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Governmental supervision and rapid detection on dengue vectors: An important role for dengue control in China

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ABSTRACT

Background: China experienced an unprecedented outbreak of dengue fever in 2014, the National Health and Family Planning Commission of the People's Republic of China (NHFPC) carried out a series of supervision work on integrated vector management (IVM), and Chinese Center for Disease Control and Prevention (China CDC) conducted a rapid detection on vector density in some areas with high dengue incidence. The goal of this study was to explain the effect of these actions, which play an important role for dengue control, and we wish to give a good example for dengue control in China, even in the world.
Methods: Compare mosquito vector density with Breteau Index (BI) and dengue incidence after or along with control work vs. before. Data was entered and analyzed by Microsoft Excel 2007 and SPSS19.0.
Results: Average value of BI from 22.82 in September dropped to 3.93 along with supervision and rapid detection. BI showed a significant decrease (paired sample t-test, $t = 3.061$, $P = 0.018 < 0.05$). Dengue incidence decreased gradually along with supervision and rapid detection.
Conclusions: Supervised work on IVM by NHFPC and the rapid detection on dengue vector *Aedes* by China CDC promoted to cut down the dengue vector density, then reduced dengue incidence; both played an important role for dengue control throughout China in 2014.

1. Background

Dengue ranks as one of the most important mosquito-borne viral disease in the world (WHO, 2012). The four serotypes of dengue virus can cause a variety of clinical illnesses ranging from mildly symptomatic dengue fever to more dangerous clinical conditions with capillary leakage syndrome, such as dengue hemorrhagic fever and dengue shock syndrome (Gubler, 2004; Chaves et al., 2014). Currently, dengue represents a large and growing public health problem throughout the tropical and subtropical countries, with an estimated nearly 100 million clinical cases per year and 2.5–4 billion people at risk of infection (Bhatt et al., 2013). Globally, dengue virus transmission has expanded in recent years, and all dengue virus serotypes are now circulating in Asia, Africa, and the Americas (Gubler, 2004; Chaves et al., 2014). Given no effective vaccine for dengue currently available, the effective protective measures are those that suppress vector populations and prevent exposure to *Aedes* mosquito biting (Wilder-Smith, 2014; Lin et al., 2013).

In 2014, China experienced the most severe dengue outbreak since it became a notifiable disease on 1 September 1989 (Lai et al., 2015). A total of 47,056 laboratory and clinical confirmed dengue cases with six deaths were reported in mainland China in 2014, 96.1% of which were from Guangdong province and 72.2% from Guangzhou city (Lai et al., 2015). This dengue outbreak in south China might be partly attributed to inadequate enforcement of integrated vector management (IVM) at the early stage. In order to

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implement an effective IVM with the engagement of various stakeholders, the National Health and Family Planning Commission of the People's Republic of China (NHFPC) carried out a series of supervision during September and October 2014, and Chinese Center for Disease Control and Prevention (China CDC) has conducted a rapid detection on vector density in October 2014 following NHFPC's supervision in some areas with high dengue incidence at that time.

This study summarized the work of supervision and detection work and compared the vector density before and after the supervision during dengue outbreak, so as to provide some recommendations for future dengue prevent and control in the early stage of an outbreak in China and even in other countries.

2. Methods

2.1. Trigger of the supervision and early detection for dengue vector

In September 2014, it has been speculated that transmission of dengue would be unusually severe in China, and the incidence might be far beyond the current situation. The average number of cases reported each week in Guangdong province was 6 cases in June, 28 in July, 159 in August, with the highest 9966 of a week between late September and early October. There were also many inapparent or mild infections which would be uneasy to be found and reported (Wang et al., 2015). A study had indicated that dengue epidemic would spread to some provinces in southern China, including Guangdong, Yunnan, Guangxi, Hainan, and Fujian (Yang et al., 2014). All these areas with high mosquito density, favoring the transmission of dengue virus, indicated in sentinel surveillance of previous years (Prevention CCfDCa, 2005-2013).

2.2. The supervision for vector control by the NHFPC

The NHFPC is the health department of Chinese Central Government. The supervision for vector control taken by the NHFPC in 2014 was detailed as below (Fig. 1). Firstly, the supervision was conducted in Guangdong province during September 16 and 17, 2014, which aimed to make local governors understand the challenge of dengue and urge them take the leadership for dengue and vector control through the entire city. Secondly, two expert groups were sent to supervise two cities with dengue outbreaks, Guangzhou city in Guangdong province and Nanping city in Fujian province between September 24 and 30, which targeted to inspect the control of dengue at local level, such as urge prefectural- and county-level CDCs to develop action plans that would be implemented by the relevant departments. The action plans included the report of cases to the Health Department, coordination arrangements with hospitals for the patient's treatment, guideline for the Patriotic Health Campaign Committee Office to carry out environment modification in order to prevent or minimize vector propagation and human exposure to the vector-pathogen by destroying, altering, removing or recycling nonessential containers that provide larval habitats, and so on. Finally, the investigation of the dengue situation was conducted during October 6-7, 2014 in Guangzhou city where the dengue outbreak was still grim, and there were still some spots without conducting the prevention and control work (News, 2014). Some strategies for enforcement of IVM in local area were promoted under the supervision (see Supplementary).

2.3. The quick detection for vector density by the China CDC

Along with the supervision of NHFPC, China CDC, as a central technique institute for public health, start to organize a rapid detection on dengue vectors to evaluate the dengue control work in some areas with higher incidence since September 2014 (Fig. 2). The detection work was carried out from October 16 to 22 in eight cities of five provinces, including three cities (Guangzhou, Foshan, Jiangmen) in Guangdong province, two cities (Putian and Nanping) in Fujian province, Dehong Dai-Jingpo Autonomous Prefecture in Yunnan province, Nanning city in Guangxi Zhuang Autonomous Region, and Haikou city, Hainan Province. A joint working group of China CDC and the local CDC surveyed *Aedes* density on larva and adult in 8 cities mentioned above, no less than 9 communities and 3 parks as surveillance sites for each city. We carried out breeding surveillance through 70–100 houses and 3 times human baited double-nets trapping in each surveillance site get to know and advising the clearance of breeding site and adulticiding by chemical technology appropriately.

Two indicators, breteau index (BI) and biting index, were used in this study. BI is the larva index of *Aedes* density, which means the number of positive containers when checking one hundred houses. In general, for the areas with only *Aedes albopictus* as vector for dengue, when BI is more than 20 will trigger an outbreak of dengue fever, when between 5 and 20 will lead to local dengue outbreaks, and once it is less than 5 indicate it is safety, will not lead to an outbreak of dengue fever (Bureau of Disease Control and Prevention MoH, 2008). Biting index is mosquito adult activity, which are the captured mosquitoes multiplied the number 2. Human baited double-nets trapping need two people operating at the same time, one stay in the inner closed net exposing two legs to release the odor which attracts mosquitoes, and the other one wearing long-sleeved clothes collected mosquitoes between the two nets. The edge of the outer net has 30–40 mm distance to the ground. Each work continued 30 min during mosquito peak activity time, usually 16:00–18:30 pm. The index might be the direct response to mosquito density and chemical control results during the epidemic time.

All the mosquitoes morphological identified referring to the key by Lu et al. (1997). We collected larvae in bottles from breeding sites, taken to the laboratories, then sampled several larvae from each bottle for morphological identification. All the adults gotten for morphological identification. The specimens collected in these areas are all *A. albopictus* except *Aedes aegypties* in Dehong Dai-Jingpo Autonomous Prefecture in Yunnan province. We have not recorded the number of *Culex* for it has no direct relationship with the dengue epidemic.

2.4. Data sources and analysis

Mosquito density and dengue incidence are the two important indicators for risk evaluation. BI of *Aedes* before supervision was the average BI value throughout September attribution by the local CDC, and BI after supervision came from the rapid detection work by China CDC. Biting index came only from the rapid detection by China CDC (Table 1), and dengue incidence data from the online National Notifiable Infectious Disease Reporting Information System of China CDC (Lai et al., 2015).

We contrast the BI value in September with that get from the rapid detection (Fig. 2), paired sample *t*-test by SPSS19.0. We give the epidemic curves of dengue in 2014 for comparing dengue incidence cases during the measures implementing (Fig. 1). Data was entered and analyzed by Microsoft Excel 2007.

3. Results

BI dropped largely from the range 5.1–55.5 in September, to the range 0.14–13.29 during the rapid detection period (Fig. 2). The BI value of *Aedes* density of most cities dropped to less than 5 except that in Guangzhou city (6.70) and Haikou city (13.29), and the *Aedes* density of nearly all cities had witnessed a large reduction. The aver-