

Problems and solutions in vector control

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INTRODUCTION

The two vector mosquito species incriminated in the transmission of dengue fever in Malaysia are *Aedes aegypti* and *Aedes albopictus*. They are house frequenting and are found in and around human habitations. They breed in artificial and natural containers and receptacles which hold clean and clear water. Containers such as ant traps, earthen jars, flower pots, drums, buckets, basins, bowls, concrete tanks, coconut shells and tyres are some of the preferential breeding sites.^{1,2} Some neglected and unusual breeding sites are also identified during the routine larval survey. These shall be highlighted in the later part of the paper. *Aedes* mosquitoes prefer human blood and the peak biting times are during the early mornings and early evenings.

For the prevention and control of *Aedes* in and around the house, measures directed at both the larval and adult stages have to be instituted.

VECTOR CONTROL

As there is no specific treatment for dengue infection currently, vector control against *Aedes* mosquitoes is emphasised in the dengue control programme.

The objectives of the dengue control programme are, firstly, to reduce the breeding of *Aedes* mosquitoes to a level below 2.5% *Aedes* House Index and below a Breteau Index of 10, secondly, to promote public support and community participation in the prevention and control of dengue and, thirdly, to get the full participation of the local authorities in dengue control activities."

The strategies employed in vector control are directed both at the larval and adult stages of the *Aedes* mosquitoes. For larval control, the activities carried out are source reduction measures, use of Abate larvicide, regular house inspection and enforcement of the Destruction of Disease Bearing Insects Act, 1975.

For adult control, fogging activities are instituted as soon as a case of dengue is notified. The use of household pesticides by the public also helps to reduce the adult populations to a

certain extent. The use of personal protection measures such as mosquito nets, repellants and the screening of windows and doors are encouraged.

VECTOR CONTROL ACTIVITIES, PROBLEMS AND SOLUTIONS

Source reduction

The objective of source reduction is the elimination of *Aedes* mosquito breeding grounds in and around the home environment, state lands, public parks, construction sites, factories, government premises, schools and cemeteries. This is carried out with community involvement together with the various agencies concerned and the local authority.

One of the problems encountered in source reduction activities is the illegal dumping of household refuse by the roadside. This creates favourable breeding sites for the *Aedes* mosquitoes. To overcome this problem, the local health authority has to step up scavenging services and provide bins at designated areas.

Surveys carried out recently have identified neglected and unusual breeding sites which hamper source reduction efforts. Some of these breeding sites are cocoa pods, rubber tyres, septic tanks, vacant land, abandoned housing projects, roof gutters, refrigerator trays and cemeteries.

Cocoa pods

This problem was first highlighted in the Serian district of Sarawak where an outbreak of rural dengue was traced to the extensive breeding of *Aedes albopictus* in cocoa pods. The community has been advised to carry out active source reduction activities like burying or burning cocoa pods. To further reduce the problem, it was recommended that cocoa pods be cut into four parts to prevent the collection of water.

Rubber tyres

The Ministry of Agriculture and Fishery started an artificial reef project using discarded rubber tyres. The rubber tyres were collected from all

over the country and kept temporarily in depots. These tyres, if not properly covered, create breeding sites for the *Aedes* mosquitoes.

To overcome the problem, the Fishery Department has been requested to apply Abate larvicide and carry out regular fogging of the depots and to stack the tyres in straight rows to facilitate control. These measures have reduced the problem.

To this end, a set of general guidelines for the prevention and control of *Aedes* breeding in rubber tyre depots has been prepared and distributed.

Septic tanks

The problem of *Aedes* breeding in septic tanks was first detected in various housing estates in the Ipoh City Council area and in the districts of Kuala Kangsar and Manjung in Perak.

To understand the problem, one has to be familiar with the structure of the septic tank. The typical household septic tank consists of three main compartments, namely, the settling tank, the filter-bed and the pump sump section. Aerobic and anaerobic breakdown of waste material occur in the filter-bed compartment while filtered clear water flows into the pump sump area which is later pumped out into the main drain using an electric water pump.

The electric pump which is housed above the pump sump area can be operated manually or automatically. Mosquitoes have been found to breed in the filter-beds and the pump sump compartments as these are usually wet or filled with water. In the filter-bed compartment, where the water has a high organic matter content, *Culex* and *Armigeres* species are commonly found. *Aedes aegypti* and *Aedes albopictus*, however, rarely breed in this area but can be commonly found in the pump sump area where the water is clear and has less organic matter.

Survey results have shown that *Aedes* breeding occurred more intensively in septic tanks which are not properly maintained such as those with faulty pumps and where there are holes and cracks. Air vents and improperly fitted manholes are common entry points for the mosquitoes.

Various methods have been carried out to reduce the problem. These include the use of expandable polystyrene balls, bacteria, insect growth regulators, fish and wire mesh screening of all entry points. To this end, the City Council of Ipoh has issued directives and guidelines on how to prevent *Aedes* breeding in septic tanks.

Vacant land

These are empty land with potential mosquito breeding habitats within town and city areas around residential shop houses, lots and offices. To overcome this problem the Land and Survey Department has been asked to assist in identifying the private land owners and to notify them for the necessary clearing and removal of potential *Aedes* breeding grounds. Alternatively, the local health department can clear vacant land of grass and vegetation and then bill the owner for the work done.

Abandoned housing projects

These housing structures provide ideal breeding sites for the *Aedes* mosquitoes. Maintaining a close liaison between the Health Department and Housing developers can minimise the problem. Alternatively, housing developers can employ private pest control operators to look into the problem. The government is in the process of reviving some of these projects.

Roof gutters

These are suitable breeding sites for the *Aedes* mosquitoes. It is the responsibility of house owners to check regularly for blockage and to remove debris from roof gutters. Any overhanging branches of trees should be cut to avoid the collection of leaf litter in roof gutters.

Refrigerator trays

The trays which collect defrosted water in refrigerators are often neglected by house owners. *Aedes* has been found breeding in them. House owners have been informed of this special breeding site and are reminded to remove the water and to clean the refrigerator trays regularly.

Cemeteries

Flower vases used in cemeteries are also favourite breeding sites for the *Aedes* mosquitoes. Various voluntary bodies and associations should carry out cleaning-up campaigns at least once in three months to remove these potential breeding sites.

Use of Abate larvicide

The use of a suitable larvicide such as Abate is given emphasis in the dengue control programme. It is safe, effective and convenient to use especially in water holding containers. Householders

are encouraged to apply Abate 1% sand granules into water storage containers so that *Aedes* larvae will not breed. The recommended dose is 10gm or 1 teaspoonful Abate in 20 gallons of water (approximately 100 litres). Its effectiveness will last for about 3 months.

Abate is easily available in medical halls, hardware shops, sundry shops, agrochemical outlets, mini-markets and pharmacies. A nationwide survey was carried out from July-November 1989 to assess the availability of Abate since there were complaints that it was not easily available. A total of 4,092 localities were surveyed. 59,836 householders were found to be using Abate as a larvicide. 2,207 localities were found to have shops selling Abate and 1,634 localities did not have shops selling Abate. To overcome this problem, the main distributor for Abate has been approached to increase the number of Abate outlets in both urban and rural areas. The possibility of selling Abate in petrol stations is being explored.

During the intensive anti-dengue campaign months, health staff demonstrate the proper usage of Abate to the people. In the event of a dengue outbreak the health department usually applies Abate to all potential *Aedes* breeding containers.

For the past 5 years an average of 1,044 kg of Abate was applied by the health department as part of its dengue control activity.

House inspection for *Aedes* breeding

House inspection for *Aedes* breeding is carried out daily by the health authority. The purpose is to educate the people on ways and means to prevent *Aedes* breeding including the use of Abate larvicide, and looking for *Aedes* breeding in individual households.

Another purpose of house visits is to ensure that the people carry out source reduction mea-

sures. The results of the *Aedes* larval surveys can be used to assess regularly the *Aedes* situation and density in terms of time and space and to pinpoint high risk areas so that these can be identified as priority areas for prevention.

House inspection is carried out by the district dengue control team and one team can usually cover about 200 houses a day.

The local authority of the area also assists in larval surveys. During the surveys, the team members search for potential *Aedes* breeding sites in and around the houses. For the past 6 years an average of 3,528,401 houses per year were inspected for *Aedes* breeding. Of these, 12,111 (0.34%) houses were positive for *Aedes aegypti* and 29,768 (0.84%) houses were positive for *Aedes albopictus* (Table 1).

In 1991, a total of 4,178,856 houses were inspected and 44,805 houses were found positive for *Aedes* larvae (Table 2). A combined *Aedes* House Index of 1.1% was obtained. All States except Perlis and Sabah had *Aedes* House Indices of below 2.5%. Kedah, Penang, Negeri Sembilan, Malacca, Johore, Terengganu and Kelantan had *Aedes* House Indices of below 1%.

For the first 8 months of 1992, a total of 2,940,177 houses were inspected and 28,554 houses were found positive for *Aedes* larvae as shown in Table 3. A combined house index of 0.9% was obtained. The *Aedes* House Index of 2.4% for Perlis is still high when compared with the other States. Kedah, Penang, Negeri Sembilan, Malacca, Johore, Pahang and Kelantan registered House Indices of below 1%.

Some of the difficulties encountered in house inspection are that the coverage and frequency of visits to houses are inadequate. The same house can only be visited at the most once in 3 months or sometimes 6 months. For effective surveillance and control, each house should be visited at least once a month. To overcome some of these

TABLE 1: House inspection for *Aedes* breeding in Malaysia 1986-1991.

Year	No. of houses inspected for <i>Aedes</i>	No. of houses positive for <i>Aedes</i>			House Index (HI) (%)		
		<i>aegypti</i>	<i>albopictus</i>	Both	<i>aegypti</i>	<i>albopictus</i>	Both
1986	2,950,662	15,231	29,648	44,879	0.52	1.00	1.52
1987	3,485,116	13,812	37,069	50,881	0.40	1.06	1.46
1988	3,183,467	10,850	28,480	39,750	0.34	0.91	1.25
1989	3,582,133	10,632	27,848	38,480	0.30	0.78	1.07
1990	3,790,174	10,872	22,663	33,535	0.29	0.60	0.88
1991	4,178,856	11,269	32,899	44,168	0.27	0.79	1.06

TABLE 2: House inspection for Aedes breeding in Malaysia 1991

State	No. of houses inspected	No. of houses positive for Aedes	Aedes House Index (%)
Perlis	23,903	873	3.6
Kedah	346,275	2,256	0.6
P. Pinang	347,947	1,756	0.5
Perak	711,767	8,454	1.2
Selangor	660,437	7,675	1.1
W. Persekutuan	151,322	2,123	1.3
N. Sembilan	168,534	1,302	0.7
Melaka	154,720	1,215	0.8
Johor	519,208	4,857	0.9
Pahang	207,627	2,536	1.2
Trengganu	165,216	1,627	0.9
Kelantan	216,223	492	0.2
Sabah	134,389	4,333	3.2
Sarawak	371,288	5,306	1.4
Total	4,178,856	44,805	1.1

problems, the number of dengue teams will be reviewed in line with the increase in number of houses in the districts. The local authority will be requested to form its own vector control unit and not to rely solely on the health department for the Aedes survey. At the moment, only about 46% of the local authorities have their own vector control teams. This is insufficient to ensure complete coverage of the area.

Routine house inspection is carried out on a daily basis by the district dengue teams. There is a need to check the quality of their work in view of complaints by the public. There are instances where homeowners refuse entry or are doubtful of the intentions of the health staff. Towards this end, state entomology teams carry out assessment

surveys to find out the quality of the Aedes surveys carried out by the district teams. Team members will be re-trained on entomological techniques. Training on public relations is planned so as to improve rapport with house owners. There is a need for more professionalism in their work. If possible, health inspectors will be utilized to do Aedes larval surveys so as to obtain better cooperation from the public.

House inspection using the larval survey is not a sensitive method for surveillance especially in situations where the Aedes density is low. To develop a more effective and sensitive method for surveillance, the use of ovitrap is being studied by the Institute for Medical Research.

TABLE 3: House inspection for Aedes breeding in Malaysia, January-August 1992

State	No. of houses inspected	No. of houses positive for Aedes	Aedes House Index (%)
Perlis	24,609	601	2.4
Kedah	263,867	1,340	0.5
P. Pinang	212,971	1,427	0.6
Perak	493,077	6,030	1.2
Selangor	400,919	4,036	1.0
W. Persekutuan	98,821	1,457	1.4
N. Sembilan	123,482	793	0.6
Melaka	104,919	725	0.7
Johor	365,734	3,088	0.8
Pahang	127,722	978	0.7
Trengganu	106,428	1,128	1.0
Kelantan	182,233	738	0.4
Sabah	113,165	1,891	1.6
Sarawak	322,230	4,322	1.3
Total	2,940,177	28,554	0.9

TABLE 4: Enforcement of Destruction of Disease Bearing Insects Act 1975 in Malaysia 1986-1991.

Year	No. of houses positive for Aedes	No. of warning notices issued	No. of compounds issued	Compounding rate (%)	No. of court cases
1986	44,879	16,941	15,863	35.3	117
1987	50,881	16,165	18,837	37.0	212
1988	39,750	16,697	13,068	32.9	289
1989	38,480	12,617	16,476	42.8	96
1990	33,535	13,445	16,081	48.0	196
1991	44,168	14,840	21,074	47.7	224

Enforcement of the Destruction of Disease Bearing Insects Act, 1975

The enforcement of the Destruction of Disease Bearing Insects Act, 1975 against anyone found having Aedes larvae breeding in and around his house is an effective strategy especially against uncooperative and uncivic-minded individuals who ignore or refuse to follow advice and participate in the control programme.

In this aspect, legislative support is essential for recalcitrant offenders. For the past 6 years an average of 41,949 houses were found breeding Aedes (Table 4). An average of 15,118 warning notices and 16,900 compounds were issued to offenders. For those who refused to pay the compounds, an average of 189 were taken to court. In 1991 alone a total of 14,836 warning notices and 21,100 compounds were issued. A total of 224 court cases were instituted and fines totalling RM1,038,257 were collected.

Table 5 shows the performance of law enforcement by States for 1991. Perak, Johore, Selangor, Wilayah Persekutuan (Kuala Lumpur), Penang, Sarawak, Pahang and Negeri Sembilan issued over 1,000 compounds each for the year. Wilayah Persekutuan had the most number of court cases. From January-August 1992, a total of 9,085 warning notices and 15,228 compounds were issued (Table 6). A total of 22 court cases were instituted and RM883,522 collected in fines. Perak, Johore, Selangor, Penang and Wilayah Persekutuan issued over 1,000 compounds each for that year. Perak had the most number of prosecutions for that year.

Some of the problems associated with law enforcement are the refusal of the public to abide by warnings and to settle compounds issued to them. To overcome this problem, offenders are usually charged in court and they could be imposed heavier fines of up to RM1,000.

TABLE 5: Enforcement of Destruction of Disease Bearing Insects Act 1975 in Malaysia, 1991.

State	No. of notices	No. of compounds	No. of court cases	Fines collected (RM)
Perlis	777	88	0	2,665
Kedah	1,239	942	1	45,645
P. Pinang	63	1,788	1	141,555
Perak	2,116	4,580	6	224,300
Selangor	3,316	2,887	37	87,353
W. Persekutuan		2,120	166	77,710
N. Sembilan	63	1,213	0	61,515
Melaka	875	370	0	4,070
Johor	944	3,789	10	276,810
Pahang	936	1,233	0	67,765
Trengganu	1,181	72	3	3,520
Kelantan	179	173	0	5,075
Sabah	1,232	373	0	14,759
Sarawak	1,915	1,472	0	25,515
Total	14,836	21,100	224	1,038,257

TABLE 6: Enforcement of Destruction of Disease Bearing Insects Act 1975 in Malaysia, January-August 1992.

State	No. of notices	No. of compounds	No. of court cases	Fines collected (RM)
Perlis	330	213	0	6,335
Kedah	734	536	4	29,033
P. Pinang	143	1,528	0	123,410
Perak	1,385	3,197	11	262,355
Selangor	1,396	2,477	4	99,515
W. Persekutuan	—	1,421	0	55,830
N. Sembilan	31	762	0	36,390
Melaka	439	305	0	4,520
Johor	756	2,494	1	165,004
Pahang	340	519	1	30,015
Trengganu	882	54	1	2,515
Kelantan	399	288	0	20,855
Sabah	571	606	0	29,250
Sarawak	1,689	828	0	18,515
Total	9,085	15,228	22	883,522

There are some deficiencies in the implementation of the Act. To overcome this, feedback is being collected from the various States and local government with a view to amending the Act to improve its effectiveness.

Although legislation serves as a strong deterrent to mosquito breeding by careless and indifferent householders, it must be clear that the basis of initiating mass public health education is not entirely to elicit public acceptance of the legislation. More importantly, it is to highlight the role of the public in supportive activities and the importance of their participation, especially in source reduction measures.

The enforcement of legislation require health education, which is the driving force behind the Ministry of Health's objective in soliciting community participation in the prevention of Aedes breeding.

Fogging activities

Fogging activities are carried out as soon as a suspected case of dengue is notified to the health authority. For a single case of dengue, perifocal fogging for 200m around the patient's house using portable thermal fogging is carried out. For outbreak situations, ULV fogging is used to cover the whole locality.

The purpose of fogging is to kill infected and infective Aedes adult mosquitoes as soon as possible so that the spread of the disease can be prevented. During a dengue outbreak, the first adulticidal treatment is normally followed by a

second application 7 – 10 days later. The two treatment cycle is based on the life-cycle of the Aedes mosquitoes of about 1 week and the incubation period of the virus in the mosquito of about 10 days. If no new cases are introduced into the area, an epidemic attacked in its early stages can be arrested by achieving a 20-day transmission-free period. If there are no mosquitoes capable of transmitting the disease, a reduction in reported cases should follow.

The insecticide of choice for fogging is 4% malathion in fuel oil for thermal fogging and 96% malathion technical grade for ULV. Regular air-borne bioassay tests have indicated that the Aedes mosquitoes are still susceptible to the insecticide. This is also evidenced by the reduction in number of dengue cases after fogging rounds.

In 1991 a total of 1,391,526 houses were fogged. From January-August 1992, a total of 1,242,014 houses were fogged.

Some of the problems encountered in fogging activities are as follows:-

- (a) Some homeowners close their doors and windows during fogging. This will reduce the chance of the spray droplets reaching the target mosquitoes. To overcome this problem, the health department employs mobile health education vans to inform the people of fogging. Fliers are also distributed before the fogging to inform the public of the purpose of fogging and to seek their cooperation.

- (b) Other problems include the difficulty of achieving total coverage of all the houses and the difficulty of carrying out the second fogging within 7-10 days after the first round. The health department will have to purchase more machines and have more manpower to cope with the increase in the areas to be covered. The local authorities are advised to purchase enough fogging machines and insecticide and to have their own control teams to deal with any outbreak of dengue.
- (c) Some local authorities are using new synthetic pyrethroid insecticides for fogging. Apparently some of these insecticides are not effective in controlling outbreaks. The Health Ministry has set up a committee to look into this problem and to conduct field trials on the new insecticides to assess their effectiveness. The Health Ministry will continue to advise the local authorities on all aspects of fogging and vector control activities.
- (d) There are reports of private pest control operators going around fogging and charging a fee for the work done. Some of them pretend to work under the auspices of the health department and force the homeowners to accept the service. The health department is aware of this problem and is working closely with the Pesticides Board of the Agriculture Ministry to come out with suitable regulations, code of ethics or guidelines to advise the private pest control operators and seek their cooperation. For the control of dengue, the health department and the local authority will continue to conduct fogging for free.

CONCLUSION

While awaiting a breakthrough in the development of a dengue vaccine or any suitable drug, vector control will remain an important strategy for the prevention and control of dengue. In the vector control programme, there are problems identified in carrying out source reduction activities, house inspection, enforcement of the law and fogging activities. Possible solutions are available but they can only help to reduce the problems.

Although it is difficult to assess the effectiveness of source reduction by house inspection and law enforcement on an individual basis, past experiences have shown that the contributions of such activities as part of an integrated vector

control programme to be enormous and significant.

Indeed, such measures are time-tested methods to obtain the desired response from the public. In the long run, it paves the necessary ground work for the more permanent solution of preventing *Aedes* breeding. Although there will be resistance because of the indifferent attitudes of certain individuals, legislative action is the only solution to deal with these people. As the educational process gains momentum and with greater involvement of the public, a natural and spontaneous habit of good housekeeping can be inculcated among the population.

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