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Dengue Outbreak Management - Field Experience in Managing Dengue Involving an Urban Residential Area in Kota Kinabalu, Sabah Malaysia

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Abstract

Introduction: Dengue fever is endemic in Malaysia. It is a major public health challenge that has caused significant morbidity and mortality. A dengue outbreak is contributed by entomological factors, epidemiological and environmental factors. Outbreak response is crucial to reduce cases and death. This study is a descriptive dengue outbreak report in an urban residential area in Kota Kinabalu, Sabah Malaysia.

Methods: This is a report of a dengue outbreak that started in middle of November 2019 and ended early December 2019. A dengue outbreak in Malaysia is defined when more than one dengue cases is reported in the same locality within 14 days from the date of notification of the first case. Cases were analysed descriptively looking at epidemiology and vector control database.

Results: This outbreak involved 6 cases. The source reduction activities by elimination of breeding sites were conducted 3 times covering an area of 200 meter radius. A total of 110 premises were checked with coverage of 86%. The number of containers inspected was 923, with 454 outside the premises and 469 inside the premises with no positive results for dengue larvae. Insecticide space spraying via thermal fogging was conducted with added ultra-low volume (ULV) spraying done within the 400 meter radius with coverage of 100%.

Conclusion: Effective preventive measures have to be paired with responsible communities, as both play very vital roles in the control of dengue.

Keywords: Dengue fever, Urban Residential Area, Kota Kinabalu, Vector control database, Breeding sites

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Introduction

Dengue fever is thought to be the most common arbovirus infection with 390 million infection annually worldwide (Bhatt, S. *et al.*, 2013). Malaysia is a dengue endemic country with the first case detected back in 1902 (Suppiah, J. *et al.*, 2018). Dengue occurs throughout the year in Malaysia, as we experience equatorial temperatures. Higher number of cases tends to occur following the monsoon seasons in Malaysia (Ahmad, R. *et al.*, 2018). Many studies conducted in Malaysia indicated an association between dengue, vector indices, rainfall and temperature and a lag period ranging from days to weeks (Hii, Y.L. *et al.*, 2016 & Shafik, M.A.M. *et al.*, 2020).

Today almost 90% of the population have a life time risk of developing dengue (Chew, C.H. *et al.*, 2016). It has also been forecasted that the number of cases will increase six times higher in 2040 compared to 10 years ago (Adam, B.M. *et al.*, 2017). In 2017 and 2018, Malaysia reported 83,849 and 80,615 cases respectively (Suppiah, J. *et al.*, 2018).

In Sabah, dengue cases are significantly lower than in Peninsular Malaysia (Murphy, A. *et al.*, 2020). However, this is rapidly changing. In 2016, Sabah reported the highest number of cases at 3,668 cases and following that there was brief in decrease in cases to 2560 in 2017. These numbers did not remain low but increased to 3,423 cases in 2018 (Kaur, N. *et al.*, 2020). Unfortunately, with these increasing dengue cases, the dengue mortality has increased as well.

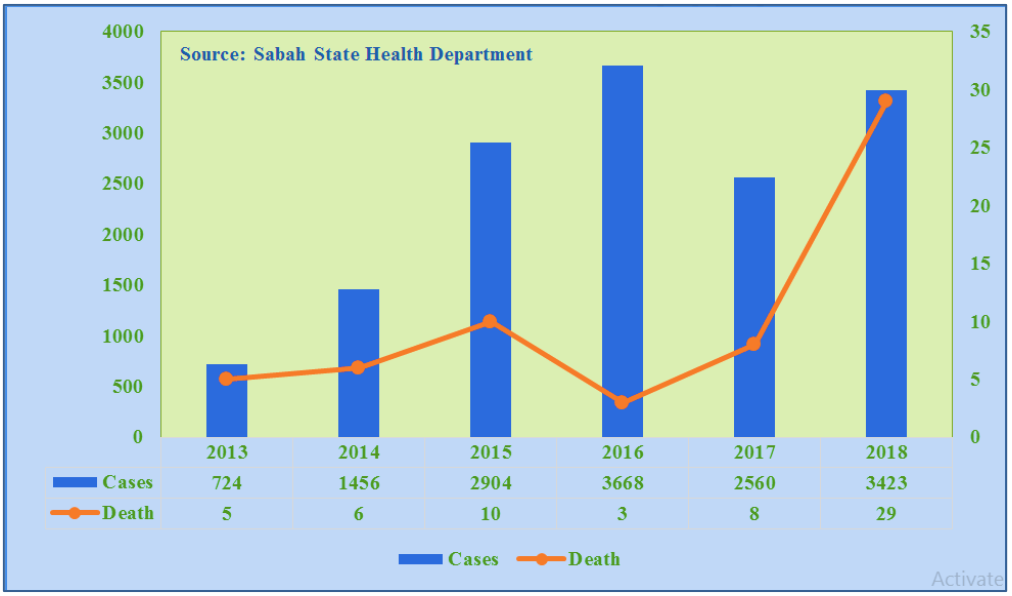

Figure 1: Number of Dengue Cases & Deaths in Sabah during 2013-2018

From 2016 to 2017, no dengue cases were reported from this locality however 1 case was reported back in 2018 and 4 cases in 2019. Due to that, this locality was classified as a priority 1 locality. A priority 1 locality is a place that has had a previous dengue case or outbreak. Disease control activity was conducted in the locality on the 18th November 2019, within 24 hours after the outbreak was declared. Inspection was done involving 46 houses out of the total 128 premises that were within the 200 meter radius of the index case. During the removal of breeding site (source reduction), no positive dengue larvae were detected from the potential containers. The entomological index during the control activities were Aedes Index (AI) 0%, Breteau Index (BI) 0 and Container Index (CI) 0%.

An outbreak is defined as excess number of cases beyond response capabilities (Brady, O.J. *et al.*, 2015) or in other words the occurrence of a disease higher than expected in a particular area during a specific duration (Husam, I.S. *et al.*, 2017). A dengue outbreak is contributed by the entomological factors, epidemiological as well as environmental factors such as rainfall, temperature and humidity. A dengue outbreak response is crucial to reduce case fatalities and number of cases. An outbreak is only detectable via a sound systematic surveillance system (Harrington, J. *et al.*, 2013 & Azhar, Z.I. *et al.*, 2016). At the moment the best way to control dengue is by controlling the vector and by reducing human vector contact (Hamdan, N. *et al.*, 2019).

These control measures can be broadly divided into physical control, chemical control and biological control. Under physical control, there is GIS mapping of dengue foci where dengue positive cases are located, and preventive strategies are concentrated in those areas. A study conducted in Thailand also highlighted the importance of home identification for dengue cases based on dengue transmission patterns (Gandhi, G. *et al.*, 2017). The next is effective surveillance that aid in collecting spatiotemporal distribution of cases which again is used for concentration of prevention strategies (Salje, H. *et al.*, 2017). Determination of oviposition sites is another strategy to eliminate the mosquito population (Scarpino, S.V. *et al.*, 2017), community based control programme that function to educate communities regarding the dengue prevention as well as the knowledge regarding dengue.

The next is chemical control, which are chemical compounds that act as insecticides to control the vector. Although this method has been widely used, it unfortunately has some negative effects to the environment (Wong, J. *et al.*, 2011). Under biological control, several strategies are in use such as Wolbachia carrying mosquitoes, where this bacterium is introduced into the vector and eventually colonize the vector population. This bacteria has the ability to supress the vector population by dysregulating its sexual cycle (Araújo, H.R.C. *et al.*, 2015). Another biological method is by using sterile insect technique (STI) where the male vectors are sterilized in a target population. Besides that, the use of larvivores fish and crustaceans such as the guppy fish in open water bodies to control the vector larvae population in an eco-friendly and cost effective way (Wilke, A.B.B. *et al.*, 2015). For prevention methods, RM 295 million is spent annually in Malaysia for vector control (Warbanski, M.L. *et al.*, 2017) which accounts for 1.2% of the RM 24 million total healthcare funding (Packierisamy, P.R. *et al.*, 2017). The objective of this study is describing the outbreak in an urban residential area and outlining its management on the field.

Methods

This was a descriptive study involving a series of reported cases involved in an outbreak that occurred in a local residential area in Kota Kinabalu involving 6 cases. A dengue outbreak was declared on the 17th November 2019 at an urban residential area after dengue cases from the heath facilities were notified to the District Heath Office. The dengue cases were diagnosed at the heath facilities based on the clinical symptoms as well as a positive NS-1 combo test kit that identifies NS-1, IgM and IgG. Active case detection was also conducted to identify other cases. The outbreak locality is situated in the sub-district of Luyang, in the district of Kota Kinabalu. This locality is an urban living area with arranged housing. There are 86 houses located in this locality with a total population of 340 people. The majority ethnic group of the people living there are Chinese followed by Dusun and Kadazan.

Dengue fever case is defined as any individual that presents with fever and two more symptoms such as headache, body ache, joint pain, retro-orbital pain, rashes, vomiting, diarrhoea or bleeding tendencies, along with a positive blood test [NS-1 (Non-structural protein 1) or ELISA (enzyme-linked immunosorbent assay)] (Murphy, A. *et al.*, 2020). A dengue outbreak is defined when more than one dengue cases is reported in the same locality within 14 days from the date of notification of the first case (Husam, I.S. *et al.*, 2017). An outbreak is considered over when no new case reported from the locality after 14 days of the last notified case. Interview of the cases were done based on the PBV(D)202 forms which is standard used in the Ministry of Health Malaysia (MOHM, 2020). All cases that comply with the criteria of case definition will be registered into the eDengue database system within 24 hours of notification based on the standard operating procedure (MOHM, 2021).

In accordance with the standard operation procedure, dengue control is done 24 hours when the case has been registered into the eDengue system. Dengue control consists of source reduction by inspection and elimination breeding sites and space spraying. Inspection of breeding site includes demolishing breeding site 200 meter from the house of the reported case, heath education, obtaining the entomological indexes such as the Aedes Index (AI), Breteau Index (BI), and Container Index (CI) (Lutomiah, J. *et al.*, 2016). AI is the percentage of houses infested with larvae. BI is the number of positive containers per 100 houses and CI the percentage of water-holding containers infested with active immatures (Nordin, O. *et al.*, 2017 & Focks, D.A., 2004). Ovitrap allows better assessment of entomological densities as compared to the standard larvae search methods. Having said that, some studies found weak correlation between ovitrap index and dengue cases (Azhar, Z.I. *et al.*, 2016).

Destruction of Disease Bearing Insect Act 1975 (Act 154) is used for the enforcement activities towards premises that are positive breeding site of Aedes larvae. Other initiatives such as larvaciding using temephos and/or Bacillus thuringiensis israelensis (Bti) and the use of outdoor residual spraying with pyrethroids are recommended (Ong, S.Q., 2016).

Results

All cases notified had an epidemiological link and were from the same locality with similar incubation periods.

Table 1: The information of the reported cases detected from the dengue outbreak

S.No.	Age (years)	Gender	Race	Results	Onset	Date of Notification	Date Registered	Serotype
1*	30	Male	Chinese	NS1	16.11.19	17.11.19	18.11.19	DENV 3
2*	39	Male	Chinese	NS1	12.11.19	17.11.19	19.11.19	ND #
3*	66	Female	Chinese	NS1	13.11.19	17.11.19	19.11.19	DENV 3
4	43	Male	Chinese	NS1	16.11.19	17.11.19	18.11.19	-
5	35	Male	Chinese	NS1	17.11.19	18.11.19	19.11.19	-
6	61	Female	Chinese	NS1 & IgM	15.11.19	19.11.19	21.11.19	-

*Same family (Household); # Not detected; - Serotype was not done

The index case was a 30-year-old Chinese male working as an accountant from home in Malaysia. The onset of his symptoms on 16th November 2019 is fever, headache with joint and body ache. From the investigation, it was found that the case was mostly at home for the past week leading to his symptoms and only went to the local street market briefly. He sought treatment at nearest public specialist hospital on the 17th November 2019 and was confirmed to have dengue with rapid test kit antigen NS-1 positive result.

The second case was a 39-year-old Malaysian Chinese male working as a salesman in Inanam which is about 7km away from his home. This case is the older brother of the index case. The onset of his symptoms was on the 12th November 2019 and presented with fever followed by headaches, joint and muscular pain, and diarrhoea. From the investigation, the case was regularly working in Inanam from 8am to 5pm and did not travel anywhere else prior to the onset of symptoms. Upon developing fever, the case consumes paracetamol, and delayed seeking treatment in the hospital. The case later sought treatment from the nearby public hospital on the 17th November 2019 the same day as his brother and was confirmed to have dengue with rapid test kit antigen NS-1 positive result.

The third case was a 66-year-old Malaysian Chinese lady who is the mother of the 1st and 2nd case. She is retired and lives in the same house as her sons. The onset of her symptoms was on the 13th November 2019 and presented with fever, headache, with joint and muscular pain. Weeks prior to her symptoms, she claims was at home and did not travel anywhere and she sought treatment only on the 17th November 2019 along with her sons and was diagnosed as dengue with a rapid test kit antigen NS-1 positive result.

The fourth case was a 43-year-old Dusun male who works as a security guard. The onset of his symptoms was on 16th November 2019 and presented with symptoms of fever, headache, body ache and retro orbital pain. From the investigation, the case claimed that he has only been traveling to work. His working hour is from 8am to 8pm for the day shift and 8pm to 8 am for the night shift. Upon developing symptoms, the case took paracetamol and sought treatment the next day on the 17th November 2019 at the nearby public hospital and was also diagnosed with dengue with a rapid test kit antigen NS-1 positive result.

The fifth case was a 35-year-old Indonesian Chinese male who worked as a manager at a petrol station in Menggatal, Kota Kinabalu. The onset of his symptoms was on the 17th November 2019 and presented with fever, retro orbital pain, headache with body and joint pain. He mentioned to be working every day from 9am to 6pm. The case also has flexible working hours and would return home at odd times off the day. He would also stop by a coffee shop in Kota Kinabalu city centre daily before returning home in the evenings. The case sought treatment at a private hospital on the 18th November 2019 and was diagnosed as dengue with a rapid test kit antigen NS-1 positive result.

The sixth and final case was a 61-year-old Malaysian Chinese lady who is retired. The onset of her symptoms was on the 15th November 2019 and presented with symptoms of fever, headache, and joint with body aches.

Throughout the weeks leading to the onset of symptoms she claims to be at home and did not travel out. She sought treatment on the same day (15th November 2019) at a private clinic and was diagnosed as viral fever. She returned to the clinic on the 18th November 2019 and was diagnosed with dengue with a positive antigen NS-1 test as well as IgM antibody.

The source reduction activities by elimination of breeding sites were conducted 3 times covering an area of 200 meter radius on the 18, 23rd and 25th of November 2019. A total of 110 premises were checked with a coverage percentage of 86%. The number of containers checked was 923, with 454 outside the premises and 469 inside the premises with no positive results for dengue larvae. The AI, BI and CI were all 0%. Containers that were potential breeding sites were destroyed and larvicide was done.

A total of 30 ovitraps were placed on the 19th November 2019 around the locality and of which 2 were positive (6.7%). Space spraying *via* thermal fogging was conducted 3 times (18th, 23rd and 25th of November 2019). Besides that, 2 cycles of ultra-low volume (ULV) spraying done on the 18th November 2019 and 29th November 2019 within the 400 meter radius with coverage of 100%.

Discussion

For dengue outbreak, the control measures were conducted within 24 hours of the case registration. Source reduction by elimination of breading sites managed to cover 86% of the premises for this outbreak locality. The space spraying was not satisfactory as it only managed to cover 24%, 25% and 54% of the premises. Space spraying has a known problem of difficulty in getting good coverage usually because of residents not cooperating or absent from home (Usuga, A.F. *et al.*, 2019).

The AI, BI and CI indexes were nil, but the ovitrap findings found some areas of breeding. These indices are used during dengue outbreak to measure the entomological contributions. However, this may need some revisions as they are very subjective in terms of the individual conducting the surveillance as well as the current weather conditions. Heavy rain would have washed off larvae just prior to inspection. Some studies shave also indicated that these indices apparently have a weak association with DENV transmission, and are limiting in ability to identify vector presence or absence (Lutomiah, J. *et al.*, 2016).

In terms of the serotype of the virus, the case no.1 and 3 were infected with DENV 3. Case 2 serotype was not detected as the case only presented to the heath facility on day 6 of illness. Due to the delay, the viral load may have already decreased. Interestingly the NS-1 was still positive, but the serotype was not detected. As for the 4th case, serotype results were not available. For the other 2 cases, they sought treatment at private clinics and the serum samples were not sent to for serotyping.

Epidemiologically based on the investigation all the cases fulfilled the dengue case definitions and were registered within 24 hours in the eDengue system, and the cases sought treatment. However, it should be stressed and advised during health promotion talks to seek treatment early especially if they live in dengue prone areas. The outbreak management was in par with the standard operating procedure.

Rapid detection of outbreak is a priority for disease surveillance (Jeffree, M.S. *et al.*, 2020). Besides that, control methods involve integration of GIS application which can assist the health authorities to implement surveillance, control and prevention of dengue outbreak (Azhar, Z.I. *et al.*, 2016).

Conclusion

The source of infection was from the surrounding area of the cases' home as the new cases were within 200 meter radius. The preventive measures for vector control place a heavy burden economically. Therefore, for the optimization of prevention measures, the community has to play a very important role. There must be more rigorous health promotion to educate and focus on behaviour modification. Strong emphasis must be given on the importance of cleanliness of their own homes especially the surrounding outside area as it is a breeding ground for Aedes mosquitoes. Early presentation to heath facilities is very crucial as it helps us detect an outbreak earlier and thus able to manage it more efficient and prevent further spread. Effective preventive measures have to be supported by responsible communities, only then can we truly control dengue.

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Ethical Approval

Ethical clearance was obtained from the National Medical Research Register (NMRR-18-2869-41360). The confidentiality of each case is maintained as no identifiable individual information was recorded or published.

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Conflicts of Interest

The authors declare that there are no competing interests in this study.

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