

Prevention of Dengue Fever in Taiwan – A Year 2004 Report

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Introduction

Three dengue epidemics occurred on the island of Taiwan, in 1915, 1931, and 1942. The epidemic in 1942 affected five-sixths of the population (five million people). The use of DDT during the period of malaria prevention in the 1950s destroyed the habitats of transmitting mosquitoes, and thereby also interfered with the transmission of dengue (Gubler, 2004). In addition, infrequent international travel prevented the importation of dengue from other countries. Therefore, there was no outbreak of dengue in Taiwan for almost 40 years. In 1981, dengue was re-introduced from the Philippines by fishermen of Shiou-Liu-Chiu and infected 80% of the population there (Fun, 2004). In 1987 and 1988, there were also outbreaks of dengue in Pingtung and Kaohsiung, and domestic cases occurred almost every year thereafter (Fig 1).

Long-term occurrence of dengue in certain regions, especially recurrence of different types of viruses, will increase the incidence of dengue hemorrhagic fever

and shock syndrome. Therefore, if dengue is not properly controlled, severe cases will significantly increase in the future (Gubler, 1998). In southern Taiwan, *Aedes aegypti* is present in Kaohsiung City, Kaohsiung County, Tainan City, and Pingtung County, and they are high-risk regions for dengue epidemics. Type 1, 2, 3, and 4 dengue viruses occur each year there, and dengue hemorrhagic fever also occurs, resulting in one death in 1994 and 1998, 21 in 2002, and 1 in 2003. The occurrence of dengue not only results in high social costs, but also causes public panic. Therefore, effective prevention of the occurrence and epidemics of dengue have become the goal of the government and the public.

Introduction to dengue epidemics

A. International dengue epidemics

Dengue occurs in tropical and subtropical countries, including Asia, Middle and South America, Africa, and North Australia where *Aedes aegypti* is present. Countries in Southeast Asia, which are in close relationship with us, are all epidemic regions of dengue. In 2003, epidemics of dengue occurred in Thailand, Vietnam, Singapore, and Indonesia. In 2004, the epidemics continued to spread, resulting in more than sixty thousand cases in Vietnam (87 deaths), seventy thousand cases in Indonesia (669 deaths), one hundred and thirty cases in Thailand (22 deaths), thirty three thousand cases in Malaysia (58 deaths), and nine thousand cases in Singapore (3 deaths). There were also epidemics in the Philippines and Hong Kong (Fig 2).

B. Domestic dengue epidemics

Imported cases

Since 1989, there have been imported dengue cases every year. The number

of tourists to Southeast Asia has also increased since the end of martial law on July 15, 1987. Southeast Asian foreign laborers (currently three hundred), 33.9% from Thailand, and 28.7% from the Philippines) were also imported since 1989. In addition, marriage between Taiwanese and people from Southeast Asia has increased to a total of one hundred thousand (63.1% of the marriages were with Vietnamese). The frequent social intercourse between Taiwan and the countries of Southeast Asia, which have year-round dengue epidemics, is the main source of imported dengue cases.

There were ninety-one imported dengue cases in 2004. Among them, two were cases of dengue hemorrhagic fever, but no mortality occurred. Twenty-six of the cases were from Vietnam, 14 from the Philippines, 13 from Thailand, 13 from Indonesia, six from Malaysia, six from Singapore, four from Cambodia, one from India, one from Bangladesh, and one from China (Table 1). The cases were distributed in 20 districts: 2 cases were in Keelung City, 11 in Taipei City, 13 in Taipei County, 13 in Taoyuan County, 1 in Hsinchu City, 2 in Hsinchu County, 2 in Miaoli County, 6 in Taichung County, 4 in Taichung City, 3 in Changhua County, 2 in Nantou County, 2 in Yunlin County, 2 in Chiayi County, 4 in Tainan County, 1 in Tainan City, 10 in Kaohsiung City, 2 in Kaohsiung County, 7 in Pingtung County, 3 in Yilang County, and 1 in Yaidon County.

Among the 91 imported cases (Fig 3), 57 cases (62.64%) were screened out at the international airport by body temperature measurement, 29 (31.87%) were reported by hospitals, 1 (1.10%) was reported by the patient, and 4 (4.40%) were screened out by blood sampling. The incidence (Fig 4) was highest in February (10 cases), July (9 cases), August (17 cases) and September (10 cases). The reasons for travel were primarily due to foreign marriage, sightseeing, religious activities, business, and work opportunities. Nineteen of the viral isolates were

type 1, 27 were type 2, 6 were type 3, 16 were type 4, and 23 were nontypable (Table 1).

Domestic cases

In 1987, an indigenous epidemic of dengue (527 cases) occurred in Tonkang, Pingtung County and the Sunmin district of Kaohsiung City. An outbreak (4389 cases) of dengue also occurred in the Kaohsiung metropolitan area the following year (1988). Thereafter, yearly indigenous epidemics occurred mainly in Kaohsiung County, Kaohsiung City, Tainan City, and Pingtung County where *Aedes aegypti* is present. The epidemic in 2002 (5,336 cases) was like that of 1988, and was caused by amplification of the previous year's epidemic. Epidemics that occurred in middle and northern Taiwan, (179 cases in Chungho City, Taipei County in 1995, 8 cases in Taichung City in 1995, 10 cases in Taipei City in 1996, and 3 cases in Changhao County in 2001) indicated that the risk of an outbreak is also significant in areas where *Aedes albopictus* is distributed.

Three hundred and thirty six domestic cases of dengue occurred in 2004, and among them, five were cases of hemorrhagic dengue fever. No mortality occurred. Two hundred and eighty one cases occurred in Pingtung County, 36 in Kaohsiung City, 12 in Kaohsiung County, 4 in Tainan City, 1 each in Taichung City (laboratory infection), Taichung County, and Taoyang County (related to epidemics in southern Taiwan). One case occurred in April, 10 in July, 11 in August, 60 in September, 130 in October, 94 in November, and 9 in December. One hundred and ninety seven viral isolates were type 1, 21 were type 4, and 118 were nontypable. One hundred and sixty five cases were male, and 171 were female. The cases were mostly between 20 and 65 years of age (248 cases, 73.8%, Fig 6). The five cases of hemorrhagic fever were between 26 and 30 years of age

(1 case), 56 and 60 years of age (1 case), and 61 and 65 years of age (3 cases).

Two hundred and eighty three cases were reported by a hospital, 25 from augmented case screening, 11 from active surveillance, 4 by the patients directly, and 13 from hospitals as fever of unknown origin. As to the effectiveness of reporting (Table 2), 130 (45.94%) cases were reported within 3 days of occurrence, 59 (20.85%) cases on the 4th day, 37 (13.07%) on the 5th day, and 57 (20.14%) after more than 5 days.

The dengue viruses in the epidemics of southern Taiwan in 2004 have been sequenced and analyzed by the CDC (Table 3). They may be caused by type 1 virus from the Philippines and type 4 virus from Vietnam.

Epidemic in Taichung City

On April 26, 2004, a college student in Taichung City was reported by a local hospital as a suspected case of dengue. An infection by dengue virus type 1 was later confirmed. Further analysis indicated that the infection was from a laboratory (the sequence was the same as the virus from the laboratory). No further spread occurred after authorities undertook preventive measures.

Epidemic in Pingtung County

On July 9, 2004, the first case of domestic dengue fever (type 1) occurred in the Chung-Un neighborhood of Pingtung City. Later a case of type 4 dengue occurred on August 2 in the Da-Wu neighborhood. Failure to control the first outbreak resulted in spreading of disease (Fig 7). In 2004, 281 cases of domestic dengue occurred in Pingtung County. Fifty two of the seventy nine districts in Pingtung City had cases. Among them, Tan-Chian (41 cases), Wei-Shing (30 cases), Yung-An (24 cases), Yung-Chung (21 cases), Da-Wu (12 cases), Chang-An (12 cases), Chung-Lang (10 cases), and Hou-Sheng (10 cases) districts

were most severely affected. Da-Wu, Yung-An, Hou-Sheng, and Ching-Shi districts also had type 1 and type 4 cases simultaneously. Areas near Pingtung City, including Gang-Li, Nei-Pu, Yan-Pu, Lin-Lo, Chng-Chih, Kao-Shu, Shin-Yan, and Ton-Kang districts, also had sporadic cases. Investigations revealed that all of them were related to the epidemic of Pingtung City.

Epidemic in Kaohsiung City

The Sing-Sing district of Kaohsiung City had a confirmed case of type 4 domestic dengue on September 7, which, after gene sequence analysis, did not relate to the epidemic of Pingtung City (Table 3). A type one dengue case cluster occurred in the Lin-Ya district in early October, and in area near San-Ming High School of the San-Ming district. Domestic cases in the Kaohsiung metropolitan area totaled 36 in 2004 (Fig 8).

Epidemic in Kaohsiung County

Since early October, there were sporadic cases occurring in Lu-Chu, Gang-Shan, Tzu-Guan, Feng-Shan, Shan-Ming, Chi-Shan, Ren-Wu, Da-Liau, and Da-She (Fig 9). The number of cases totaled 12, and among them, 5 were related to the epidemics of Pingtung County and Kaohsiung City. Da-Liau I had one case which occurred during the last week (the 53rd week) of 2004.

Epidemic in Tainan City

Four cases of domestic dengue fever occurred in late November in Tainan. Of the cases, two lived in the An-Nan district and were detected by the active disease surveillance system. Another two cases were workers of a post office, and lived in the eastern and middle-western areas of Tainan City, respectively. The infection source of the two cases could not be confirmed.

Preventive Measures

Ordinary preventive measures

Control of Imported cases

Body temperature measurement for travelers entering Taiwan at international airports

Since July 2003, infrared body temperature measurement was performed at all international airports to prevent the importation of diseases such as SARS. Travelers with abnormal body temperatures would have blood samples tested for diseases such as dengue fever and malaria. Mosquito curtains were also provided for use for one week at home or in hospitals to prevent the spreading of diseases by mosquitoes. Fifty-seven imported cases (62.63% of all imported cases) were discovered by this measure, which effectively hindered the spread of dengue fever (fig.4).

Measures to prevent the importation of dengue epidemics from Southeast Asia

The CDC, Tourism Bureau of the Ministry of Transportation and Communication, and Travel agencies have asked travelers going to dengue endemic areas to take mosquito-protective measures, to report suspected symptoms voluntarily to authorities at airports, to see a doctor and to report immediately if they have symptoms after returning to Taiwan.

High-risk areas in Taiwan were asked to intensify measures toward travelers from Southeast Asia, especially those from Indonesia and Vietnam. Health education by phone and interview was carried out. A case of dengue was found on April 5, 2004 in Shan-Hua, Tainan County by this measure, and the spread of

the disease was intercepted by immediate preventive action.

Health education and preventive measures for foreign laborers and spouses

Health education materials were printed in five languages (Chinese, English, Thai, Vietnamese, and Indonesian), provided to all counties and cities, and were given to employers and foreign laborers.

Agents and Employers of foreign laborers were asked to monitor the status of health of foreign laborers. If foreign laborers had symptoms of fever or rash, they were asked to see a doctor and report travel histories.

The CDC asked health screening hospitals to take blood samples of foreign laborers for examination if suspicious symptoms such as fever were found.

Intensify health education of the public and promote dengue prevention capability

Health education materials for dengue prevention were sent to branches of the CDC, health authorities around the country, junior high, and elementary schools for further education and information.

Educational video tapes, advertisements, and TV programs were broadcast on TV and published in newspapers promoting the active clearance of habitats of mosquitoes.

Press releases and conferences were held during or after each epidemic, torrential rains or typhoons to remind the public of dengue preventive measures.

Promotion of community mosquito habitat clearance and establishment of a transmitting mosquitoes monitoring system

The CDC deployed 168 people to high-risk districts of dengue where *Aedes aegypti* resides to assist in the transmitting mosquitoes monitoring system and prevention programs. In 2004, 80,067 districts were monitored for their density of the transmitting mosquitoes. Each district was monitored every 1 to 3 months.

88% of the districts have a Breteau index below or equal to one.

The CDC continued to monitor viruses from the transmitting mosquitoes in order to assess viral activity in high-risk areas. Due to infection mainly caused by imported cases in recent years and frequent sub-clinical infections, active monitoring of viruses from the transmitting mosquitoes before the coming of epidemic seasons was of vital importance. 2,171 pools of transmitting mosquitoes, which totaled 103,065 mosquitoes, were screened, and type 4 dengue viruses were found in the Yung-Ling neighborhood of Sin-Sin districts in Kaohsiung City on September 8-9, 2004.

Volunteer groups in high-risk areas were promoted and supported in carrying out community habitat clearance programs.

Improvement of techniques of the transmitting mosquitoes monitoring and emergency insecticide administration

Nine seminars about the training for the transmitting mosquitoes monitoring and emergency insecticide administration were held by the CDC in April and May of 2004. (One each in northern, middle, and eastern Taiwan, and six in southern Taiwan). A total of 997 people from the health authorities participated in the seminars.

The CDC and the Environment Protection Administration of the Executive Yuan held four trainings programs for professional personnel of disease prevention in 2004. One hundred people participated, and 97 of them passed the final exam. These professionals have a great influence on the quality of the mosquito monitoring emergency insecticide administration.

Equipment for the emergency insecticide administration

The goal of the emergency insecticide administration was to kill mature

mosquitoes, which may carry dengue viruses.. The particles of regular sprays are too large for sustained suspension. Therefore, the CDC has purchased new equipment in 2004 and distributed it to branches of the CDC and the health authorities of each county or city.

Insecticides such as Cyhalothrin, Deltamethrin, and Cyfluthrin were bought after assessment of their mosquito-killing effects on different subspecies of mosquitoes by professionals.

Improve medical treatment of patients with dengue fever and dengue hemorrhagic fever

To improve the quality of care for patients with dengue fever and dengue hemorrhagic fever, five training programs for health care providers were held by the CDC in April and May of 2004. A total of 1,053 people have participated in the programs.

To improve the medical treatment of patients with dengue fever and dengue hemorrhagic fever, 19 medical and disease prevention professionals were sent to the Ho Chi Minh City of Vietnam to participate in a clinical management training course for dengue fever and dengue hemorrhagic fever lasting 2 weeks. These participants became the instructors for other professionals in Taiwan.

Management of Dengue Epidemics

Emergency management

Measures for disease surveillance and prevention were undertaken once suspected cases of dengue were reported by hospitals.

After the emergence of a domestic case on July 9, 2004, health authorities of Pingtung County conducted a surveillance of the habitats and density of transmitting mosquitoes, and during the epidemics, measures for blood sampling

of close contacts and the emergency insecticide administration. Due to the increased mosquito density, experts on the transmitting mosquitoes were also sent to the area to help.

Execution of the laws governing epidemics

At the beginning of the dengue epidemic in Pingtung City, although persuasion was initially attempted on people who did not comply with the habitats clearance program, the epidemic had not subsided. Since persuasion was of limited success, the Department of Health of the Executive Yuan asked the Pingtung Government on August 23 to proclaim Pingtung City an epidemic area of dengue fever, and to request that the public actively clean the habitats around their houses or work places. People who did not comply with the law for transmitting disease prevention by completely eliminating mosquito habitats were punished accordingly.

The Pingtung Government completed the proclamation on September 6, including items necessary for compliance by the public and rules for punishment. According to the law for transmissible disease prevention, 279 persuasive and 25 compulsive punishments were released by the Pingtung Government in 2004.

Increase reporting by hospitals

According to the law for transmissible disease prevention, dengue fever was ranked as a group 2 transmissible disease, and has to be reported within 24 hours. Health authorities have to conduct surveillance and preventive measures and collect samples for examination once they receive reports. All test results were sent back to the respective doctors and health authorities via internet or fax.

The CDC also asked hospitals to take blood samples of patients who did not meet the criteria of dengue fever. Once health authorities received a report of

“fever of unknown origin”, they should conduct surveillance of the patients and the epidemic, investigate suspected cases, and undertake preventive measures such as habitat clearance and insecticide administration if necessary. Follow up blood tests were also required. Nevertheless, certain hospitals still usually reported cases meeting the criteria of dengue fever as cases of “fever of unknown origin”.

After August 13, the period of dengue epidemic, cases of “fever of unknown origin” were asked to be treated and reported as cases of dengue by the CDC.

After September 9, to meet the spreading dengue epidemic and to hasten preventive measures, suspected cases of dengue were to be reported via the transmissible disease reporting system to health authorities, not as cases of “fever of unknown origin.”

Modify principles of insecticide administration

After September, certain residents of Tan-Chian, Wei-Shin, Yun-An, and Da-Wu neighborhoods of Pingtung City have had insecticide administration more than 5 times, but the epidemic was still progressing. Hence, intensive insecticide administration, which would lead to public refusal, was of no help in controlling the spread. Therefore, the CDC and the Pingtung Government decided in a meeting on November 17 to set guidelines for insecticide use in Pingtung City according to the results of examinations and local outbreaks.

Examination results of reported cases: all suspected cases and samples collected from disease surveillance were sent to the southern branch of the CDC for examination. Methods included RT-PCR and enzyme-linked immunoadsorbent assay (ELISA) (IgM, IgG). The results could be obtained on the same day if samples were received before 10 AM. The results were taken as

the basis for insecticide use.

If the results of IgM, IgG, and PCR were all negative, no insecticide would be used.

If any one result of IgM, IgG, or PCR was positive, the insecticide would be administered accordingly (notification was released on the same day the results were available, and insecticide was administered on the next day).

If repeated sampling revealed negative results, insecticide administration would be discontinued.

If confirmed cases were still present after insecticide use 3 times :

Assessment of whether they are of the same epidemic should be performed. If they are of the same epidemic, surveillance for mosquito density should be repeated. Insecticide administration will be stopped if Breteau index is below one.

Health authorities should inform the Bureau of Environmental Protection to synchronize their indoor and outdoor insecticide use.

Establish the scope of dengue prevention

In October, the CDC established the scope of disease surveillance, sampling, and insecticide administration for the health authorities of Pingtung Government based on the date of disease onset. The radius was 50 meters if onset was within 5 days, 100 meters if onset was between 5 to 12 days, 200 meters if more than 12 days. These were set to prevent the spread of disease due to delay in hospital reporting.

Manpower assistance for disease prevention

To respond to the epidemic of dengue fever in Pingtung City, the CDC sent more than 20 people to the command center of emergency disease control in the Health Bureau of the Pingtung County from mid-September to late December.

They were grouped as the Augmented Surveillance Group, Habitat Clearance Group, and Emergency Insecticide Administration Group to assist in dengue prevention. Meetings were held daily with the Health Bureau to discuss setbacks which occurred on that day and measures for improvement were discussed.

Between October 4 and 6, the army provided 300 soldiers daily to assist in disease prevention. They were divided into five groups and sent to 15 priority districts to evacuate abandoned houses and areas. The spraying of insecticides was undertaken by the chemical crops.

Sharing of experiences of community activity

Dengue is a community environmental disease. To eliminate transmitting mosquitoes, means of promoting community participation should be established to promote active clearance of water-accumulating containers. The fruitful experiences of community participation of the Jing-Hua neighborhood of Tainan City was shared with other neighborhoods in a conference held on October 19 at the Health Bureau of Pingtung County.

After the occurrence of a domestic dengue epidemic in Pingtung City, it persisted despite prompt clearance of habitats and insecticide administration. A monitoring program was therefore established at a meeting about dengue prevention held by the Pingtung Government. Between October 23 and November 28, monitoring and rewarding principles were enacted accordingly to promote active clearance of habitats and transmitting mosquitoes in every neighborhood. Nevertheless, elevated transmitting mosquito indices were still found in 37 of a total of 79 neighborhoods, and the expected goals were not fully met.

Tests for resistance to insecticides

To understand the drug resistance of transmitting mosquitoes in Pingdung City, two surveillances for drug resistance were held at the sites of emergency insecticide administration. The use of insecticides and spraying equipment, and techniques of personnel were also monitored at the same time in order to control the epidemic.

Review of setbacks and measures for improvement**Delay in reporting by hospitals**

Causes: insufficient alertness of doctors caused failure to report suspected cases of dengue fever immediately to health authorities, or the diagnosis may have been concealed upon requests of patients.

Measures for improvement: improve training for establishing a correct clinical diagnosis, inform hospitals and clinics through health authorities to report suspected cases immediately, and punish those who conceal the epidemics.

Poor compliance of the public with disease prevention measures

Causes: due to misunderstanding of the route of transmission, species of transmitting mosquitoes, the significance of emergency administration of insecticides, and information about the epidemics; the public had a tenacious resistance to health authorities about emergency insecticide administration, disease surveillance, and clearance of habitats.

Measures for improvement:

Strengthen health education by informing the public about the importance of habitat clearance in the prevention of dengue fever. Designate areas that have been cleared to avoid frequent disturbance and public refusal.

Inform the public about the importance of emergency insecticide administration to kill and eliminate virus-bearing adult mosquitoes. Strengthen the professionalism and skills of insecticide administration personnel to increase the efficacy of public communication and insecticide administration.

Add the skill of disease surveillance to the course of training for personnel of health authorities to increase compliance by the public and accuracy of the results to meet the requirements of disease prevention.

Persuade those who are not compliant with the measures of disease prevention, and punish those who are not compliant.

Issues about abandoned areas and houses

Causes: abandoned areas and houses were dead spaces for disease prevention due to lack of management and growth of transmitting mosquitoes in adjacent water containers.

Measures for improvement: request local governments to list abandoned areas and houses, and request the owners to clean the areas periodically and within a set time limit. Local laws should be set to ensure the efficacy of management.

Issues about shortage of disease prevention personnel

Causes: the public was apathetic about dengue prevention and ignored active clearance of water containers nearby their houses. Due to the cutback of government personnel, there will be a shortage of personnel if there is an epidemic outbreak.

Measures for improvement:

In addition to continuing to promote preventive measures by the public,

teams of volunteers are also formed to promote public participation via community participation.

Each health authority should train its personnel to equip them with the ability to help prevent disease. After an outbreak of disease, they can be re-assigned to assist in disease prevention to avoid shortage of personnel.

Discussion

According to yearly statistics of dengue fever in Taiwan, besides the epidemics of 1998 and 2002 caused by continuation of the epidemics of the previous years, epidemics each year were almost caused and spread by imported cases, who brought dengue viruses from foreign countries. Due to severe epidemics of dengue in Southeast Asia and the frequency of social intercourse with the Taiwan people, imported cases increased significantly in recent years. Among the cases, foreign spouses and laborers were predominant and totaled 31 cases. Other routes of infection included travel (12 cases), religious activity, business, and employment. They were opportunities for health authorities to strengthen their disease prevention measures.

The peaks of imported cases in 2004 were concentrated in February, July, August, and September, which was compatible with seasons of travel during the summer and winter vacations. Health authorities should strengthen promotion of travel health during those periods and quarantine measures at borders to prevent epidemics from the outset.

Since the initiation of body temperature measurement in July 2003 at CKS and Kaohsiung international airports, the importation of dengue viruses has been significantly impeded. Nevertheless, sub-clinical and latent infections still result in imported cases. Therefore, to completely prevent importation of dengue viruses,

active reporting by the public and by hospitals has to be further emphasized.

As to the efficacy of reporting by hospitals, only 45.94% of cases were reported within 3 days of onset, 20.85% on the fourth day of onset, and 13.07% on the fifth day of onset. 20.14% of cases were reported more than 5 days after onset. Dengue viremia occurs between one day prior to onset of symptoms and five days after its onset. An early report of a suspected case will lead to effective preventive measures by health authorities and reduction of the chances of dissemination. As is common behavior of our people, cases usually sought treatment at two to three hospitals before they were reported. The lack of alertness by doctors and the delay in case reporting resulted in the loss of the golden period for disease prevention.

The 336 domestic dengue cases in 2004 were mainly adults between 20 and 65 years of age (73.8%). The five cases of dengue hemorrhagic fever were one 26-30 year-old, one 56-60 year-old, and three 61-65 year-olds. No pediatric cases have been reported. The age distribution of cases in Taiwan was different from those in Vietnam (more than 70% were children less than 15 years old), Thailand, the Philippines, and other countries in Southeast Asia (Hung, 2002), and was similar to those countries in middle and south America, such as Cuba. In Thailand, females accounted for two times the cases of males among admissions for dengue hemorrhagic fever. In Singapore, the incidence of dengue hemorrhagic fever in males was 1.46 times more than that in females (McBride, 2000). In Taiwan, among five cases of domestic dengue hemorrhagic fever, only one of them was female.

In the five cases of domestic and the two cases of imported dengue hemorrhagic fever, there was no evidence of previous infection with other types of dengue viruses. Therefore, dengue virus may cause severe hemorrhagic disease

or shock in the primary infection.

Although more cases of dengue occurred in 2004 than in 2003, and seven cases of domestic and imported hemorrhagic cases were reported, there was no mortality among the cases. This revealed that clinicians had their ability to provide appropriate care for patients strengthened after years of dengue epidemics and training courses held by health authorities.

The types, components, indoor and outdoor distribution of containers breeding *Aedes aegypti* were related to urbanization and industrialization of the areas and habits of the public. Mosquito-breeding containers were more abundant in districts where dengue spread than in those where no cases were reported (Hung, 1995). In the Wei-Shing, Tan-Chiang, Da-Wu, and Yung-An neighborhoods of Pingtung city here cases continued to recur, before the Pingtung Government enforced the cleaning up of habitats, Breteau indices in those areas were as high as four. In southern Taiwan where city planning was not sufficient, over-crowding of population, deterioration of living conditions, accumulation of garbage in basements, yards, and fire-proof alleys had become dead spaces for breeding of transmitting mosquitoes. The outskirts of cities usually have new neighborhoods, old buildings, abandoned areas and houses, and accumulation of garbage. The Chiang-Cheng district of Kaohsiung and Fung-Shan city of Kaohsiung County in 2002, and the Chiang-An, Da-Wu, Wei-Shing, and Chiang-Tan neighborhoods of Pingtung City in 2004 had the aforementioned conditions when they experienced dengue epidemics. Once dengue viruses spread, it is difficult to eliminate them within a short time. Therefore, the government of southern Taiwan should designate dangerous areas and clean them up in advance in order to prepare for the arrival of the dengue epidemic seasons.

In July 2004, the beginning of the dengue epidemic in the Cheng-An neighborhood of Pingtung City, the local government was not effective in coordinating the efforts of various government departments. Therefore, the epidemic could not be controlled within the golden period, resulting in the spread to other districts. Some residents also failed to comply with the recommendations of health authorities to actively clean habitats of transmitting mosquitoes, and even hindered emergency insecticide administration, disease surveillance, and habitat clearance undertaken by disease prevention personnel. These were the most significant obstacles in dengue fever prevention. The situation did not improve until September 2004 when the Pingtung government declared Pingtung City an epidemic dengue fever area, and took control of the situation according to laws related to transmitting disease prevention. In the experiences of 2004, we appreciate that if we cannot control the epidemic from the very beginning, its spread will result in higher social costs.

Perspectives

Southern Taiwan is an area where the rainy, hot climate is optimal for the growth of disease transmitting mosquitoes. Dengue epidemics during summer and fall have become great challenges to the health and environmental protection authorities. Reviewing the experiences of dengue prevention over the past years, completely eliminating water-accumulating containers in order to impede the growth of transmitting mosquitoes is the most important factor in dengue prevention. Therefore, learning how to foster the active participation of local communities in habitat clearance is the goal and direction of future efforts.

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Confirmed cases

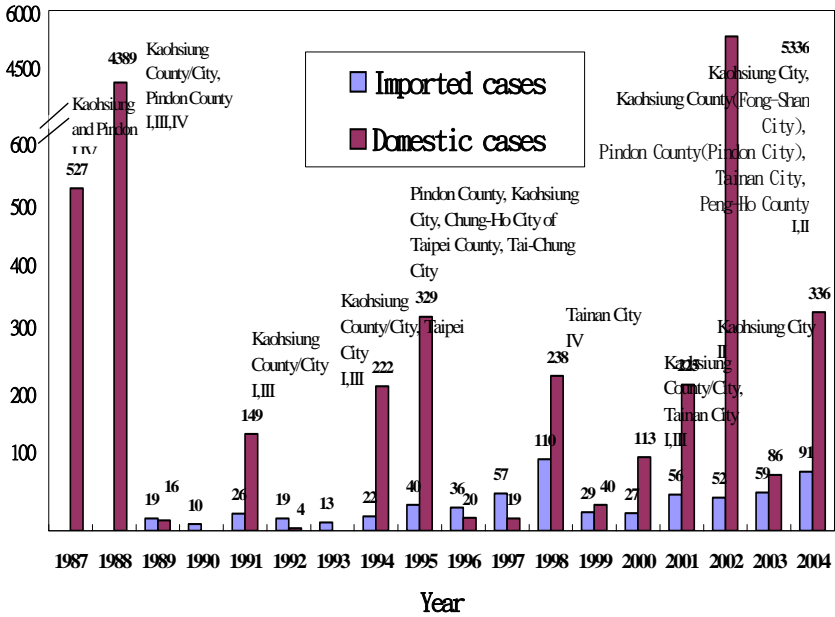


Figure 1: Distribution of domestic and imported cases of dengue fever between 1987 and 2004 in Taiwan



Figure 2: Distribution of dengue epidemic in southeastern Asia in 2004

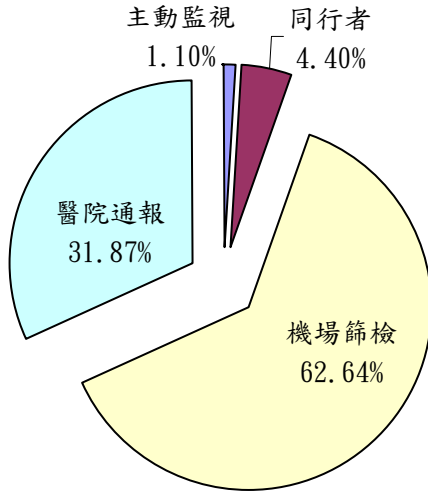


Figure 3: distribution of the sources of imported dengue cases in 2004

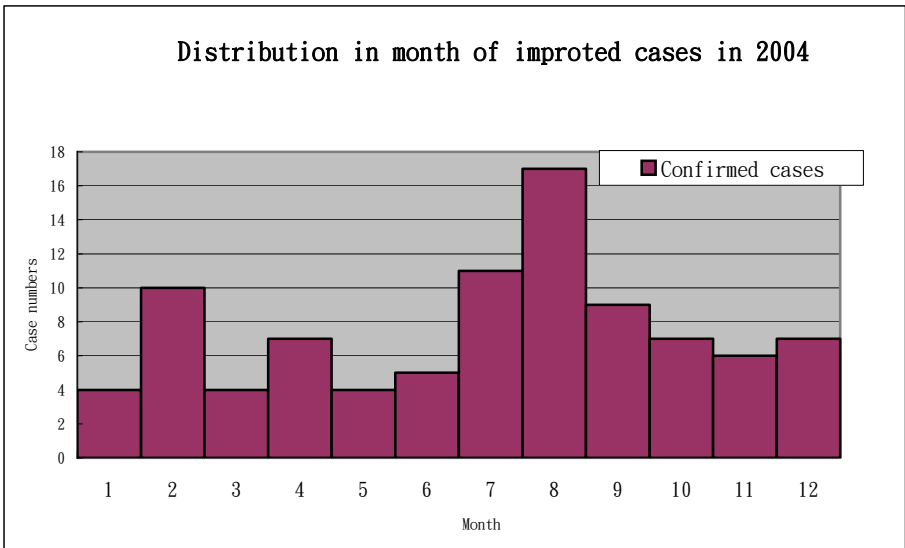


Figure 4: distribution in month of dengue imported cases in 2004

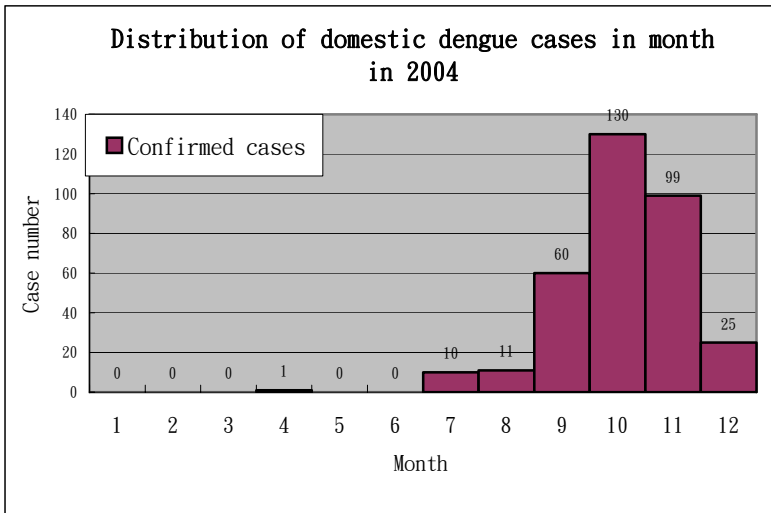


Figure 5: distribution of domestic dengue cases in month in 2004

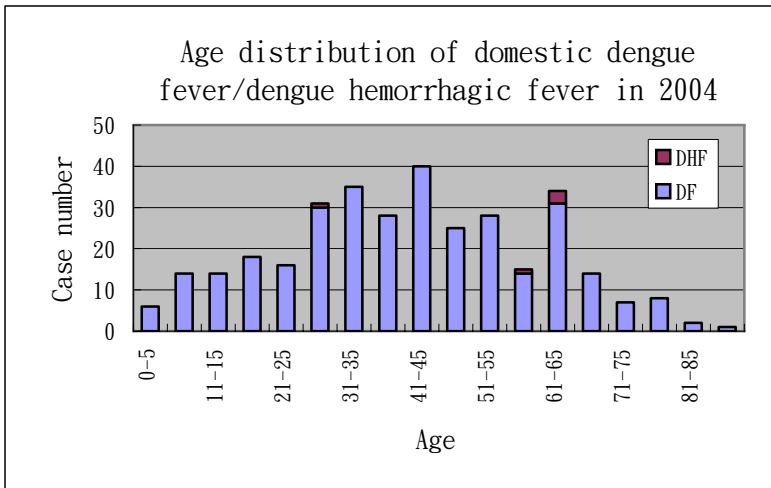


Figure 6: age distribution of domestic dengue fever/dengue hemorrhagic fever in 2004

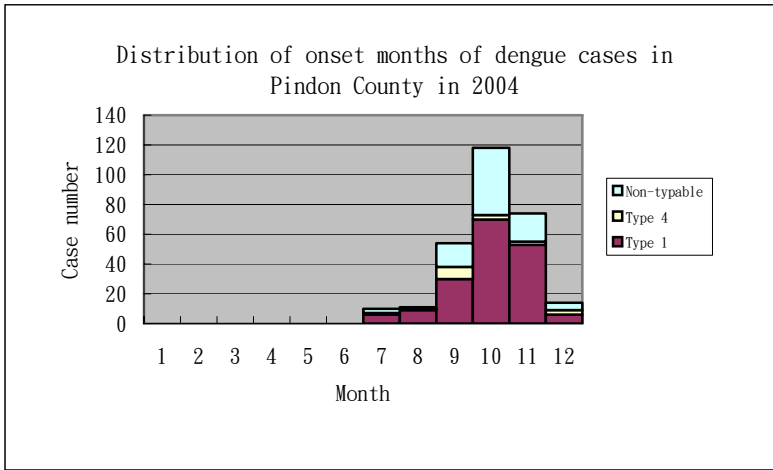


Figure 7: distribution of onset months of dengue cases in Pindon County in 2004

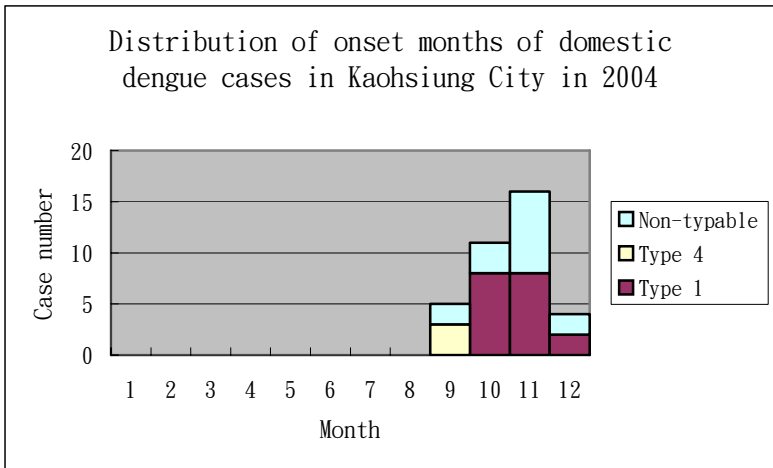


Figure 8: distribution of onset months of dengue cases in Kaohsiung City in 2004

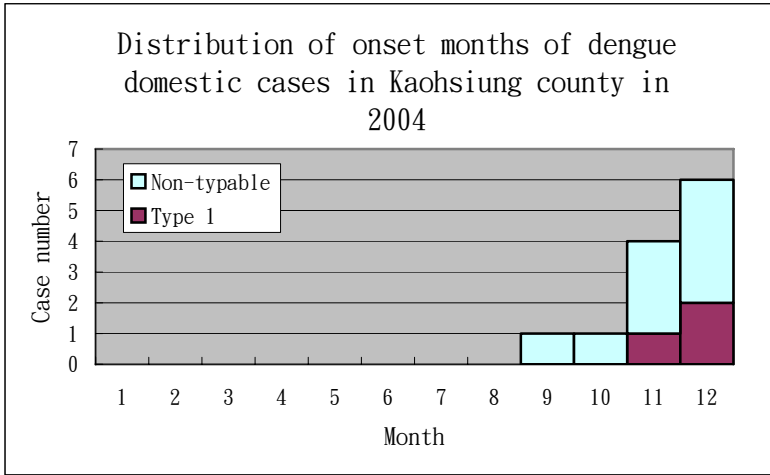


Figure 9: Distribution of onset months of dengue cases in Kaohsiung County in 2004

| Countries | Type | | | | | Total |
|-------------|------|----|-----|----|-------------|-------|
| | I | II | III | IV | Non-typable | |
| Vietnam | 3 | 9 | 5 | 1 | 8 | 26 |
| Philippines | 5 | | | 8 | 1 | 14 |
| Thailand | 3 | 2 | | 5 | 3 | 13 |
| Indonesia | 2 | 6 | 1 | 2 | 2 | 13 |
| Myanmar | | 4 | | | 2 | 6 |
| Malaysia | 3 | 1 | | | 2 | 6 |
| Singapore | 3 | | | | 3 | 6 |
| Cambodia | | 3 | | | 1 | 4 |
| India | | 1 | | | | 1 |
| Bangladesh | | 1 | | | | 1 |
| China | | | | | 1 | 1 |
| Total | 19 | 27 | 6 | 16 | 23 | 91 |

Table 1: Origins and types of imported dengue cases in 2004

| Efficacy of reporting confirmed domestic dengue cases by hospitals | | | | | | | | | | | | | |
|--------------------------------------------------------------------|------|-------|-------|-------|-------|-------|-------|------|------|------|------|------|-------|
| Day(s) from the day of onset | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | >10 | Total |
| Case number | 9 | 33 | 41 | 47 | 59 | 37 | 29 | 7 | 5 | 4 | 1 | 11 | 283 |
| percentage | 3.18 | 11.66 | 14.49 | 16.61 | 20.85 | 13.07 | 10.25 | 2.47 | 1.77 | 1.41 | 0.35 | 3.89 | 100 |

Table 2: Efficacy of reporting confirmed domestic dengue cases by hospitals

| Year | County/City | Endemic area | Type | Suspected importing country | Closest imported viral strain (similarity) |
|------|----------------|---------------------------------|-------|-----------------------------|--------------------------------------------|
| 2004 | Pindon County | Pindon City | DEN-1 | Philippines | iPH03a (99.6%) |
| | Kaohsiung City | Ling-Ya and Shan-Ming districts | DEN-1 | | |
| | Pindon County | Pindon City | DEN-4 | Vietnam | iVN04a (99.1%) |
| | Kaohsiung City | Shing-Shing district | DEN-4 | Vitnam | iVN02 (99.4%) |

Table 3: sequence analysis of viruses from domestic dengue cases in 2004