Control of Dengue Fever/Dengue Haemorrhagic Fever in Singapore

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Abstract
The control of dengue fever/dengue haemorrhagic fever (DF/DHF) in Singapore is largely through source reduction, health education and law enforcement. Adulticiding is carried out when the house index exceeds 2%, and when there is a reported case or a localized outbreak. Regular Aedes surveillance is conducted in areas identified as dengue-sensitive. The national annual Aedes house index has been kept below 2% since 1979; however, the number of cases has seen an increase since 1986. Data for the first four months of 1997 showed that landed properties, schools, construction sites and vacant premises were the main premises-types breeding Aedes mosquitoes. The commonest habitats indoors were ornamental containers, domestic containers, receptacles exposed to rain, canvas sheets and roof gutters. In the public areas, discarded water-bearing receptacles were the major culprit. The Ministry of the Environment, Singapore, which is responsible for dengue control, is constantly looking for permanent ways of eliminating potential breeding habitats. It is also educating householders, construction contractors, estate managements and schools on measures to prevent mosquito breeding in their premises through the mass media, seminars and exhibitions. Enforcement action is stringently carried out. Research to explore new tools to monitor the Aedes population and forewarn about an outbreak is under way. There is a need to establish a reliable population indicator for Aedes breeding found in the open areas outside of premises, as the present premises indices do not include these.

Introduction
DHF was first reported in Singapore in 1960(1). Since then, it has become endemic. Large epidemics occurred in the years 1966-1968. The largest, with 1187 cases and 27 deaths, occurred in 1973(2). Another epidemic occurred in 1978 with 384 cases and two deaths(3). From 1979 to 1985, the number of cases remained low at less than 300 cases per year with deaths of two or less per year. However, the number of DF/DHF cases started to rise in 1986 and reached a peak in 1992, with 2878 cases reported. The 1992 epidemic was brought under control.
and a dramatic drop to 946 cases in 1993 was seen. However, DF/DHF cases again crept up since 1993. The national annual Aedes house index has remained below 2% since 1979.

**Aedes control strategy**

The control of dengue fever/dengue haemorrhagic fever (DF/DHF) in Singapore is the responsibility of the Vector Control & Research Department (VCRD), Ministry of the Environment (ENV). It plans and carries out vector control operations, analyses trends and conducts research on vectors. The Quarantine and Epidemiology Department (QED) investigates and monitors vector-borne diseases.

Control of the vectors, *Aedes aegypti* and *Aedes albopictus*, is largely through source reduction, health education and law enforcement. As far as possible, permanent measures to eliminate potential habitats are carried out. Adulticiding with thermal fogging machines and cold foggers using Actellic (a.i.: pirimiphos-methyl) is carried out whenever the *Aedes* house index exceeds 2%, and when there is a case reported or a localized outbreak. A localized outbreak is defined as two or more cases reported within a 200 m radius.

Vector control operations to disrupt disease transmission are carried out upon notification of suspected DF/DHF cases, without waiting for laboratory confirmation. Besides the emergency vector control response to cases, there is also a preventive, routine *Aedes* surveillance programme in areas which are identified as dengue-sensitive based on the history of cases, *Aedes* population densities, presence of conducive housing types, development and construction activities, and human population density to support transmission in these areas. This routine *Aedes* surveillance programme in which a dengue-sensitive area is completely surveyed within a 1 - 3 months cycle, has successfully reduced the number of DF/ DHF cases in these sensitive areas.


In the last five years since 1993, DF/DHF has been continually on an upward trend. The number of cases were 946 in 1993, 1239 in 1994, 2008 in 1995, 3128 in 1996, and 1700 as at June 1997. Over 70% of the cases were sporadic ones scattered all over the island. The remaining 30% occurred in localized outbreaks. The morbidity and mortality rates are shown in the table below.

**Table.** DF/DHF morbidity and mortality rates (per 100 000 population), 1993-1996

<table>
<thead>
<tr>
<th>Year</th>
<th>No. of DF/DHF cases</th>
<th>Morbidity Rate</th>
<th>No. of Deaths</th>
<th>Mortality Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1993</td>
<td>946 (152)</td>
<td>32.9</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Control of Dengue Fever/Dengue Haemorrhagic Fever in Singapore

<table>
<thead>
<tr>
<th>Year</th>
<th>Imported Cases (Total)</th>
<th>Aedes HI</th>
<th>Breeding Sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>1994</td>
<td>1239 (155)</td>
<td>42.3</td>
<td>1</td>
</tr>
<tr>
<td>1995</td>
<td>2008 (252)</td>
<td>67.2</td>
<td>1</td>
</tr>
<tr>
<td>1996</td>
<td>3128 (251)</td>
<td>102.7</td>
<td>3</td>
</tr>
</tbody>
</table>

Note: Figures given in brackets refer to imported cases which are included in the total.

**Aedes situation (1993 – Apr 1997)**

The national annual *Aedes* House Index (HI) remained low at 1.3% in 1993, 1.07% in 1994, 1.16% in 1995, 0.69% in 1996 and 1.92% in 1997 (up to April 97). However, in some neighbourhoods, the *Aedes* HI for the estates can reach as high as 10% - 20%.

The main premises types found breeding *Aedes* mosquitoes were landed properties (H.I. 2.1%), flats (0.6%), shophouses (1.14%), schools (27.0%), construction sites (8.3%), factories (7.8%) and vacant premises (14.6%). The main breeding habitats in premises were ornamental containers (29.6%), domestic containers (30.4%), receptacles placed in the compound exposed to rain (12.9%), canvas sheets (5.0%) and roof gutters (2.6%). Although breeding found in roof gutters was only 2.6%, there might be many more which were breeding or had the potential to breed but were not detected because of the difficulty in accessing roof gutters.

A large number of *Aedes* mosquito breedings have also been found outside of premises in the public areas. The majority of such habitats were discarded receptacles (46.3%), closed perimeter drains (9.6%), domestic containers left by residents in the public areas (5.6%) and infrequently-used gully traps (4.8%). The problem of discarded receptacles in public areas breeding *Aedes* is increasing as manpower for public cleansing work is difficult to come by in manpower-scarce Singapore. Closed perimeter drains are difficult to maintain, and there is now a move towards removing the covers so that these drains can be maintained properly by the Town Councils. The infrequently-used gully traps on the void decks of flats in public housing estates used to be the second highest outdoor habitats. In 1996, the Government embarked on a project to install anti-mosquito valves into these gully traps, and since then, there has been a significant drop in the number of these gully traps breeding *Aedes* mosquitoes, from 13.2% in 1995 to 7.5% in 1996 and 4.5% in 1997. The project is expected to be completed in early 1998.

**Source reduction**

Source reduction is still the main emphasis in the control of DF/DHF. Householders are advised to remove potential habitats as much as they can (e.g. flower pot plates, roof gutters, ground depressions), or else treat these habitats with temephos sand granules or...
insecticide paint. In the case of estate management, construction sites, schools and factories, ENV shows them the types of potential habitats in their premises, and requires them to engage pest control operators to do mosquito control in their premises.

ENV is also constantly looking for permanent measures to eliminate Aedes breeding habitats. Besides retrofitting gully traps with anti-mosquito valves and opening up closed perimeter drains as mentioned in the preceding paragraph, it is also studying the designs of sewers, drainage systems and roof gutters to make them mosquito-proof.

Public education
Public education is an ongoing process through the media, pamphlets and posters, house-to-house visits, talks, seminars and exhibitions. The education programmes are tailored for the different target groups: householders, schools, estate management, construction contractors and architects. In the surveys conducted by ENV over the past few years, it has been shown that people generally have high knowledge of dengue fever and the Aedes mosquitoes. However, this knowledge has not been translated into action in checking and removing stagnant water in their premises. This is especially so when the public generally sees the control of DF/DHF as fully the Government’s responsibility.

 ENV has also started to highlight to the population that litter thrown into public places can breed the Aedes mosquito which transmits DF/DHF. It is hoped that when people realize that their littering behaviour poses a health hazard to themselves, they will then refrain from littering.

Enforcement
The legislation to prohibit the breeding of mosquitoes is the Destruction of Disease-Bearing Insects Act (Cap. 79). The maximum fine under this legislation is $2000. Enforcement action is taken stringently against anyone who breeds vector mosquitoes in their premises. With effect from 1 October 1997, the compound fine for householders, schools, factories, commercial premises, etc., has been increased from $50 to $100 for the first offence, and from $100 to $200 for subsequent offences at the same premises. In the case of construction site contractors, the compound fine which is offered for the first offence at a site only has been increased from $200 to $500; for subsequent offences at the same site, the contractors will be required to attend court. In addition, if a construction site is constantly unkempt or breeding mosquitoes repeatedly, ENV will serve a stop-work order under the Environmental Public Health Act (Cap. 95) to stop all construction activities until the site is spruced up
and mosquito control measures are properly carried out.

Chemical control

Temephos (sand granules and emulsifiable concentrate) and anti-mosquito oils are the main chemicals used for larviciding. However, wherever possible, the potential habitats will be permanently eliminated. Pirimiphos-methyl is used for adulticiding. Thermal fogging is carried out for adult mosquito control in open areas and in the compounds of landed properties. Because of resistance from the public to thermal fogging within the house, houses are sprayed with water-based mixture of Actellic using an electrical cold fogger. The use of cold fogger for spraying within houses has increased the accessibility into houses to spray up to 70% from below 30% when thermal fogging machines were used.

Research

ENV is currently exploring several new tools to help in the monitoring of the Aedes population and forewarning of an outbreak in a locality. The Geographic Information System (GIS) is being developed to enable us to view the breeding sites in a locality and also the whole of Singapore over time and space. This will enable us to analyse the Aedes population trends spatially and to determine control priority areas. A method to detect and type dengue viruses in adult Aedes mosquitoes using reverse transcriptase polymerase chain reaction (RT-PCR) has been established jointly with the National University of Singapore. Field studies are now being carried out to determine if the proportion of infected mosquitoes in a locality would be a better indicator of an outbreak than the traditional Aedes HI.

As there are many Aedes habitats in open areas, there is a need to look into the possibility of establishing an index for Aedes breeding in open areas, which should be reliable and preferably be easy to determine. An outdoors index, together with the premises indices, would give a more complete picture of the population densities and distribution of both the Aedes vector species and help us to understand more of each of their roles in disease transmission.

Conclusion

There has been a resurgence in DF/DHF in the region in recent years, despite much efforts and resources pouring into dengue control programmes. More research to understand the Aedes mosquitoes and how they manage to overcome our efforts to stamp them out is urgently needed. There is also a need for a greater sharing and exchange of information and ideas amongst the countries.
affected by the disease. This could be done through information technologies (e.g. Internet, electronic mails) which have sped up communications by leaps and bounds. With such exchanges of information and expertise, we could learn from each other’s experience and expertise, with the hope that we will be able to control the disease more effectively in the future.

References


