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Zika virus disease expansion rate: The analysis from the first detection in Thailand

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ABSTRACT

The outbreak of Zika virus infection is an important public health problem. The worldwide expansion of disease becomes a big health issue. There is still no specific report assessing the expansion rate of disease in affected county. Here, the authors studied on Zika virus disease expansion rate based on the analysis from the first detection in Thailand until present (September 2017). The GIS based technique was used for disease mapping, and then further calculation of the disease expansion rate was done. Finally, mathematically modeling technique was used to formulate the equation representing the expansion distance, affected area and outbreak acceleration.

1. Introduction

Zika virus is a new problematic pathogen. The virus can cause acute febrile illness and can also induce unwanted teratogenic effect if it infects a pregnant subject. The outbreak of Zika virus infection is an important public health problem. Now it affects several countries around the world including those countries in tropical and non-tropical areas. The worldwide expansion of disease becomes a big health issue. In tropical area, the disease already exists and continuously expands[1].

The Zika virus infection is considered an acute dengue-like illness. The disease might have the similar clinical presentations to dengue, but it can have unwanted clinical

complications such as neurological disorder and teratogenic effect. The disease is widely distributed in several areas of the world at present and there is a need for disease control and management. To manage the case, early case detection and management is the basic principle. In preventive medicine, prevention of mosquito bite and safe sexual practice is generally recommended. At present, there is still no specific antiviral drug or vaccine against Zika virus for disease treatment or prophylaxis. In epidemiology, a close disease monitoring is required. The data from disease surveillance can be useful in public health and the surveillance is generally recommended for any countries. Implementation of a good surveillance system is the basic requirement. Nevertheless, how to make use of the derived surveillance data is the topic that should be discussed. At present, surveillance of Zika virus infection is done in many countries around the world but the further use of the collected data is extremely limited.

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2. Materials and methods

This is an epidemiological informatics analysis. The collected data on the disease appearance in Thailand according to local Thai Center of Disease Control (CDC) is used as primary data for further study. Stepwise, the main focused parameters in the record of Thai CDC are time and place of disease appearance. Focusing on place data, the mapping of the location was done based on the Google Map. The distance between each site of disease detection can be assessed based on the derived map. Also, the data on time of disease occurrence at each site is used for further calculation on velocity of disease expansion according to the formula “distance (S) = velocity (V) × time (T)”.

Summarizing on the progress of disease from a case detection to the next case detection is done and the finalized velocity can be calculated. Using the mathematical model technique, the distance of disease expansion can be represented by integral equation and the acceleration of disease expansion can be presented by differential equation. Additional, the area of expansion can be calculate by the equation “area = distance².”

3. Results

According to the mapping, the disease appears in 16 provinces of Thailand with 81 confirmed Zika virus infected patients during 19 months of disease existence (February 2016 to September 2017). From location mapping, the disease already migrates for 2606 km in Thailand giving the expansion velocity equal to 5.06 km/day.

From mathematical modeling, the function for distance expansion can be $S = \int^T V dt$ or $5.06T$. The calculated area of expansion can be $25.6036T^2$. For the acceleration of disease expansion, the equation can be represented as dV/dT . According to the present analysis, there is a linear progression of Zika disease expansion. Therefore, there is no acceleration of disease expansion in the studied setting.

4. Discussion

Surveillance is the basic procedure against any new emerging disease. When a new emerging disease occurs, the general rule of any countries is setting of the team for monitoring of the disease and surveillance for the possible emerging of disease is

needed. The standard routine surveillance is widely practiced and the data is usually store in local database. In depth analysis of the collected surveillance data is very interesting and can be useful but it is limited performed worldwide. For making use of the surveillance data, the basic clinical epidemiology concept can be applied. In the present study, the authors use the combined basic clinical epidemiology and mathematical modeling for analysis of the collected surveillance data on Zika virus infection in Thailand. The authors successfully generate the model for explanation the situation of disease outbreak and spread in the studied area.

The two main important parameters in epidemiology is time and place. Using the new informatics and GIS technology, the disease mapping can be done and helpful for disease control and surveillance. In this report, the authors present the use of the new technique for representing the situation of Zika virus outbreak in Thailand. In Thailand, the Zika virus has just been recorded for a few years and there have been continuous case reports[2]. Similar to other countries in tropical Indochina, the disease in Thailand was believed to be delivered from international traveler[3].

Based on the present epidemiology study, it can be found that there is no trend of big Zika virus disease outbreak in Thailand due to non-accelerating nature. In addition, based on the fact that Thailand has an area about 513.000 km², if there is no successful disease control, the disease will expand covering all area of the country within 141.5 days. Nevertheless, at present, the disease is still confined, which can imply the success of disease control in Thailand.

Based on clinical epidemiology and mathematical modeling technique, the model representing the Zika virus spread in Thailand can be derived. The model based on time function can show the progressive trend of disease in Thailand. Based on this study, the authors recommend that the similar studies should be performed by any settings with the similar problem of Zika virus infection.

Conflict of interest statement

We declare that we have no conflict of interest.

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