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Prolonged dengue outbreak at a high-rise apartment in Petaling Jaya, Selangor, Malaysia: A case study

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Abstract. There was an increasing trend in dengue infection in Malaysia with many outbreaks that occurred in Petaling District, Selangor in 2013 – 2014. A high rise apartment in Petaling Jaya reported ten episodes of dengue outbreaks from June 2013 to June 2014. We studied the prolonged dengue hotspot at this residential complex in Petaling Jaya, Selangor and made recommendations to prevent future prolonged dengue outbreaks. This was a retrospective exploratory study by analysing secondary data on dengue outbreaks from years 2013 to 2014. Small group discussions, interview sessions with staff and site visits were carried out to obtain necessary information. Two hundred and ninety-one cases were notified during the dengue outbreaks from Epid week (EW) 25 in 2013 to EW 26 in 2014 with no mortality reported. Information entered into dengue databases might be incomplete or mixed up. Active case detection and environmental risks assessment based on cases were not carry out due to the massive outbreak. Basic information on the population in the outbreak locality was unavailable. Various control activities were carried out with varying outcomes. Community participation was poor with little cooperation from residents during health education and community-based mosquito breeding prevention activities. To ensure better management of dengue outbreaks and to prevent prolonged dengue outbreaks in the future, integrated case findings, effective control activities, extensive environmental assessment on the outbreak locality and adopting innovative community outreach initiative with sufficient staff are required to curb dengue vector.

INTRODUCTION

Dengue is a common arthropod-borne viral infection caused by *Aedes aegypti* and *Aedes albopictus* mosquitoes, the primary vectors for dengue. *Aedes aegypti* mosquito lives in urban habitats and breeds mostly in man-made containers. Its transmission has become a major public health concern (Bhatt *et al.*, 2013). The World Health Organisation (WHO) currently estimates that there may be 50–100 million dengue infections yearly worldwide. Since there is no specific treatment for dengue fever, prevention and control depends on effective vector control measures (World Health Organisation, 2014).

In Malaysia, dengue cases were on the increasing trend from 2000 until 2010 with a huge decrease in 2011. However, the dengue cases started to increase again in 2012 reaching 103 610 cases in 2014 (Mudin, 2015). In the Petaling district, Selangor, dengue was on the upward trend throughout 2013 as compared to 2014 (Figure 1) (Petaling District Health Office, 2014).

Several episodes of dengue outbreak have occurred in the Petaling District, Selangor in 2013 – 2014. The longest duration of outbreak and the hotspot area was reported from a high-rise apartment in Petaling Jaya (refer to apartment thereafter). This outbreak occurred from 17 June 2013 to 23 June 2014 (Figure 2). A total of ten episodes of dengue outbreaks were reported from this apartment from 30 January 2012 to 15 September 2014 (www.edengue.gov.my) (Ministry of Health Malaysia). The aim of the study was to analyse the prolonged dengue hotspot at a high-rise apartment situated in Petaling Jaya, Selangor and made recommendations to prevent future prolonged dengue hotspots. The locality was chosen for this study because it had the longest record of dengue outbreak in Petaling District from 2013 – 2014.

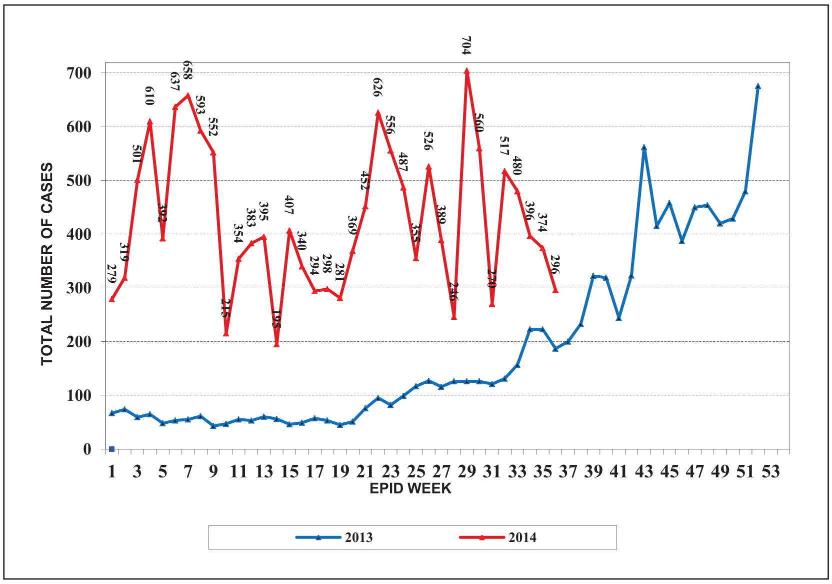

Figure 1. Trend of Dengue Cases in Petaling District, Selangor
(Source: Petaling District Health Office, 2014)

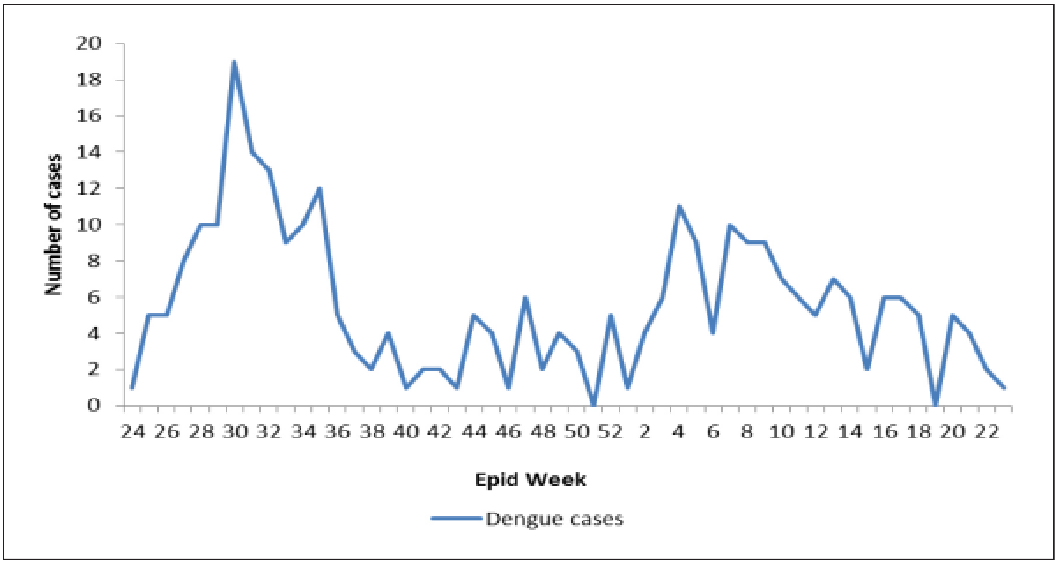

Figure 2. Notified Dengue Cases at an apartment in Petaling Jaya, Petaling District from EW 24 in 2013 to EW 26 in 2014
(Source: eDengue Database; www.edengue.gov.my)

METHODS

Study site

The apartment was situated in Petaling Jaya under the Petaling District, Selangor. It comprised of seven blocks that was divided into Court 1 (Block A, B, C and D) and Court 2 (Block E, F and G) with a total of 3 469 units including 52 penthouses. According to the Joint Management Board (JMB), about 70% of the residents were tenants, mostly foreigners from Africa, Mongolia, Bangladesh, India and the Middle Eastern countries.

There are three covered car park podiums (A, B and C). This apartment featured condominium facilities; including a gymnasium, swimming pool, two playgrounds, a jogging track, 24 units of shops which included restaurants, cybercafés and convenience stores, a nursery, a badminton court, a basketball court, a multipurpose hall, a *surau* (a praying place for Muslims), a barbeque area, six garbage collection centres and 24 hours security services. The apartment is easily accessible by three Highways; namely Federal Highway, New Pantai Expressway and Damansara Puchong Highway.

Study Design

We used a retrospective exploratory study design to analyse secondary data of dengue outbreaks from years 2013 to 2014. Data on dengue cases and control activities were obtained from Petaling District Health Office (PDHO) and eDengue; an online database (www.edengue.gov.my) to record cases and control activities in dengue control used by Ministry of Health Malaysia (Ministry of Healthy Malaysia).

Study Procedures

Further information pertaining to the actual dengue situation and control activities were obtained through small group discussions with programme head and researchers from Ministry of Health. Staff from PDHO were interviewed on the Standard Operating Procedure used in managing a dengue case, resources (staff, vehicles and machines) available during the outbreak, control activities and health education activities conducted during that period.

Several site visits to the apartment were carried out to observe its surroundings and environment. These visits were accompanied by Assistant Environmental Health Officer (AEHO) and Public Health Assistant (PHA) from PDHO who were in-charge of dengue cases and outbreaks at the said apartment. Observations were carried out on the state of hygiene, potential mosquito breeding sites, waste management, and health education materials found at the apartment as well as the structural design of the apartment which had potential breeding sites for *Aedes* mosquitoes.

RESULTS AND DISCUSSION

Trend of dengue cases

Two hundred and ninety-one cases were notified during the dengue outbreaks from Epid week (EW) 25 in 2013 to EW 26 in 2014 with no mortality reported. Most of the cases (98.6%) were diagnosed as dengue fever. The outbreak started on EW 25 in 2013 and reaching its peak on EW 30. Subsequently, the cases fluctuated with decreasing trend from EW 36 in 2013 to EW 1 in 2014. The cases increased again from EW 2 until EW 4 in 2014. The highest number of cases notified per week was in EW 30 in 2013 with 19 cases (Figure 2).

Descriptive Epidemiology

From the total cases notified, 58.8% were males, 42.6% were aged 19-25 years old and 75.3% were Malaysians. A detailed description on the socio-demographic profile of the cases is as shown in Table 1.

Assessment on Dengue Control Activities

Dengue Databases

Case information based on the Investigation Case Report Form were entered into two databases; i.e. eNotifikasi and eDengue by AEHO after confirmation and endorsement by senior AEHO and Epidemiologist. Discrepancies in databases which showed segregation in control activities could be due to incomplete information from the

Table 1. Socio-demographic Characteristics of Dengue Cases at an apartment in Petaling Jaya, Petaling District

Socio-demographic characteristics	Count (n)	Percentage (%)
Gender		
Male	171	58.8
Female	120	41.2
Age groups (Years)		
0 – 4	13	4.5
5 – 12	15	5.2
13 – 18	32	11.0
19 – 25	124	42.6
26 – 35	75	25.8
36 - 45	25	8.6
46 – 55	5	1.7
$\geq$ 56	2	0.7
Nationality		
Malaysian	219	75.3
Non Malaysian	72	24.7

Investigation Case Report Form, multiple entries on the same case by different health facilities when the case was being notified more than once or similar localities had been registered with different outbreak episodes.

In addition, shortcomings with eDengue database were found: data were not updated; such as the results of *Aedes* species in the positive containers in 2013 were still with 'Pending' status and the information on *Aedes* breeding containers could not be downloaded from files containing larvae survey activities but had to be extracted manually.

Dengue Case Investigation

Due to massive outbreaks in the Petaling District and staff shortage, AEHOs were unable to carry out active case detection and environmental risks assessment based on cases. Passive case detection by telephone was carried out and AEHO faced challenges in detecting cases from the apartment. In addition, risks assessment findings were not compiled in the Investigation Case Report Forms and there was no variable on risk assessment findings in both databases.

Information on the Locality

PDHO did not have information on the number of vacant apartments that could be used for planning of control activities as the JMB only had information on owners but limited information about the population residing there especially tenants.

Control Activities

Our study revealed that PDHO had limited resources for vector control activities for the whole district; with 22 PHAs and 31 general workers (of which 11 were temporary staff); 35 units of thermal fogging machines and two ultra-low volume (ULV) machines that were in working condition, as well as 16 vehicles. However, despite limited resources, PDHO had implemented various vector control activities to reduce the transmissions.

Larvae Survey

Throughout the outbreak periods, 17 234 premises were inspected in 46 larvae survey activities. However, only 41.3% (7 115) of the premises were thoroughly inspected (indoor and outdoor); 109 premises were found to be positive with *Aedes* breeding with 104 positive containers. Majority of larval breeding (77.9%) were found outdoors since the number of premises inspected indoors were low. The most common breeding places were drains and gully traps. The study revealed that the number of activities carried out was insufficient as most of the activities covered a small percentage of the total number of premises in the apartment; e.g. 149 premises were inspected on 14 April

2014 (i.e. 4% from the total premises). It was not known whether the activities covered all the premises as there was no data available from the eDengue database. It is important to inspect indoors as one of the most common breeding places was gully traps that were found indoors.

Larvaciding

Larviciding activities were undertaken by PDHO using Temephos and *Bacillus thuringiensis israelensis* (BTi) formulation. The application involved direct application of larvicide into stagnant water and spraying using a spray can or mist blower. There was a joint activity carried out with the Institute for Medical Research (IMR) for 20 weeks starting EW 5 in 2014. Seventy larviciding activities were carried out resulting in 69 852 premises and 63 932 containers treated. Although the application of larvicide with the mist blower can give a bigger coverage, it was not suitable at the apartment since not all insecticides could be distributed to the targeted stagnant water. The distance that droplets are projected by the mist blower is about 15m horizontally and 8m vertically in still air. The wide dispersal of the insecticide will mostly land on the walls and ground surfaces.

Adulticiding by Space Spraying

A total of 46 space spraying activities (thermal fogging and ULV) were carried out and 76% of the spraying were carried out simultaneously using thermal fogging and ULV. The number of premises that were covered by thermal fogging and ULV activities were 8 670 and 62 902 premises respectively. This study found that activities were carried out less than once a week which was insufficient as cases were reported every week during the outbreak. In outbreak situations, the space spraying should be repeated at a 7-days interval for the elimination of possible infected mosquitoes. The indoor coverage was rather small as only 8 670 premises were covered using thermal fogging. It was found that the activities were not done correctly as fogging should have covered at least a 200m radius in accordance to the *Aedes* flight range.

Entomological Surveillance

Vector surveillance was carried out by officers from the Selangor State Health Department to monitor the presence of *Aedes* mosquitoes at the apartment using sticky traps and ovitraps during the outbreak periods. Various mosquito species were found to be present during the outbreak period; i.e. *Aedes aegypti* (58%), *Aedes albopictus* (2%) and *Culex* sp. (40%). Additionally, Ovitrap Index showed a high density of mosquito at the apartment; ranging from 30% to 93% (Figure 3).

Mass Larviciding using BTi

PDHO collaborated with IMR to study the effectiveness of mass larviciding using BTi for 10 weeks from EW 5 to EW 25. Dengue cases declined with the application of BTi; however, the mosquito density was high (Figure 4). The study also found that the predominant virus during the outbreaks were DEN-2 and DEN-3.

Transovarian dengue virus

A study by IMR also found that there were five larvae samples with transovarian dengue virus at the apartment. This information was imperative to indicate a higher population with infective *Aedes* (Lee, 2014). The data showed that the control activities were probably not effective because the average Ovitrap Index was still high.

Assessment on Environmental, Structural and Waste Management

Many potential breeding sites at the apartment as well as the surroundings within a 400 meters radius were found: abandoned and uncollected bulk garbage such as cartons and discarded furniture; puddles of stagnant water at the underground car park due to a faulty water pump leading to water clogging at the affected area, domestic wastes not collected on a regular basis and often only occurred upon request by JMB when the wastes accumulated; litters accumulated on tree branches, monsoon drains and roof tops. Other larvae breeding sites identified included gutter drain perimeters and gully traps, as well as untrimmed vegetation surrounding the apartment.

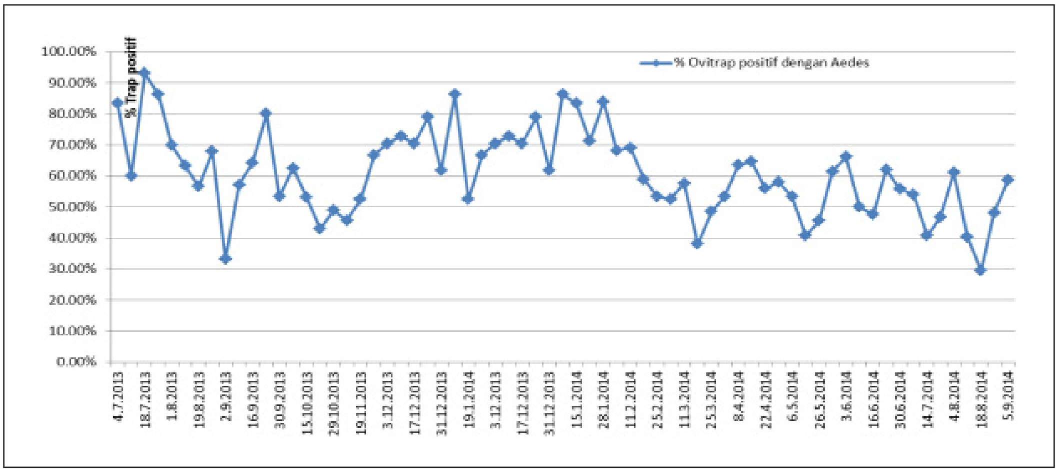

Figure 3. Ovitrap Index at an apartment in Petaling Jaya, Petaling District
(Source: Selangor State Health Department)

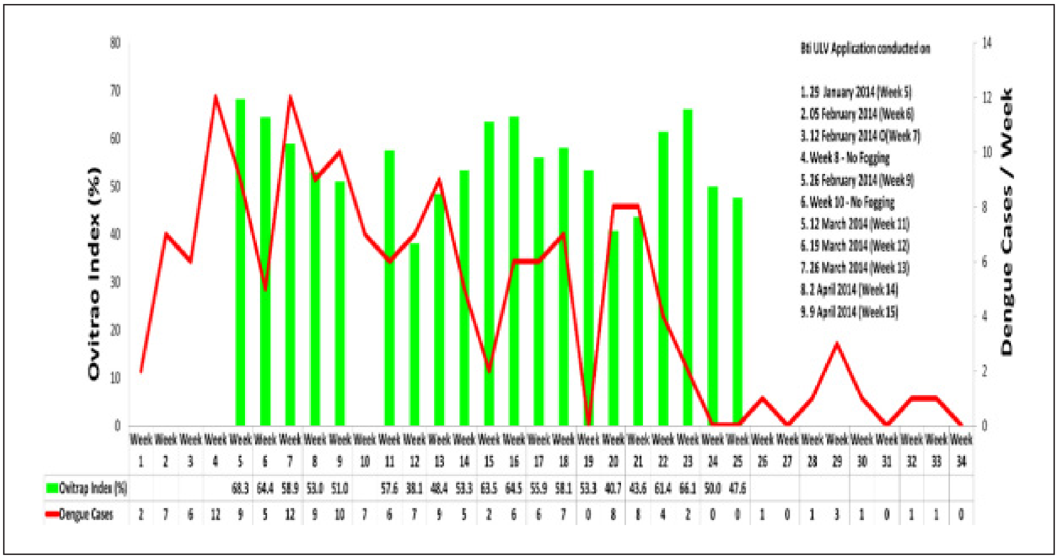

Figure 4. Impact of BTi Application on Ovitrap Index and Dengue Cases
(Source: Institute for Medical Research)

Health Education and Community-Based Mosquito Breeding Prevention Activities

Various obstacles were encountered when carrying out health education and community-based mosquito breeding prevention activities. The major obstacles included language barrier as majority of the residents at the apartment were non-Malaysians; poor community participation and co-operation in health campaigns and *gotong royong* (communal work) (Table 2); residents were not co-operative during premise investigation for *Aedes* survey, fogging and larviciding activities; difficulties in disseminating health information to the locals during the outbreak. Hence, no Communication for Behavioural Impact (COMBI) activity was successfully carried out for the prevention of dengue cases at the apartment.

Table 2. Health Education Activities Carried Out at an apartment in Petaling Jaya, Petaling District* (19 June 2013 – 21 July 2014)

Health Education Activities	No. of activities
Lecture	1
Communal Work *(Gotong royong)*	7
Public announcements	218
Banners and buntings	115
Personal advise	1022
Exhibitions	7
Small group discussions	1412
Posters	72
Brochures	5744
Demonstrations	2396

*Source: Petaling District Health Office, 2014

Population Density and Mobility of People

The apartment in our study had a dense population of residents; 70% were foreigners and tenants of various ethnicities, socio-cultural and hygiene habits. Studies had shown that rapid urbanization, many occupants within one apartment, high number of residents per household and susceptible individuals within the locality were found to be highly efficient for dengue transmission and hence increased the exposure of infection (Bohra and Andrianaslol, 2001; Ooi, 2001; Teixeira *et al.*, 2013; Bohra and Andrianaslol, 2001). Thus, the risk of dengue infection is high within crowded areas and among those who live in close proximity to the flight range of the vector from its breeding source, despite low house index of vector breeding (Bohra and Andrianaslol, 2001). Even though control activities had been carried out at the household and residential levels, breeding and potential breeding sites of the vector in the surroundings immediately outside the gate of the apartment were found; i.e. within the 200m flight range of the vector.

The apartment was strategically located at the main transport hub and stations of the surrounding neighbourhood, the south area of the apartment was bustled with pedestrians and this could possibly be a new dispersal point of virus as any virus-carrying individual (pedestrian) could induce the contagion of vector at the vicinity (Barmak *et al.*, 2011). Apart from that, there were bushes and shrubs that could provide an ideal resting place for the vector, while puddles of water and indiscriminate waste disposal at the surrounding walkway could also provide breeding sites. All these conditions were ideal for subsequent transmission to either the susceptible pedestrians or residents of the apartment (Bohra & Andrianaslol, 2001).

Limitation of the Study

This study has few limitations. Firstly, no line listing of cases was available specifically for the apartment locality, data were obtained from eDengue. However, variables in eDengue and eNotifikasi were limited. Some information about cases and patients' histories had to be obtained from hardcopy files. Secondly, we could only obtained basic data on the owners of the apartments but no information on tenants were available from the JMB of the apartment.

CONCLUSION AND RECOMMENDATIONS

A few factors contributed to the prolonged dengue outbreak at the high-rise apartment from June 2013 to June 2014. One of the factors was the problem on case findings. It is recommended to empower integrated case findings and control activities; as segregation of work will inculcate routine behavior in staff and permit inefficient coverage of control activities. Active case findings among cases, family members and neighbours to confirm the source of outbreak and to identify the coverage of the affected areas within the time frame of sporadic cases is important for the betterment of control strategies. On the other hand, extensive environmental assessment will complement effective control strategies on the surroundings as to curb dengue vector.

The vector control activities were ineffective which might be partly due to insufficient staff to carry out those activities. It is recommended that larvae survey should cover all the premises within the 200m radius which is about 3 500 units. In a dengue control scheme, accessibility to every housing unit is important to ensure the success of the programme (Chab, 1967). In order to increase the number of homes that can be inspected, larvae survey routine may need to be changed to evenings and weekends since many residents leave for work in the morning and come home in the evening or late at night.

Our Findings showed that large-scale outdoor larviciding using ULV spraying machine did not seem to be the best solution to kill *Aedes* mosquitoes because Ovitrap Index recorded was more than 30%. Therefore, indoor larviciding activities should be emphasized since significant numbers of indoor breeding places were found during the larvae survey activities. In addition, bioassay studies on the large-scale larviciding must be carried out with the aim of improving the outcome of such activities.

The lack of staff in PDHO to carry out adulticiding activities may be outsourced to private sectors. We propose to carry out residual spraying covering the wall outside each apartment unit, walkway etc. This method does not require spraying inside each unit, therefore the problem of unoccupied units or refusal of entry by occupants would not affect the application of the insecticide. A special task force that acts as a single entity representing the district health office with permanent members in the team should be established to monitor this locality; i.e. to record, analyse, design and implement all the vector control activities.

Structural defects of the buildings with uneven surfaces of the floor gradient and drainage as well as poor waste management especially bulk garbage also contributed to the prolonged dengue outbreak at the high rise apartment. We had made recommendation to the JMB to have extra staff for housekeeping which should include and integrate activities that can prevent dengue breeding at the apartment. These activities include maintenance works on architectural defects and uneven cement rendered floors in order to prevent stagnation of water; implementation of scheduled collection for domestic wastes; hiring private waste contractors to remove bulk wastes that are abandoned at the apartment and appointing local councils to prune and trim shrubs and bushes within the surroundings. In addition, JMB should establish a database of not only on the owners but also the tenants in order to have a proper maintenance and management of the buildings; this will also help to prevent dengue outbreak at the apartment.

To circumvent the problem on the lack of community participation in mosquito breeding prevention activities, it is recommended to prepare health education materials in dual languages and to activate Community Policing (*Rukun Tetangga)*; adopting innovative community outreach initiative to educate and empower community in the dengue control programme such as "Ten Minute Mozzie Wipeout" project as implemented in Singapore (De Silva, 2010). This can also be done through social media such as Twitter to track dengue fever outbreaks, (Corby, 2011) and web search query data to monitor dengue epidemics (Chan *et al*., 2011).

The above mentioned factors need to be addressed to ensure a better management of dengue outbreaks and to prevent prolonged dengue outbreaks in the future. Research on innovative community outreach projects; integrated and combined use of vector control methods and research directed towards developing new vector control technology should be explored.

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