Trop. Med., 35 (4), 201−207, December, 1993

Recent Outbreak of Dengue in Taiwan

Ying Chang WU, Jih Ching LIEN and Hour Young CHEN

National Institute of Preventive Medicine,
161, Kunyang Rd., Nankang, Taipei, Republic of China

Abstract: In 1987 a dengue outbreak occurred in southern Taiwan, and it persisted throughout the year 1988. Although some cases were reported yearly since then it did not constitute an epidemic as severe as that of 1988. During the period from November 1987 to 30 June 1993, a total of 5,168 serologically or virologically confirmed cases was detected. Of all the cases, 5,085 were considered locally infected, and 83 imported. The proportions of indigenous cases to imported cases were 527 to unknown in 1987, 4,389 to unknown in 1988, 16 to 19 in 1989, 0 to 10 in 1990, 149 to 26 in 1991, 4 to 19 in 1992, and 0 to 9 in 1993. The sources of the imported cases were Thailand (54 cases = 65.1%), Philippines (11 = 13.3%), Singapore (8 = 9.6%), Indonesia (5 = 6%), Malaysia (2 = 2.4%), Vietnam (1 = 1.2%), India (1 = 1.2%) and Sri Lanka (1 = 1.2%). The dengue viruses were isolated both from mosquitoes and humans. Nine D-1 virus isolates were obtained from female mosquitoes of *Aedes aegypti* among the nine species of mosquitoes collected in houses in 1987 and 1988. The virus isolates from humans were 298 D-1 and 5 D-2 in 1987, 3,534 D-1, 3 D-4 and 1 D-3 in 1988, 5 D-1, 2 D-2 and 1 D-4 in 1989, 1 D-1 and 1 D-2 in 1990, 16 D-1 and 4 D-3 in 1991, and 2 D-1 and 2 D-3 in 1992.

INTRODUCTION

Several dengue outbreaks occurred in Taiwan before restoration of Taiwan to China in 1945 (Kojima & Akagi, 1915; Koidzumi, Yamaguchi & Tonomura, 1917; Goto, 1923; Nomura & Akashi, 1931; Akashi, 1932; Ohi, 1943; Akashi & Rin, 1943; Rin, 1944; Ko *et al.*, 1944; Sakai & Chin, 1944; Sato, 1944; Oda, Kyo & Tamaoka, 1944). Since then no dengue outbreak had ever been reported until 1981 when an outbreak of dengue due to type two virus occurred in the island Liuchiu off the southwestern coast of Taiwan (Hsieh *et al.*, 1982; Wu, 1986; Lin *et al.*, 1986). About 80% of the population (12,500 out of 16,000) on the island was affected (Hsieh *et al.*, 1982; Wu, 1986). The outbreak was quickly suppressed. In November 1987 an outbreak of dengue due to type one virus was again detected in Tungkang, a coastal town on the southwestern coast of Taiwan Proper, close to the island Liuchiu. Shortly after this an outbreak in the seaport city of Kaohsiung was also detected, and it persisted throughout the following year (Anonymous, 1989, 1991, 1992; Chuang, 1989a, 1989b; Gubler, 1988, 1991).

In 1988 a dengue emergency control center covering seven specialities was then

organized (Anonymous, 1989, 1991). The Department of Health is responsible for five units covering epidemiology, entomology, insecticide application, laboratory diagnosis and medical care, while The Environmental Protection Administration is responsible for work on source reduction and public relations (Anonymous, 1989, 1991). As an emergency measure, ultra low volume (ULV) spray of 3.6% water-base permethrin was applied to the interior of all houses within a 50-meter-radius of the house in which a case was found (Anonymous, 1988, 1989, 1991). Another follow-up spray was done after 7-10 days in order to eliminate newly infected mosquitoes. As warnings of risk, monthly reports on the *Aedes* indices of the more important localities were distributed to the relevant units for reference and action (Anonymous, 1989, 1991).

Ten species of the subgenus *Stegomyia* in the genus *Aedes* are known to occur in Taiwan, however only two of them, i. e. *Aedes aegypti* and *Ae. albopictus*, are closely associated with men, and are considered to be involved in the transmission of dengue (Lien, 1988, 1989 ; Lien *et al.*, 1992). *Ae. albopictus* is very widely distributed from hilly areas of 1,000 meters in elevation down to coastal areas throughout Taiwan, while *Ae. aegypti* is limited to southwestern plain and coastal regions south to tropic of Cancer (Lien, 1988, 1989 ; Lien *et al.*, 1992).

MATERIALS AND METHODS

Epidemiological investigations : Investigations were carried out by the members of the Epidemiological Division of the institute and the local health workers on every reported case. The investigation includes (1) recent travel abroad, country and date, (2) organization of service, (3) previous experience of dengue infection and date, (4) localities and durations of residence 2 weeks before and 1 week after onset of the disease, and (5) health status of the members living together. Blood samples were taken from reported dengue cases twice, i. e. during acute and convalecent periods, the second samples being taken 14 -28 days after the oneset of the disease.

Serological confirmation of reported cases : The sera were examined by hemagglutination inhibition test with sucrose acetone extracted antigen from dengue virus type 1 (Hawaiian atrain) infected suckling mouse brain (Clarke & Casals, 1958). Those with fourfold or more rise of titre are considered positive. Examination for anti-dengue IgM antibody was used as a rapid laboratory diagnosis since 1991 (Chow & Hsu, 1989 ; Chow *et al.*, 1992). Those with positive IgM were considered confirmed dengue cases.

Virus isolation from humans : Virus isolation was attempted with the sera collected within 7 days of the onset of illness. Culture of sera for virus was performed with *Ae. albopictus* cells C6/36 at 28°C for 1 week (Wu, 1986). Modification of the work procedure after 1990 is that the sera collected within 5 days of the onset of illness only are subject to virus isolation.

Serotype identification of the virus isolates : The virus isolates were examined by indirect flourescent antibody technique with monoclonal antibodies of the 4 serotypes of

dengue viruses (Wu, 1986).

RESULTS

The cases of dengue infection in recent years are shown in Table 1. In 1987 the second blood samples could be taken from about 40% of 1,123 reported cases, and 527 cases were serologically or virologically confirmed. In 1988 the second blood samples could be taken from only about 13% of 10,420 reported cases, and 4,389 cases were confirmed. From 1989 on, the second blood samples could be taken from about 80% of the reported cases. In 1989 among 594 reported cases only 16 were confirmed as indigenous and 19 as imported. In 1990 among 133 reported cases only 10 cases were confirmed as imported. In 1991 again a small outbreak occurred, and among 804 reported cases 149 cases were confirmed as indigenous, and 26 cases as imported. In 1992 among 239 cases, 23 cases were confirmed, 4 indigenous and 19 imported. By 30 June this year among 90 reported cases 9 were confirmed as imported.

The dengue virus isolates obtained from the indigenous and imported cases in Taiwan for the period from 1987 to 30 June 1993 are shown in Table 2. Among the 3,875 isolates D-1 consists of 99.5% (3,856), D-2 0.21% (8), D-3 0.18% (7) and D-4 0.1% (4).

Table 1. Reported and confirmed dengue cases in Taiwan (1987-30 June 1993)

Year	Reported cases	Confirmed cases		
		Indigenous	Imported	Total
1987	1,123	527	–	527
1988	10,420	4,389	–	4,389
1989	594	16	19	35
1990	133	0	10	10
1991	804	149	26	175
1992	239	4	19	23
1993	90	0	9	9

Table 2. Virus isolates from the indigenous and imported cases (1987-30 June 1993)

Year	Indigenous cases				Imported cases			
	D-1	D-2	D-3	D-4	D-1	D-2	D-3	D-4
1987	298	5	0	0	–	–	–	–
1988	3,534	0	1	3	–	–	–	–
1989	5	1	0	1	0	1	0	0
1990	0	0	0	0	1	1	0	0
1991	15	0	1	0	1	0	3	0
1992	0	0	1	0	2	0	1	0
1993	0	0	0	0	0	0	0	0
Total	3,852	6	3	4	4	2	4	0

The majority of the confirmed indigenous cases occurred in the city of Kaohsiung (Table 3) and its neighboring areas. The indigenous dengue cases occurred mostly in the months of September and October as shown in Table 4.

The sources of imported cases are tabulated in Table 5. Of the 83 imported cases 54 (65.1%) are from Thailand , 11 (13.3%) from the Philippines, 8 (9.6%) from Singapore, 5 (6%) from Indonesia and the rest 5 (6%) from Malaysia, Vietnam, India and Sri Lanka. Although more numerous imported cases occurred in September, they are more or less evenly distributed in each month and each county.

Table 3. The confirmed indigenous dengue cases in Kaohsiung city and other areas of Taiwan during 1987-1992

Year	Total indigenous cases for entire Taiwan area	Kaohsiung city only	
		No.	%
1987	527	300	56.9
1988	4,389	2,636	60.1
1989	16	13	81.3
1991	149	113	75.8
1992	4	3	75.0

Table 4. Monthly occurrence of confirmed indigenous cases during 1987-1992

Year	J	F	M	A	M	J	J	A	S	O	N	D	?	Total
1987	–	–	–	–	–	–	–	–	–	18	399	95	15	527
1988	3	6	10	0	87	89	114	482	1032	1694	683	23	166	4389
1989	3	1	1	1	0	0	0	0	0	2	3	5	0	16
1991	0	0	0	0	0	14	22	25	52	29	5	1	1	149
1992	0	0	0	0	0	2	0	0	0	0	1	0	1	4

Table 5. The sources of the imported dengue cases in Taiwan (1987-30 June 1993)

Sources of importation	Imported cases	
	No.	%
Thailand	54	65.1
Philippines	11	13.3
Singapore	8	9.6
Indonesia	5	6.0
Malaysia	2	2.4
Vietnam	1	1.2
India	1	1.2
Sri Lanka	1	1.2
Total	83	100.0

Discussion

Since the detection of dengue outbreak in the Taiwan area in 1987, only classic dengue cases have occurred mostly in Kaohsiung City and its neighboring areas due mainly to dengue type 1 virus, and rarely to other 3 type viruses. Special attention must be paid to the possibility of DHF occurrence and spread of dengue outbreak to other parts of Taiwan in the future.

The epidemiological investigations revealed that clusters of cases occurred in the areas with presence of both *Aedes aegypti* and *Aedes albopictus*, and that sporadic cases occurred in the areas with presence of only *Ae. albopictus*. In fact 9 isolates of serotype one virus were made from female *Aedes aegypti* among the 8 species of mosquitoes collected in houses (Lien *et al.*, 1992). *Ae. aegypti* is, therefore, considered playing an important role in the present outbreak. Although no concrete proof has been shown, *Ae. albopictus* might have played a minor role in the transmission of the disease sporadically in the areas where *Ae. aegypti* was definitely absent.

Recent boom of national tourism to Southeast Asia is the direct reason for recent importation of dengue to Taiwan. From Table 5, it is apparent that Thailand is the most favored place for tourism by the travellers from Taiwan, and that dengue situation there is bad.

Acknowledgements

The authors wish to express their sincere thanks to the Director General Dr. Po-ya Chang of The Department of Health, The Executive Yuan, Republic of China, and the Director Dr. Chibyi Horng of the National Institute of Preventive Medicine for their encouragement and support, to the members of the Division of Entomology, Epidemiology, Malaria & Parasitology, and Virology of The Institute, and also to the counterparts from the local health units for their participation in the work connected to dengue fever control operation.

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