The Epidemiology of Imported Dengue Fever Cases in Taiwan, 2007 and the Performance of Thermo-screening at Taiwan Taoyuan International Airport

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Abstract

There were a total of 179 imported cases of dengue fever in Taiwan during 2007, which consisted of 74 cases (41%) detected through fever screening at international airports and 105 cases (59%) reported by community doctors according to report sources. There were 54 residents of dengue fever cases in Tainan City/County and Kaohsiung City/County. Besides, the imported cases were mainly dengue type 2 virus infections, the same as most endemic cases in southern Taiwan in 2007. Countries where cases got infection were mainly Southeast Asian countries: Vietnam (55 cases, 31%), Indonesia (40 cases, 22%), and Philippine (22 cases, 12%). The main months for cases getting dengue fever were June to August (72 cases, 40.8%) and October to November (46 cases, 25.7%).

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We divided cases into two groups which included cases reported through fever screening stations at international airports and through community doctors. The statistical data showed that the time from date of illness onset to report date were 4.8 days in average at the first group and 10.2 days at the other.

In addition, we divided the 54 imported cases that consisted of residents in Tainan City/County and Kaohsiung City/County into two groups included cases reported through fever screening stations at international airports and through community doctors. According to the transmission period of dengue fever, we compared time correlation of the two groups with endemic cases in the cities/counties mentioned above. We discovered that there were 23 cases at the first group, of which, one case (1/23, 4%) exhibited time correlation with the first outbreak of dengue fever endemic in the county. There were 31 cases in the second group, of which, 5 cases (5/31, 16%) exhibited time correlation with the first outbreak of dengue fever endemic in the county within three weeks after returning places of residence. The results of using Fisher's exact test to analyze the protective factor that educating public health guidelines to cases reported through fever screening stations could reduce cases in endemic places. Public health education to patients could prevent endemic dengue fever in their places of residence. However, no statistical significance was showed in Fisher's exact test (P value=0.0922). By primary statistical analysis about the period from the onset date to the medical start date, we found that educating public health guidelines separately to cases detected through fever screening stations at international airports could influence their medical care seeking behavior.

Keywords: dengue fever, imported cases, fever screening stations, dengue fever transmission period, time correlation

Introduction

Dengue fever is a common endemic disease in Southeast Asian countries [1]. There were about 2.5 billion people living in dengue fever endemic areas and about 50 to 100 million infected cases of dengue fever each year, which include 250 to 500 thousand cases of dengue hemorrhagic fever and 25 thousand death cases [2]. However, Taiwan is not a dengue fever endemic country in Southeast Asia. When a non-imported case was happening in summer every year, dengue fever endemic cases were increasing then cases slow down in December, which might correlate with the average temperature in December is below 18℃ in Taiwan [3]. According to the literature review, female *Aedes aegypti* would not bite animals when the temperature drops below 17℃ [4]. Besides, *Aedes aegypti* could not survive under the weather condition of 7-10℃. As a result, low temperature could inhibit mosquito vector emergence so the Breteau index would decrease and ceased the outbreak [5]. Besides, compared the viral serotypes of endemic cases of dengue fever each year, there were no obvious correlation between each genotype. As a result, we could predict that dengue fever is not endemic in Taiwan yet. In conclusion, it is important to prevent importation of dengue fever to reduce the threat to public health in Taiwan.

To prevent and control of SARS into Taiwan, we implemented fever screening stations at international airports in 2003 to effectively survey febrile passengers and prevented infectious diseases from entering Taiwan [6-7]. Until now, the infrared temperature sensor detection has become regular quarantine work for immigration passengers. For passengers with abnormal temperature, quarantine officers would follow legal procedures

to confirm if passengers had infections and collected specimens needed for further examination. Besides, examination and diagnosis of imported cases of dengue fever at quarantine stations is a point procedure at international airports as well.

To realize the role of imported cases in the epidemiology of dengue fever in Taiwan during 2007, we applied the Notifiable Infectious Diseases Report System database of the Taiwan Centers for Disease Control (Taiwan CDC) for relevant analysis that was emphasized on statistical data about travel destinations and onset month. The data could be a reference for quarantine officers at international airports while surveying imported passengers about quarantine works of infectious diseases.

In addition, imported passengers who might infect dengue fever were not forced to go to medical center for medical treatments, self-health management in patients were necessary after immigration while returning to places of residence. As a result, these patients possibly became the source of endemic dengue fever. In this research, we separated 54 imported cases of dengue fever into two groups which included cases reported through fever screening stations at international airports and through community doctors. Besides, according to the transmission period of dengue fever [8], we compared time correlation between the two groups and endemic cases in Tainan City/County and Kaohsiung City/County in 2007 to realize the effectiveness of diseases prevention after educating public health guidelines to patients at international airports.

Materials and Methods

Target population and study period

We applied the Notifiable Infectious Diseases Report system database of the Taiwan CDC as data source to gather statistics for imported cases of dengue fever. The time was based on the onset date of illness and the data was collected between January 1 and December 31 in 2007.

Laboratory diagnosis

Laboratory diagnostic methods include virus incubation in the serum, viral nucleic acid test, and antibody detection. Cases of dengue fever are confirmed by one of the following methods: a. Dengue fever virus can be isolated from patient's specimens; b. Sample results are positive via viral nucleic acid screening method; c. Both IgM/IgG antibody screening of dengue fever are positive and IgM antibody of Japanese encephalitis virus are negative in single serum samples or an increase of more than four-fold in IgM/IgG antibody values of dengue fever virus in paired serum samples [9].

Data analysis

1. Epidemiological characteristics: statistical information was collected about report sources of imported cases, city/county of residence, travel destinations, onset month, and viral types. 2. Assessment of border quarantine effectiveness: a. We divided 179 imported cases into two groups, which consisted of cases reported by fever screening stations at international airports and by community doctors and compared the time in average from the onset date to the report date in the two groups. b. Epidemiological analysis of the 54 cases which consisted of residents in Tainan City/County and Kaohsiung City/County, of which, 23 cases were reported through fever screening stations at international airports and returned to places of residence after receiving public health education and 31 cases were not educated quarantine information by border quarantine

officers. According to the transmission period of dengue fever, we defined a protective factor that educate patients public health guidelines could prevent endemic dengue fever in their places of residence and compared time correlation between two groups and endemic cases in Tainan City/County and Kaohsiung City/County. About cases reported by fever screening stations, the basic date were defined by the date that patients returned places of residence. While about cases reported by community doctors. Thus, if there were no endemic cases of dengue fever three weeks before the basic day while endemic cases of the same type were reported during 11-22 days after the basic date, we defined that time correlation were established. (p.s. the incubation period of virus in vector mosquitoes is 8-14 days while the incubation period of newly infected cases are 3-8 days, thus we predicted that the observation period of a new outbreak is 11-22 days.)

Results

Epidemiological characteristics

1. Report sources of imported cases

   We analyzed a total of 179 imported cases, of which, 52 cases were reported through fever screening stations at Taoyuan International Airport and 22 cases were reported through fever screening stations at Kaohsiung International Airport, that means 74 cases (41.3%) were reported by quarantine officers while 105 case-patients (58.7%) were not febrile during immigration so they were not detected by fever screening stations.

2. City/County of residence

There were a total of 179 imported cases of dengue fever in 2007, which consisted of residents in 20 counties after immigration, of which, 58 cases in Taipei area (Taipei, Yilan, and Keelung), 19 cases in northern area (Taoyuan, Hsinchu, and Miaoli), 28 cases in central area (Taichung, Changhua, and Nantou), 45 cases in Yunlin-Chiayi-Tainan area, 28 cases in Kaohsiung City/County and Pingtung area, and 1 case in eastern area (Hualien and Taitung). Besides, there were 23 patients returned to places of residence in Tainan City/County and Kaohsiung City/County, of which, one patient was immigrated from Taoyuan International Airport and 22 patients were immigrated from Kaohsiung International Airport.

3. Travel destinations

About travel destinations, 55 cases (31%) were imported from Vietnam, followed by Indonesia (40 cases, 22%), Philippine (22 cases, 12%), Cambodia (11 cases, 6%), Thailand (10 cases, 6%), China (9 cases, 5%), Myanmar (8 cases, 4%), Malaysia (7 cases, 4%), Singapore (3 cases, 2%), Solomon islands (2 cases, 1%), and 1 case (1%) was imported from India and Bangladesh each. The other 10 cases were lack of information.

4. Onset month

Of the 179 imported cases, June (24 cases), July (21 cases), August (26 cases), October (28 cases), and November (19 cases) were the months with the largest number imported cases of dengue fever, followed by September and December (14 cases each), April (10 cases), January (9 cases), May (7 cases), February (5 cases), and March (2 cases).

5. Viral types

Of the 179 imported cases, 45 cases were infected with dengue type 1

virus (25.1%), followed by type 2 (33 cases, 18.4%), type 3 (22 cases, 12.3%), type 4 (6 cases, 3.4%), and the remaining 73 cases were not categorized (40.8%). Furthermore, there were 1,986 endemic cases in Tainan City/County and Kaohsiung City/County, of which, 1,099 cases were type 1 infection (55.3%), followed by type 2 (75 cases, 3.8%), and the remaining 812 cases were not categorized (40.9%). Both imported cases and endemic cases were mainly dengue type 1 virus infection.

The effectiveness assessment of border quarantine

1. The time in average from the onset of illness to the report date.

   Of the 179 imported cases of dengue fever including 74 cases that were detected through fever screening stations at Taoyuan International Airport and Kaohsiung International Airport. The period between the onset date to the report date was 4.8 days in average. The other 105 cases were not detected through fever screening stations, all of which were onset of illness after immigration and the onset date to the report date was 10.2 days.

2. The epidemiological analysis of imported cases that consisted of residents returned to Tainan City/County and Kaohsiung City/County.

   A. Statistics of cases

      A total of 74 cases which were detected through fever screening stations, of which, 23 cases returned to places of residence in 4 counties in southern area (23/74, 31%), which consisted of Tainan City (10 cases), Tainan County (4 cases), Kaohsiung City (5 cases), and Kaohsiung County (4 cases). Besides, 105 cases were not detected through fever screening stations including residents returned to Tainan City/County and Kaohsiung City/County (31/105,

29.5%) which included Tainan City (11 cases), Tainan County (8 cases), Kaohsiung City (7 cases), and Kaohsiung County (5 cases).

B. Risk analysis of cases that induced an outbreak of endemic dengue fever

a. The definition of time correlation

Cases reported by fever screening stations were defined the basic date by the date of patients back to their residence, while as cases reported by community doctors were defined the basic date by the onset of dengue fever. Thus, if there were no local dengue fever cases three weeks after the first date (the date patients back to residence or the onset of illness) and local dengue cases with the same type were reported between the 11-22days after the basic date, we defined that time correlation were established. (p.s. the incubation period of virus in vector mosquitoes is 8-14 days while the incubation period of newly infected cases are 3-8 days, thus we predicted that the observation period of a new outbreak is 11-22 days.)

b. The analysis of cases reported from fever screening stations

There were a total of 23 imported cases back to residence in Tainan City/County and Kaohsiung City/County, of which, 1 case returned to residence where no cases were reported three 3 weeks before. However, endemic cases with the same type were detected 20 days later.

c. The analysis of cases not reported from fever screening stations

There were a total of 31 imported cases back residence in Tainan City/County and Kaohsiung City/County, of which, 5 cases back to

residence where no cases were reported three 3 weeks before. However, endemic cases with the same type were detected separately during 15-21 days after onset of infection.

d. The phylogenetic analysis of viral genotypes

We applied the Notifiable Infectious Diseases Report System database of the Taiwan CDC as data source, which does not provide gene sequences of viral strains for further alignment. As a result, further research about phylogenetic correlation of different viral strains may be performed in the future.

Discussion and suggestion

In Taiwan, there were a total of 179 imported cases of dengue fever in 2007, of which, 74 cases were identified through fever screening stations at international airports (74/179, 41.3%) and 105 cases (105/179, 58.7%) were reported through community doctors because case-patients went for medical care with febrile symptoms after immigration. Countries where infection took place were mainly Southeast Asian countries. Vietnam contributed the most number of cases (55 cases, 31%), followed by Indonesia (40 cases, 22%), and Philippine (22 cases, 12%). The onset month of infection were mainly June to August (72 cases, 40.8%) and October to November (46 cases, 25.7%), each month in average was consisting of 10% of all cases in a year. Among the months mentioned above, we predicted that the main purpose of traveling about the imported cases in June to August were home-town visiting where as the purpose of the infected cases in October to November traveled to dengue fever epidemic in Southeast Asian countries were for traveling. As a result,

quarantine officers should enforce quarantine works to passengers from Southeast Asian countries with abnormal body temperature to prevent dengue fever from entering into Taiwan.

Compare to the imported cases detected through fever screening stations that the time in average from the onset of infection to report date was about 4.8 days, about febrile cases went to the clinic after immigration reported by community doctors, the average period between onset of infection and reported date were 10.2 days. Thus, we could obviously reveal that fever screening stations at international airports could shorten the average days of detecting cases.

A total of 23 possible cases of dengue fever infection reported through fever screening stations returned to places of residences in Tainan City/County and Kaohsiung City/County, of which, 22 cases which were reported by the fever screening stations at Kaohsiung International Airport all returned to Tainan City/County and Kaohsiung City/County. This might be correlated with the geological position of Kaohsiung International Airport. A total of 52 cases reported by Taoyuan International Airport, of which, only one case returned to the place of residence in Tainan County. Dengue type 1 was the main viral strain causing imported cases infection (45 cases, 25.1%). Among 1,986 local cases of dengue fever in Tainan City/County and Kaohsiung City/County in 2007, 1,099 cases (55.31%) were infected with dengue fever virus type 1. Both of the groups were mainly dengue virus type 1 infection.

In Taiwan, the main transmission vectors of dengue fever include *Aedes aegypti* and *Aedes albopictus* [10]. *Aedes aegypti*, also as the main vector of dengue fever according to the cited reference [11], is prevalence in

southern Taiwan and predicted *Aedes aegypti* was the main cause of local dengue endemic in southern Taiwan. However, *Aedes albopictus* is prevalence all around Taiwan. Global warming might influence viral replication in mosquitoes and transmission period which promoted the transmission abilities of *Aedes albopictus* and caused the potential threat of local dengue fever endemic [13-14]. There were 179 imported cases of dengue fever in Taiwan in 2007, which live in 20 different cities and counties, of which, 54 cases (54/179, 30%) returned to places of residences in Tainan City/County and Kaohsiung City/County, 125 cases (125/179, 70%) returned to other counties and cities. Due to the main transmission vector of dengue fever is *Aedes aegypti*, when possible cases returned to the Tainan City/County and Kaohsiung City/County, they might become the index cases of disease transmission. Although there is no *Aedes aegypti* appearance north to Budai township in Chiayi County in Taiwan, *Aedes albopictus* still exists. A few local cases in Taipei area were caused by *Aedes albopictus* transmission of dengue fever virus in 1995. As a result, if possible cases of dengue fever infection returned to places of residence, dengue fever might infiltrate into Taiwan. To improve this situation, border quarantine officers provided public health guidelines to passengers about dengue fever prevention in the past. Through the analytic research, we could increase the awareness of patients about disease prevention. However, if we could provide the test result of specimens in a short time to patients, the prevention of diseases would be enforced.

The data of possible cases reported by border quarantine officers would be saved in health self-management information system in Taiwan CDC. When possible cases returned to places of residence in 7 days after

immigration, local departments of health in each counties and cities should contact the cases by phone call everyday to realize the health status and doctor consultation of patients. Besides, the viremic period of patients of dengue fever was the day before onset and 5 days after the date with febrile symptoms during which dengue fever virus could be incubated from blood samples. As a result, if patients did not consult doctors and applied suitable isolated care measures after back to residence, that could be a gap in dengue fever control and prevention. According to literature reviews [15], the outbreak of dengue fever was a month after prevalence of vector mosquito population. Besides, in the research, we divided 54 imported cases which all consisted of residents returning to Tainan City/County and Kaohsiung City/County into two groups. The analysis revealed that cases (15/23, 65%) at the first group and cases (18/31, 60%) at the second group back to residences where there had been endemic of dengue fever within three weeks ago and three weeks later. As a result, the cases mentioned above could be transmission sources to enforce disease spreading.

We analyzed the time elapsed from reporting of cases to outbreak occurrence, and compared time elapsed between cases reported through fever screening and by doctors in the community. Of the 23 cases reported through fever screening who returned to Tainan City/County and Kaohsiung City/County, one case (1/23, 4%) was associated with the first local outbreak of dengue fever. On the other hand, of the 31 cases reported by community doctors, 5 cases (16%) occurred within 3 weeks of the first local outbreaks of dengue fever. Furthermore, analysis of the protective factor that public health guidelines at fever screening stations could

prevent endemic of dengue fever in resident places of cases in Fisher's Exact Test, we found that public health guidelines at fever screening stations could prevent endemic of dengue fever in resident places of cases. However, there was no statistical significance about the protective factor (Table 1). Besides, we discovered that the case-patients who were educated public health guidelines separately at fever screening stations in international airports would change their medical behavior. That is to say, patients attending doctors earlier due to received the information about public health guidelines. However, more analysis would be necessary to evaluate the effect in the future.

Table 1. The analysis of time correlation between imported cases and local endemic of dengue fever

Report sources \ Time correlation	Correlated to the time period	Not correlated to the time period
Imported cases through fever screening stations (Provide public health guidelines)	1	22
Reported by community doctors	5	26

Fisher exact test: P value = 0.0922

The laboratory diagnostic methods of dengue fever nowadays include antibody test, virus detection, and virus incubation. All of which need accurate biological molecular equipments. As a result, we should send the specimen of patients to laboratory for examination. However, rapid test could easily manipulate and read the results in a short time, which can test patients at border quarantine stations. Then, notify patients and local health departments that the passenger is highly possibly infected dengue fever on the way to resident places from airports. Besides, the local health department officers can assist patients attend doctors immediately.

According to the Transmission Prevention Work Manual, if confirmed cases stayed at home for more than one hour, the local department of health should clean and sterilize surroundings at residence and working places of patients. As a result, if we can notify the test results to patients before they back to places of residence, we can avoid the following preventive works and effectively reduce the infectious disease threaten public health in the country.

Besides, we suggested that using rapid test for patients who are suspected with dengue fever infection at fever screening stations in international airports. If the result showed that the patient was highly suspected with dengue fever infection, quarantine officers at airports should follow Article 41 of Regulations Governing Quarantine at Ports and send patients to assigned hospitals nearby for further observation and treatment. Besides, there was supposed to be some relevant measures to form a complete set as followed: 1. If we assessed the rapid test method and assured its specificity and sensitivity, it should become the standard test listed in Communicable Diseases Control Workbook and a formal test report in laboratories, and could also be a reference for relevant prevention. 2. According to Article 41 of the Regulations Governing Quarantine at Ports that if members who confirmed or possibly infected with communicable diseases, quarantine departments should force them to nearby medical center for medical treatments or isolation care. Besides, according to Document No. 0960000720, issued by the Executive Yuan's Department of Health on August 8, 2007, explained about Article 44-1-2 of the Communicable Disease Control Act that patients with communicable diseases shall be placed under isolation care in designated isolation care institutions which

means that patients with communicable diseases have possibility infected other people. As a result, when confirmed cases of dengue fever were detected by rapid test at fever screening stations, we should notify case-patients for medical treatment and suggested border quarantine officers placed patients to designated medical institutions to prevent viremic patients who back to places of residence and became a potential threat of public health in Taiwan.

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