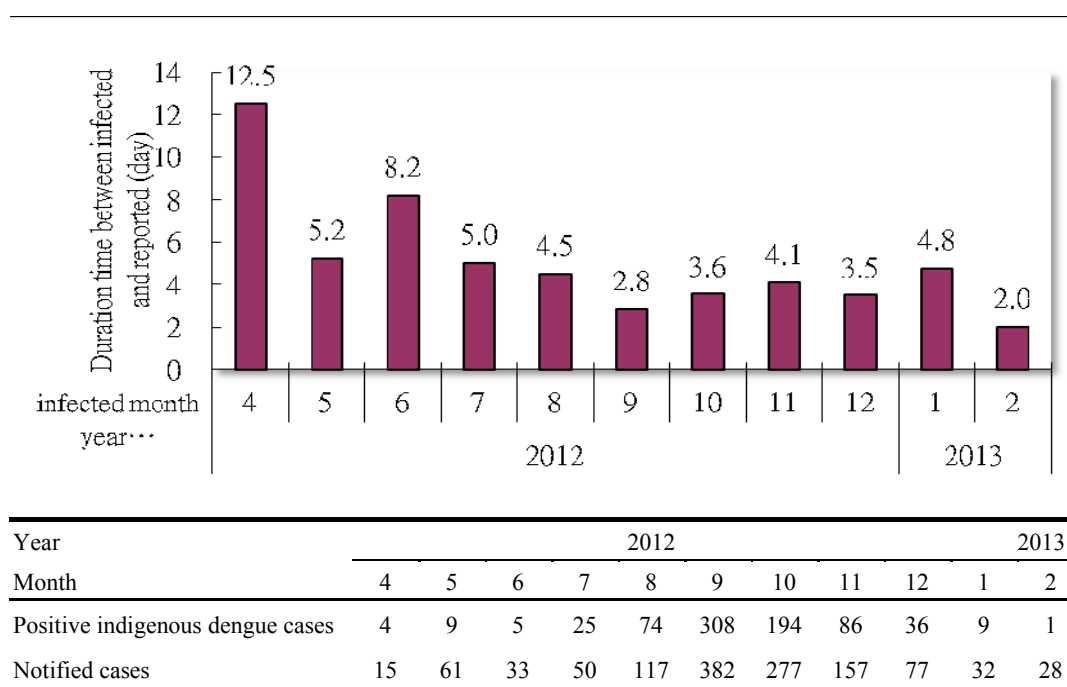


Figure 6. The duration time between onset and notification date of the indigenous positive DF cases in Tainan City.

Shanhua district had the longest duration time (5.3 days) while the shortest was 2 days appeared in both Rende and Qigu district. North, South and West Central district had more serious dengue epidemics and their mean duration time were all 4 days, which was longer than the average (3.6 days).

(3) The number of hospital visit before notification

According to the Epidemic Investigation System, the number of hospital visit before notification for indigenous positive DF cases was shown in Figure 7. The average number of hospital visit before notification was 1.8 times among the 751 cases. If by onset month, January 2013 had the highest number (2.7 times) of hospital visit and the lowest number (1.6 times) was in December 2012. The number of hospital visit before notification for DF cases in most months were less than 2 times, while in April, July and August 2012 and in January 2013 were more than 2 times.

By residential locations, the number of hospital visit before notification for DF cases in each district was shown in Table 2. Jiali and Guanmiao district had maximum number (3 times) of hospital visit before notified and Xinhua had least (1 time) but the representativeness was insufficient due to the case number was too few. In contrast, the number of hospital visit before notification for DF cases in East and South district was more than the others among the 6 districts in old Tainan City, they were 2.1 and 2.2 times separately.

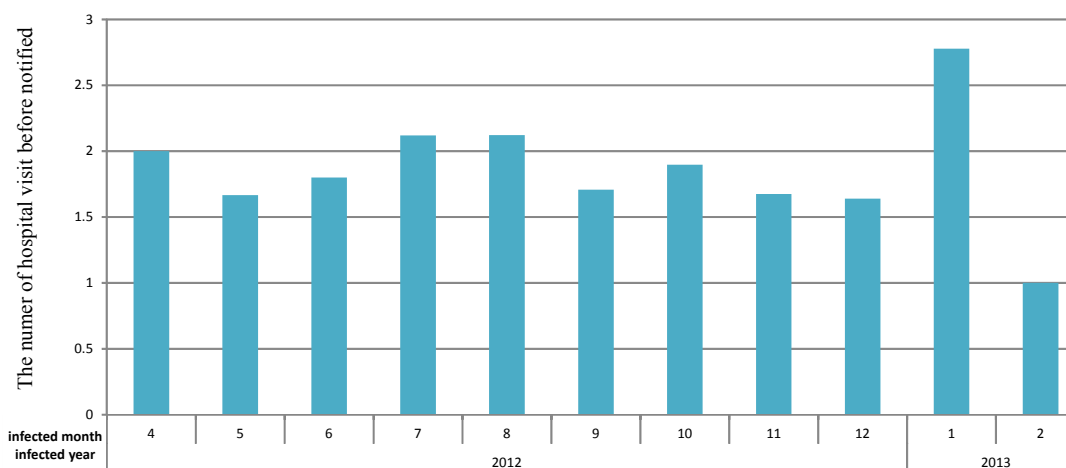


Figure 7. The number of hospital visit with onset date before notification for DF cases in Tainan City.

Table 2. The number of hospital visit before notification for DF cases in each district of Tainan City.

Residential area	Annan District	North District	South District	West Central District	Yongkang District	East District	Anping District	Shanhua District	Xinying District	Rende District	Xinshi District	Qigu District	Xigang District	Jiali District	Xinhua District	Guiren District	Guanmiao District
Positive indigenous dengue cases	313	148	105	104	35	23	7	3	3	2	2	1	1	1	1	1	1
Notified cases	372	232	150	140	88	89	28	8	7	28	5	2	1	6	11	13	9
The number of hospital visit before notified	1.8	1.8	2.2	1.5	1.7	2.1	1.7	1.3	1.7	1.5	1.0	2.0	2.0	3.0	1.0	2.0	3.0

4. Analysis of DHF cases

There were 5 DHF cases (0.7 %) among the 751 indigenous positive DF cases; Annan, West Central and North district had 2, 2, and 1 case, respectively. Their onset dates were between the 35th week in 2012 and the 1st week in 2013. The infected age of resident was between 7 and 78 years old and the average age was 54.6 years old. There were 2 deaths among the 5 DHF cases and the mortality rate was 40 %, which occurred in North and Annan district. The age of 2 deaths was 74 and 61 years old separately and they all had chronic diseases history such as hypertension.

5. Joint investigation and the inspection of Mobile Task Force

Since the dengue outbreak in 2012, the Southern Regional Center of Taiwan CDC established the Mobile Task Force immediately to assist the control operations in Tainan City. They also cooperated with relevant units of the Tainan City Government to conduct joint investigation, community diagnosis and evaluate the control efficiency. The major operations in the districts with more severe dengue epidemic were as below:

(1) Annan district

Dengue epidemics were concentrated in Haidian, Anfu, Xinfu and Guo'an village. The first indigenous positive DF case was occurred in Anfu village of Annan district and a lot of uninhabited houses with numerous wastes were found in this district. A large construction site with dirty and mass of breeding sources located in the junction of Haidian and Guo'an village. Wenxian market of Xinfu village had numerous positive ditches. Residents were used to store water for planting and it was convenient for mosquito reproduction. The uninhabited houses in Anfu village had been announced by the Tainan City Government and demand the administrator to improve the sanitation before the deadline. Through the double efforts and fined by the Tainan City Government together with the garbage disposal by the Departments of Health and the Environment Protection Department, the epidemic was finally ceased.

(2) West Central District

The first indigenous DF positive case occurred in Minzhu village of West Central district. Because of the messy environment and numerous uninhabited houses with a lot of dengue vectors, it became the triggering point of the dengue epidemic at the beginning. This district had a lot of old communities, uninhabited houses and temples. The streets were narrow with crowded residents and the basements were full of stagnant water. Since the basement of Bau'an Market in Junxi village was a large breeding site and numerous positive ditches were found in Minzhu, Jianguo, Minsheng and Junxi village, the relevant units of the Tainan City Government dosed insecticides and regulated these basements, positive ditches and uninhabited houses to control the dengue epidemic.

(3) South district

The dengue outbreak was concentrated in Nanhua and Nandu village of South district at the beginning. The main problems in Nanhua village were the stagnant water of buckets and parterres in condominiums, water containers on roofs and messy fire alleys and lanes. Stagnant water in abandoned tubes, vegetable gardens and orchards were found in Nandu village. Junnan, Mingxing and Mingliang village had a lot of vegetable gardens and vacant areas with numerous water containers which bred mosquito larvae. Other cases clustered areas were in Wenhua and Wennan village, positive breeding sources such as canvas, setting basins and abandoned ponds were found in the neighboring Suipingwen Park, which became a high risk area since the presence of numerous vector breeding sources.

(4) North district

The environments in Xiaokang and Zhengjue village with old communities dominated were similar to the West Central district, which contained a lot of uninhabited houses, vacant areas and unoccupied houses. Lots of basements with stagnant water became large breeding sites were found in Shijian village. Another cases clustered area were in Wenyuan and Dahe village, which had a lot of vegetable gardens, vacant areas and water containers.

(5) Yongkang district

Xiqiao and neighboring villages had more cases than the others. These villages had a lot of vegetable gardens and vacant areas. The residents had inadequate prevention concept of DF control and accustomed to store water with buckets and water containers, these provide breeding sources for mosquitoes. Feiyan and Yingju-3rd community of the military had lots of vacant areas and uninhabited houses with numerous garbage lead to the mosquito mass reproduction. After informed, the military had already cleaned up and rearranged these areas.

(6) East district

The positive DF cases were scattered in this district. The rates of uninhabited house and resident mobility were both high and resulted to the high potential risks of dengue infection in several villages.

Control operations

I. Tainan City Government

Foremost control operations to prevent the spread of the dengue epidemics of Tainan city were listed as below:

1. Establishment and operation of Command Center for Dengue Fever Control in districts

After the first indigenous positive DF case occurred at West Central district in summer 2012 and several clusters area related to it, the Dengue Fever Command Center of West Central district was established on May 23, 2012 to coordinate related units in

DF control. The Command Center had held conference with the Departments of Health, Environmental Protection Bureau and related units regularly; Southern Regional Center of Taiwan CDC was also invited to provide advice and assistance in the meeting. Since the establishment of the Command Center in districts, the cross-departmental and cross-unit control operations could be carried out smoothly. For example, “Operations of Shabby Houses for Dengue Fever” was preceded within departments soon after some abandoned and damaged houses were found in West Central district. They also coordinated with the City Government to promote control programs, such as “One Village-One Day Source Reduction” to urge the residents to reduce water containers and cleaning their houses and communities spontaneously. For example, Annan district had conducted “*Mosquito Control Program*” since September 22, 2012 to reduce mosquito breeding sources. HaiDian, Guoan, Xingfu and Hainan villages were united to execute “*Mosquito Control Program*” on September 22 and 23 too and more than 2300 households were inspected and 90 households had water containers or breeding sources been cleared up subsequently.

2. Tainan Dengue Fever Command Center

Because the DF epidemics became more serious since August 2012, the Tainan City Government had held on Cross-Departmental Meeting on August 28 and the Emergency Meeting was directed by the Mayor, Deputy Mayor and Secretary-General several times. Tainan Dengue Fever Command Center was set up on October 4 based upon the Communicable Diseases Control Act. It demanded the progress and assistance needed for control operations were posted by each department and district office staffs daily. Problems of the execution of DF control operations could be discussed and solved during the conferences through cross-departmental assistance. Organization of Tainan Dengue Fever Command Center was shown on Figure 8.

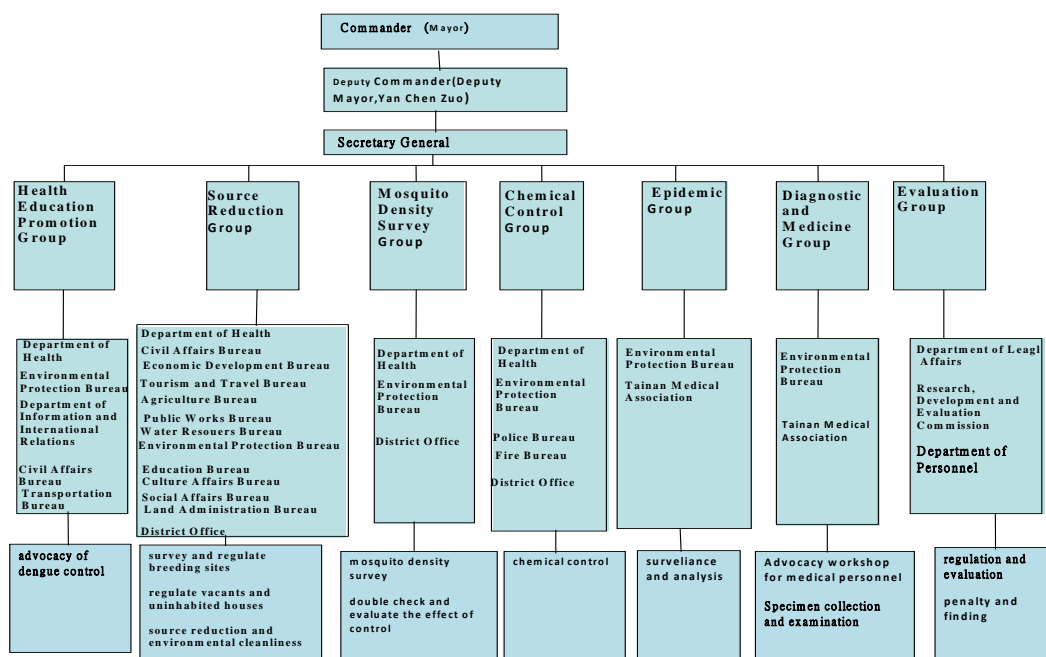


Figure 8. Organization of Tainan Dengue Fever Command Center

Chief of each district was in charge of the local dengue epidemic control program. Each “District Dengue Fever Command Center” should integrate every related resource and urge residents to reduce mosquito breeding sources. Each district should report its outbreak situation and control operations in order to solve problems immediately by the assistances of related departments and check the progress daily. Department of Health was in charge of *data collection and mosquito density survey*. The Environmental Protection Bureau was *responsible for eliminating high risk outdoor areas, collecting data of “One Village-One Day Source Reduction” program and insecticide management*. These operations could assist the DF control operations and the achievements would be more comprehensive and organized in the following program.

Cross-departmental meeting was held by the Dengue Fever Command Center daily and the unqualified areas would be regulated and solved instantly by related departments; finally, *the Environmental Protection Bureau would evaluate them to deregulate or not*. Besides, each important issue which needs cross-departmental assistance would be discussed and double checked daily by related departments during the meeting. Southern Regional Center of Taiwan CDC also joined the daily meeting to assist the community diagnosis, effectiveness evaluation and communication among relevant departments.

3. Community mobilization

DF control needs public participation and the effects of the control operations could be sustained by community mobilization and community strength. Tainan City Government had several experiences of community epidemic control and established the mechanism of community mobilization in the past. Since dengue outbreaks were expanding, Southern Regional Center of Taiwan CDC encouraged the Tainan City Government to implement the program of “One Village-One Day Source Reduction” with the successful experiences for community mobilization in other cities and counties. The Group Meeting of Dengue Fever Control was held by the Tainan City Government on August 28, the “One Village-One Day Source Reduction” program was finally decided and strengthened the range and frequency of mobilization in every epidemic area. After Tainan Dengue Fever Command Center was set up, the whole city executed the “One Village-One Day Source Reduction” program and reported the results to the Command Center every day.

District offices, Dengue Fever Control Volunteer Teams and village residents were the major implementation units for the “One Village-One Day Source Reduction” program. The village officer was responsible for communicating every units in the village and supporting each control operation; officer of the Department of Health guided his staff to eliminate mosquito breeding sources, health education, results recording and household inspection; the Environmental Protection Bureau and its district teams targeted major breeding sites and regulated areas to clear up garbage and keep the outdoor environments clean; the supervisors and chief secretaries of the district were in charge of irregular inspection.

4. Enforcement of public authority

In addition to the Communicable Disease Control Act and the Waste Disposal Act, the Tainan City Government had announced “Vacancy Management Autonomy Ordinance of Tainan” and “Environmental Clean Autonomy Ordinance of Tainan” on June 21 and September 13, 2012 separately. According to the “Vacancy Management Autonomy Ordinance of Tainan”, the dengue epidemic control staffs could enter those uninhabited houses and areas for inspection in accordance with police or village chief when it is necessary. Besides, if the firebreak alleys were dirty and messy, the owners could be fined according to the “Environmental Clean Autonomy Ordinance of Tainan”.

The Environmental Protection Bureau of Tainan City Government and related departments had executed “Mosquito Larvae Reduction Project” on September 13, 2012 to inspect those high risk areas, such as communities, construction sites and resource recycle yards; Department of Health was responsible for the indoor and outdoor containers and mosquito breeding sources for reducing the epidemic therefore reinforced the public authority. If the containers were filled with stagnant water and bread with the mosquito larvae or the uninhabited houses and areas were too messy that might affect the environment sanitation, the owners would be fined on the basis of the Waste Disposal Act. Besides, the City Department of Health and the relevant units had executed “Elimination and Inspection in High Risk Area of Dengue Fever for Breeding Source Reduction” plan on September 21, 2012; any village with the number of indigenous positive DF cases above average, one neighborhood from the district is chosen randomly to conduct the general survey. If there were deficiency discovered, no matter the government departments, private companies or community residents, the owners would be fined by law. The unqualified sites of governmental departments, schools, high risk areas and communities which inspected by Southern Regional Center of Taiwan CDC would be recorded on “Inspection Recording Sheet of Taiwan CDC Mobile Task Force” and had been handed over to the Tainan City Government to fine the owners according to the related laws. This implementation was successful and obtained good effects on government departments, private companies and community residents. For example, more than 90 uninhabited houses in Annan district, uninhabited dormitories with stagnant water of National Property Administration, abandoned military communities, equipment of telecommunications companies with stagnant water and the large breeding sites resulted from the works of construction sites were cleared up quickly by continuous enforcement of government. The City Government and Mobile Task Force would double check those messy and regulated areas once in a while, if not improved, the related units would receive continuous penalties. By this enforcement of government, the public's awareness and activity of prevention for DF and the community compatibility were raised gradually. Tainan City Government had imposed 727 fines in 2012 in total and the fined units, fined amount and violation of laws was shown on Table 3.

Table 3. The imposition of fines of the Tainan City Government in 2012

Government	Laws	Cases	Fine (dollars)
Tainan Department of Health	According to article 25 of Law on the Control of Communicable Diseases	191	All 3000
	According to article 36 of Law on the Control of Communicable Diseases	1	All 3000
Tainan Environmental Protection Bureau	According to Subparagraph 1 of article 25 of Trash Clearance Act	36	All 1200
	According to Subparagraph 11 of article 27 of Trash Clearance Act	499	All 1200

5. Health education and advocacy operations

In response to the increasing and fluctuation of epidemic, health education plays an important role on DF control. The key point of health education is to let the public acknowledge the situations and scale of dengue epidemics in sight and learning the preventive methods with self-protections in accordance with the Department of Health and the Environmental Protection Bureau to clear up water containers and source reduction. Tainan City Government published press releases or dengue epidemic related news after cross-departmental meeting. Besides, they would hold press conference before executing important DF control activities and projects; for example, Tainan City Government had held press conference on September 20, 2012 and announced the double fines by the Department of Health and the Environmental Protection Bureau to inform public and related news to increase their vigilance before the “Elimination and Inspection in High Risk Areas of Dengue Fever for Source Reduction” is executed. After the Dengue Fever Command Center was set up, Tainan Information Services Department strengthened the cooperation of media to increase promotions about DF control by local cable television channels. They invited experts and relevant department directors on October 2012 to make dengue-related films and broadcast at TV station and the website of the Tainan City Government. Furthermore, Tainan mayor’s Facebook had set up DF page for communicating with the youngster and network groups to promote health education in DF control.

II. Central Government

Ministry of Health and Welfare is in charge of the DF control in Taiwan, other central departments assisted clearance of breeding sources, environmental sanitation and health education in accordance with their administrative responsibilities, such as the Ministry of Education is in charge of schools and students, the Ministry of National Defense (MND) is responsible for the place under the MND jurisdiction and Armed Forces, the Ministry of Transportation and Communication is responsible for each station and public transportation, the National Property Administration (NPA) is in charge of the land and buildings under the NPA jurisdiction and the Environmental Protection Bureau is in charge of the outdoor environment. The Ministry of Health and Welfare played the role of supervision and assist the local governments on DF control for the early response of the epidemic and prevent its spreading. In response to the dengue epidemics, the Southern Regional Center of Taiwan CDC had raised its control levels and organized staffs into groups, the main control operations were listed as follows:

1. Supervising control operations and assist community to diagnosis, control efficiency evaluation and advice suggestions

Soon after the outbreak in West Central district of Tainan City, the Southern Regional Center of Taiwan CDC had supervised and assisted the Tainan City Government to conduct several control operations such as specimens examination, contacts tracking, epidemic investigation, breeding source reduction, community diagnosis, risk level assessing and provided relevant recommendations for the dengue diagnostic and epidemic control operations. While the Tainan Dengue Fever Command Center was established, the Southern regional Center of Taiwan CDC had attended the daily Command Center meeting to assist the diagnostic evaluation of the outbreak districts and prepare diagnostic results with recommendations. When problematic areas were found, the Southern Regional Center of Taiwan CDC would post in the daily meeting and the Dengue Fever Command Center would hand it over to the related departments and demand the reciprocation of the processing as soon as possible. With the full cooperation of the Southern Regional Center of Taiwan CDC and the Tainan Dengue Fever Command Center, the control efficiency was reinforced and the assistance or recommendations were quickly executed.

2. Assisting in issues exploration and policy promotion

Because of the dengue epidemic continued to rise and community mobilization still needed to improve, the director of the Southern Regional Center of Taiwan CDC had visited the chief of the Tainan City Government and proposed “One Village-One Day Source Reduction” program in August 2012. The Tainan City Government decided to execute this project in the epidemic area at the end of August. The Mobile Task Force of Southern Regional Center of Taiwan CDC was in charge of the supervision, assistance and evaluation of this project. In order to assess the efficiency of the program, the Mobile Task Force of Southern Regional Center of Taiwan CDC had dispatched 76 members during September 11-14, 2012. There were 35 villages which had indigenous positive DF cases were investigated for mosquito densities and the Breteau index of 11 villages (31%) were over level 3, especially in Annan, Yongkang, East and North district, during the summer to September 10, 2012. The household index, number of water-holding containers per 100 households and container index were also investigated; 4 of 39 villages were higher than the others. Twenty-one villages were investigated randomly for public participation, the will of entering the household and knowledge of this program. Results showed that residents of 14 villages (66%) understood the program but the public participation was generally low. The control operations were mainly conducted by the village chief and community volunteers to broadcast the news and removed water containers at outdoors all over the community. Therefore the Southern Regional Center of Taiwan CDC had proposed to the Tainan City Government to hold practical training for the neighborhood chiefs and community volunteers by the Department of Health in order to enhance the entering into the household with health education and assist residents for breeding source reduction by way of small scale.

3. Cross-department cooperation

In order to urge the central departments to assist the DF control operations, the Southern Regional Center of Taiwan CDC had proposed to the relevant departments such as the Ministry of Education to supervise every school for mosquito breeding source reduction in August 2012 before the beginning of the semester and the Ministry of the Interior, the Ministry of Economic Affairs, and the Ministry of National Defense to execute source reduction under their jurisdictions in October 2012. The Southern Regional Center of Taiwan CDC had dispatched Mobile Task Force to inspect those areas mentioned above randomly and the records of problematic areas would be referred to the Tainan City Government for a fine and double check the progress of improvements.

4. Partition supervision of epidemic surveillance assistance and diagnostic evaluation in district

According to the infection and geographical distribution of positive DF cases, the Southern Regional Center of Taiwan CDC had divided Tainan City into several operation zones. In order to increase the information communicated and exchanged more effectively between related departments, the Southern Regional Center of Taiwan CDC had grouped into several parties to supervise the control operations, attend related conferences, assist the community assessment and epidemic surveillance, communicate and exchange information and so on in each district. This operation could fully realize the execution results and control mobilization efficiency of “One Village-One Day Source Reduction” in each district. The district with successful experience could be a model to the others, so they could learn and improve their control operations.

5. Operation of Mobile Task Force of Southern Regional Center of Taiwan CDC

The Southern Regional Center of Taiwan CDC had established the Mobile Task Force on May 9, 2012 to conduct mosquito densities survey in community, double check the regulated sites, assess the performance of the operations and evaluate the efficiency of source reduction and emergency chemical control for mosquitoes. The major mission of the Mobile Task Force was to inspect and assess: (1) the area with DF cluster occurred but could not find the key problem, (2) the major cases cluster area with severe cases, (3) special or high risk areas such as the central ministries, campuses, construction sites and markets, etc., and (4) major regulated areas. Through the inspection of the Mobile Task Force, obscured breeding sources had been recorded on the “Inspection Recording Sheet of Taiwan CDC Mobile Task Force” and turned over to the Tainan City Government to fine by the related laws. The improvements would be double checked by the Mobile Task Force. They had gone into action for 665 times and inspected 501 villages, 137 records were imposed since the establishment day to December 31, 2012.

Discussion and suggestions

With global warming and frequent human activity, DF has become a very important epidemic disease in Tainan City for recent years. Dengue epidemic in Tainan City in summer of 2012 was the largest epidemic except for year 2007 since 10 years ago. Due to the adverse factors such as heavy rainfall, the Tainan City Government had faced a great challenge in DF control. The annual average rainfall was 2,425 mm and annual rainy days were 107 days in 2012, the former was the second highest and the later was the top for the past 10 years; moreover, the rainfall concentrated from April to August, just at the beginning of the dengue epidemic. Although the relationship between the weather factors and the DF cases is yet to confirmed, the previous studies showed that there was a significant correlation between weather factors (temperature, humidity and rainfall) and mosquito larvae densities. Besides, the duration time between onset date and notification date of first indigenous DF positive case was 13 days and several positive cases were found through the specimen collection from contacts. This evidence showed that the dengue epidemic might have been spread for a while in the community before detected. According to the statistics, most of indigenous DF positive cases were found in hospitals, followed by clinics and the average duration time between onset date and notification date was 3.6 days, the average number of hospital visit before notification was 1.8 times. The duration time between onset date and notification date was 12.5 days in the first month of dengue epidemic and the average duration time between onset date and notification date was more than 5 days at the beginning of dengue epidemic from April to July. We speculate that the main reason might be the awareness to report from hospital and clinic was insufficient in the early stage of dengue outbreak, and another reason might be the individual's habit, people would buy medicine from pharmacy rather than go to hospital since not symptomatic or had no typically symptoms; it then became more severe when patient visited the doctor and was delayed for several days. Therefore, we should reinforce the relevant information in the early stage of dengue epidemic to the first-line hospital and clinic to increase doctors' awareness, such as international epidemic information, relating dengue symptoms and quickly convey the status of the epidemic to medical institutions and the epidemic of the neighboring regions when the epidemic occurred. The information and symptom of dengue epidemic are also needed to the public on suspected symptoms through the media, visit hospital as soon as possible and tell your doctor about history of activities. There were 5 DHF cases (0.7 %) among the 751 indigenous positive cases, 2 deaths among the 5 cases and the mortality rate was 40 %. Tainan City had suffered from several large scale epidemics in the recent years with different types of dengue virus, therefore, DHF cases would gradually increase in the near future. Early diagnosis and treatment becomes more and more important, so health care personnel should be reinforced for the clinical symptoms of DHF, diagnosis, treatment and clinical case discussion and other related education and training in the future in order to reduce the rate of severe and death cases.

The major control operations of DF were health education, community mobilization, source reduction and mosquito density survey. Tainan City Government had held educational advocacy training for 987 hospitals and clinics, the travel industries and agencies, volunteers of district health centers in March, 2011. Tainan City Government also conducted "Competition Plan of Dengue Fever in Districts and Villages" and joined with the "Environmental Clean Day" lead by the chiefs of the city departments for community control operations in early 2011. The chiefs of districts and villages were coordinated with "Community Mosquito-Elimination Volunteers Team" to advocate the health education and community cleaned up for environmental cleanness. Tainan City Government had established 292 "Community Mosquito-Elimination Volunteers Team" and conducted competition plan in various districts to increase the active participation of residents in DF control operations. Community mobilization for environmental improvement and community beautification enhanced the public's concern and responsibility for the community. District director should understand and record its environmental features well, check and clean up high risk locations such as uninhabited house, gardens, open areas, construction sites, etc., before dengue epidemics and to reduce the risk of spreading.

Dengue epidemic began at the West Central district and gradually spread to Annan district and others in Tainan City. According to the Program of Dengue Fever Control in Tainan City, if any area had occurrence of DF cases continuously, the District Command Center of Dengue Fever should be established to integrate the local resources for control operations. But most of the District offices set up the Command Center after the DF cases had accumulated to 10 cases in 2012 hence missed the prime period of DF control. At the beginning of the epidemic, the Command Center should be established as early as possible and the District office was the main command units responsible for leading the DF control operations and dispatching district resources. The District office mobilized various departments and community residents to eliminate breeding sites and environmental cleanness. The Environmental Protection Bureau and the Department of Health were in charge of assessment of collecting data on dengue epidemic and guidance of double check. Through the implementation of cooperation with each department and follow up evaluations, the mobilization could be comprehensive at the beginning. It needs more coordination with practical experiences to organize and operate smoothly especially in the district with severe epidemics before. The District office should hold the meeting regularly and invite the Department of Health and the Environmental Protection Bureau to discuss the progress of DF control operations, dividing authority and resolve related issues in the non-epidemic period. Cooperation of cross-departmental and community mobilization was one of the key points of DF control.

Tainan Dengue Fever Command Center was activated on October 4 based on the Communicable Diseases Control Act. Before the establishment, the Tainan City Government had held several cross-departmental meetings and the model of division of authority and regulatory assessment was preliminary organized. While the Tainan Command Center of

Dengue Fever was established, the Mayor of Tainan City determined it was in charge of the communication with the media and the public by press releases in DF fever control. Progress and assistance demands on DF control operations were posted by each department and district office staffs daily. Problems of execution for DF control operations would be discussed and solved during the conferences through cross-departmental assistance. Suggestions also would be proposed in advance of the meeting and handed to the related department and the execution status would be demanded to report every other day. The Department of Health and the Environmental Protection Bureau would double check the status of improvement and decided whether or not to deregulate. In addition, the Southern Regional Center of Taiwan CDC also assisted in evaluating and communicating with the request of relevant central ministries to participate in the meeting held by the Command Center and reported its DF control operations. Through the operation of the Tainan Dengue Fever Command Center, the communication and cooperation with other departments became more efficient and the framework of cooperation model in DF control was build up.

It was important for the District office to build a file for high risk areas, major regulatory sites and other natural and cultural environments in the district. The dengue epidemics had demonstrated that the characteristics of human activity environments of each district would derivate various problems such as the basements with stagnant water in West Central district, 92 uninhabited houses in Annan district, market and positive ditches in North district and a number of vegetable gardens in South district, etc. Previous survey on markets, temples, schools, human frequent activity places; uninhabited houses, recycling yards, basement with stagnant water and places with potential mosquito breeding in environment can be marked on the map for regular DF monitoring purpose. Reservoir elimination and container reduction should be proceeding when the mosquito larvae density was increased. If dengue fever epidemic occurred, regular monitoring map could be a reference for tracing the source of infection [12]. The "New Disease Geographic Information System" instituted by Taiwan CDC included traditional markets, hospitals, schools, government organizations and other relevant natural and cultural environmental information. The system would be updated when there was a new regulatory site. Improvement of the system needs cross-departmental co-operation and updated regularly by special unit responsible for the data collection. The system could be an important tool in community diagnosis and regular monitoring map.

The major situations found by Mobile Task Force of Southern Regional Center Taiwan CDC at the evaluation of DF control efficiency in Tainan were listed below: first, mosquito densities were still high after emergency spray of chemical control; it meant the breeding sources were not cleaned up completely; second, the mosquito densities of mainly epidemic area declined but in the periphery areas were still high; and third, the major and obvious breeding sources had been eliminated but some hidden breeding sources could still be a threat to the DF control operations. We speculate that the first reason might be the emergency chemical spray was executed hastily and short of manpower to clear away the breeding source

at the same time. Second was the community residents' alertness was decreased after chemical control. Third was to put in a lot of manpower and resources in the epidemic area but neglected the peripheral regions. The experience and intensity of the source reduction staff would also be a very important affecting factor. Source reduction should be the primary control operation while the emergency spray of chemical control was executed. Joint-regional control program should be established to demarcate the regulated area with collaborative risk and integrate cross-departmental resources. The education and training of the relevant staffs should have a long term plan in case of personnel changes.

Although the governments and the private companies had been invested a lot of resources but with the backup of laws and regulations, the dengue epidemic control operations would be more justified and even successful. The violator whether for the public authorities or community residents would be imposed fines through administrative law in order to alert the public to pay more attention on DF control operations. In addition to the Communicable Diseases Control Act, the Tainan City Government announced the "Tainan Vacancy Management Autonomy Ordinance" and "Tainan City Environmental Clean Autonomy Ordinance". Publics need to cooperate with the elimination of breeding sites and community rearrangement through the media promotion by the governments. The owner of the government organizations or private companies will be fined if any breeding sites were found in there responsible area. The Tainan Dengue Fever Command Center would follow the situation of improvement continuously and supervise the relevant units to process expeditiously; therefore the efficiency of improvement would rise greatly. The number of fines was greatly improved in this dengue epidemic relative to the past; residents had gradually understood that they would be punished if they did not clean up the water containers where mosquito larva bred. For this reason the public cleared breeding sources around the house voluntarily and assisted the DF control. Publics and government organizations reduced alertness gradually and coupled with the violators' objection while the dengue epidemic declined, these were still the major challenges for DF control operations. Punishment is not the purpose of DF control operations, the major objectiveness is to remind every organization and residents to pay more attentions to their surrounding environments and protect their own health and safety.

Conclusion

The dengue epidemic control of Tainan had faced many unfavorable influences such as rainfall, temperature and environment and so on and coupled with the first indigenous positive case of dengue fever occurred in April. With the cooperative effort of each government unit, the dengue epidemic declined after reached the highest peak in the 38th week of 2012 and did not appear another larger epidemic. The dengue epidemic was milder than in year 2007 and the experience of control personnel, community mobilization and government organization was improved. With this experience, the framework of the Command Center established, cross-departmental cooperation and district level command center as the primary responsible

unit became more mature and comprehensive, is worth for subsequent dengue epidemic control. DF control was closely related to the community and the environment according to the past experience. The efficiency of dengue control was limited if the operations were just relied on the government organizations. The fundamental goal of DF control is to alert the residents to pay more attention to their surrounding environment and participate in mobilization of community actively. It would obtain better results in DF control and enhance the public's alertness with the administrative punishment.

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Outbreak Investigation Express

A Fatal Neonatal Infection with Echovirus 30, Taiwan, 2013

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Abstract

On June 26, 2013, an 8-day-old neonate suspected of enterovirus infection with severe complications was reported to Taipei Regional Center, Taiwan Centers for Disease Control (TCDC). This was the first case of severe complications associated with Echovirus 30 (E30) infection over the past 10 years. E30 was diagnosed by the hospital and confirmed by the laboratory at TCDC. This case developed fever four days after birth. Neonatal sepsis was highly suspected and disseminated intravascular coagulation was noticed. In spite of intensive care, the case expired about one month after symptom onset. After investigation, we found that the case's mother and some relatives and friends who visited the case had fever and other uncomfortable symptoms before and after birth of the case. Because enterovirus infections can be transmitted to neonates through placenta, during delivery or by postpartum exposure, pregnant women should pay attention to health conditions of themselves and other family members as well 14 days before the child's birth and around the delivery. If any symptom or sign of infections occur in pregnant women, doctors should be informed and isolation or quarantine measures for neonates should be taken. Healthcare workers should monitor health conditions of neonates and enhance infection control measures in baby rooms to prevent from spreading of infections.

Key words: Enterovirus infections with severe complications, Echovirus 30

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