

# Epidemiological News Bulletin



JANUARY - MARCH 2006 VOL. 32 NO. 1

A PUBLICATION OF THE MINISTRY OF HEALTH, SINGAPORE

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**Suggested citation:  
Ministry of Health, Singapore.  
[Article title]. Epidemiol News  
Bull [Year]; [Vol]:[inclusive page  
numbers]**

MOH Weekly Infectious Diseases Bulletin  
[http://www.moh.gov.sg/corp/publications/  
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## Surveillance and control of dengue vectors in Singapore

The National Environment Agency (NEA)'s five key strategies in dengue control are active surveillance; control; public education and community involvement; enforcement; and research and development.

### Active surveillance

NEA has about 500 officers who conduct active surveillance in areas prone to dengue and/or high density of *Aedes* mosquitoes (e.g. construction sites, schools, compounds of landed properties). On the average, some 70,000 residential premises and 3000 non-residential premises (construction sites, schools, etc.) are inspected every month. All open public areas are also checked.

From Dec 2005, NEA had enhanced its mosquito surveillance and control system further. This system was implemented in all the 84 constituencies throughout the island. For a period of four months, NEA conducted an audit survey cum attack against the mosquito population in each of the individual constituency.

### Audit survey and attack phase

In the first two months, as a priority, NEA targeted areas where there may be more potential breeding habitats; e.g. construction sites, workers quarters, vacant/unkept premises; and crowded areas such as markets, places of worship and bus terminals. In the third and fourth months, NEA continued to check homes, especially 1-2 room flats that were being rented out, industrial premises and other areas.

During this time, pest control operators engaged by NEA supplemented efforts with checks of ground areas in housing estates. These

ISSN 0218-0103

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areas included pump rooms, chamber valves, risers, gully traps, perimeter drains and rooftops of public housing apartments. The effort served to audit the work of Town Councils (TC) and their pest control programme.

## Maintenance phase

Following the “attack phase”, NEA is now in the maintenance phase where all premises, including low risk areas, will be checked within a three to sixth month cycle with intermittent attack when certain thresholds on the number of breeding sites have been breached. For example, 100% of vacant premises, shop houses, places of worship, bus interchanges, MRT (subway train) stations, factories and commercial buildings will be checked within a three-month cycle. As for construction sites, these will be checked within a one-month cycle.

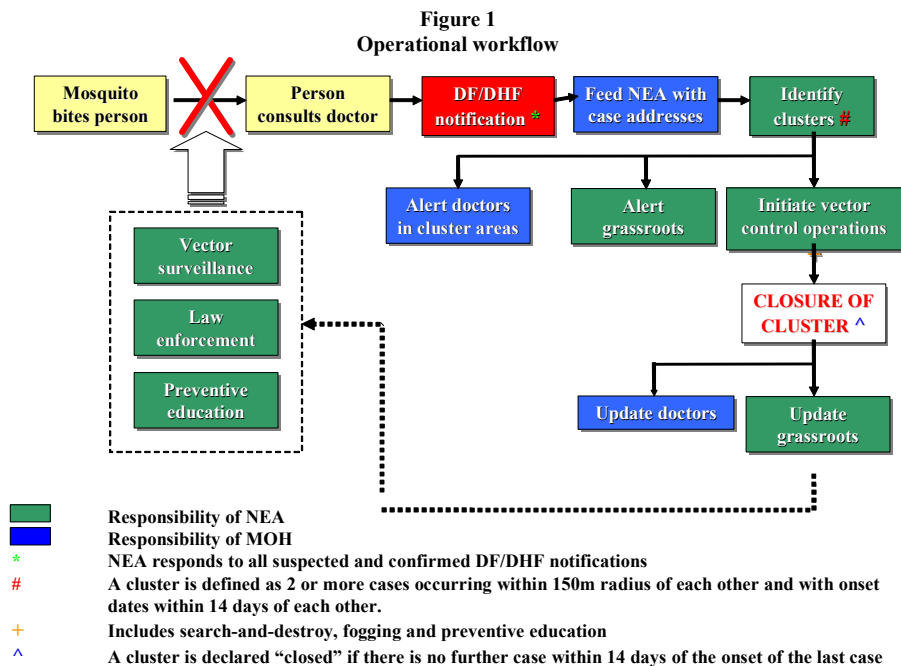
## Intelligence & analysis

Surveillance operations are coordinated through the situation room located at NEA HQ. Since 2003, a geographical information system (GIS) is employed

in the situation room to monitor and analyse the distribution of *Aedes* mosquitoes and dengue cases. The GIS integrates information on the location of *Aedes* breeding sites, ovitraps (which allow mosquito to lay eggs & trap the larvae), dengue cases, dengue serotypes, mosquito complaints, weather data (rain-fall, ambient temperature and relative humidity) with map layers of roads, buildings, schools, construction sites, electoral divisions and vacant premises. Epidemiological and vectorial trends can then be generated. The information allows the management to deploy manpower in accordance with the operational needs. The current operational workflow for dengue, from the time a dengue case notification is received from the Ministry of Health (MOH)(case management) to the subsequent follow-up activities by NEA (mosquito surveillance & control) is summarized in *Fig 1*.

## Control

When dengue cases are reported in an area, the NEA will quickly carry out search and destroy opera-



tions at the affected locality and the immediate neighbourhood. When a dengue cluster (i.e. 2 or more dengue fever cases within 150 metres and within 14 days) is reported, NEA will send in an outbreak control team to thoroughly comb the area and carry out checks and vector control operations until the cluster is closed. Fogging will also be carried out if there is a high mosquito population or when there are many dengue cases reported in a localized area. The intent is to break the disease transmission by preventing more mosquito breeding through removal of all breeding sources as well as killing the adult mosquitoes which could be carrying the dengue virus. NEA will also alert the residents and rope in the grassroots organisations to help in an immediate outreach programme to get the residents in the affected area to remove the breeding habitats in their homes. The standard operating procedures (SOP) for responding to a dengue cluster and sporadic cases are shown in *Tables 1* and *2*.

### **Dedicated mosquito control programme**

Breeding in common public areas under TC have risen recently, constituting about 28% of the total breeding found. To reduce the number of breeding found in TC-maintained areas, NEA has provided financial assistance to help TCs introduce dedicated programmes for more effective mosquito control. NEA is funding 100% for the first 3 months and 50% for the subsequent 3 months for TC's contract with pest control operators. To date, 15 out of 16 TCs have implemented the programme. NEA has also trained 168 officers in 15 TCs to be the estate environmental officers in vector management so that they could supervise and audit the performance of the dedicated pest control operators engaged for mosquito control.

### **Public education and community involvement**

NEA carries out public education on dengue through posters at bus shelters and MRT stations, panels in MRT and LRT trains, advertisements in newspapers, and dengue messaging on radio (*Fig 2*).

NEA launched the 'Mozzie Attack' programme in Apr 2004, with the aim to encourage residents to get rid of stagnant water that can potentially breed mosquitoes in their homes. Since Jun 2005, the programme has successfully rolled out to all 84 constituencies in Singapore to get residents into the act of removing potential breeding habitats.

NEA also keeps the grassroots and other agencies updated regularly through the following channels:

- updates in the monthly Citizen Consultative Committees (CCCs) meetings;
- monthly reports on mosquito breeding and dengue situation to all TCs; and
- fortnightly reports on mosquito breeding and dengue situation to schools.

For private and public organisations such as schools and construction sites, NEA works with them to put in place dengue control programmes; eg, the environmental control officers (ECOs) programme for construction sites.

NEA also puts up public communication efforts through various mass media such as radio live reads and posters at bus shelters.



**Table 1. Standard operating procedure (SOP) for responding to a dengue cluster****1 Definition of cluster**

- 1.1 A dengue cluster is defined as an area that comprises:
- any two confirmed dengue cases occurring not more than 150m from each other; and
  - the onset dates of the two confirmed dengue cases are within 14 days from each other.
- 1.2 In a cluster of 2 cases, the introduction of a third confirmed case becomes part of the cluster if it is not more than 150m from either one of the two confirmed cases **and** within 14 days of either one of the onset dates of the two confirmed cases.

**2 Definition of state of alert**

- 2.1 For the purpose of operation, the following state of alert (SOA) are used:

State of Alert	Definition
WHITE	A cluster of 2 dengue cases to not more than 10 cases.
YELLOW	A cluster of 11 dengue cases to not more than 20 cases.
ORANGE	A cluster of 21 dengue cases to not more than 30 cases.
RED 1	A cluster of 31 dengue cases to not more than 40 cases.
RED 2	A cluster of 41 dengue cases or more.

**3 Closure of cluster**

- 3.1 If no new confirmed dengue case is declared within 14 days from the last onset date, the cluster is closed and kept under surveillance. Skeleton staff will be left behind to monitor situation.
- 3.2 If no new case is declared within 21 days from last onset date, the cluster is removed from the weekly dengue situation report list.

**4 Review of dengue operations**

- 4.1 In SOA “WHITE”, each time the last onset date changes, the Senior Manager, Sanitation & Vector Control (SM, SVC) will review the operations with the officer-in-charge of the cluster.
- 4.2 In SOA “YELLOW”, each time the last onset date changes, Head/General Managers (Regional Offices, RO) will review the operations with SM(SVC).
- 4.3 In SOA “ORANGE” and above, each time the last onset date changes, Head (Operations) will review the operations with the RO.

**5 SOP for dengue cluster control**

- 5.1 The principal strategies for the control of outbreaks involve:
- eliminating the vector-breeding sources (larval control); and
  - eliminating the mosquito vectors (adult control).
- 5.2 The SOP for responding to sporadic cases and to each SOA is described in Table 2.

**6 Service of dengue alert letter**

- 6.1 The purpose of the dengue alert letter is to inform residents in dengue cluster area of the presence of dengue in their locality and to solicit their help in taking measures to curb the spread of the disease. The guidelines for serving the dengue alert letter are as follows:
- Dengue Alert Letters are to be served to residents whenever there is a cluster of 2 or more dengue cases in the immediate neighbourhood
  - Dengue Alert letters should be served to residents as soon as the cluster/outbreak is confirmed.



Table 2 SOP for responding to sporadic dengue cases and clusters

SOA	Staff to be deployed	Source reduction	ULV/Outdoor fogging	3P activities
1 case	1 team (2 officers)	<p><b>If case address is a HDB flat (public housing),</b></p> <ul style="list-style-type: none"> <li>Carry out source reduction at case address and 3 floors above and below.</li> </ul> <p><b>If case address is a landed property,</b></p> <ul style="list-style-type: none"> <li>Carry out source reduction at case address and houses within 50m radius</li> <li>All search-and-destroy operations should be completed within 2 days.</li> </ul>	<ul style="list-style-type: none"> <li>Carry out ultra-low volume fogging (ULV) at case address and other houses found breeding mosquitoes.</li> <li>Carry out ULV at case address and neighbouring houses found breeding mosquito</li> <li>Carry out outdoor fogging when ground breeding is detected.</li> </ul>	<ul style="list-style-type: none"> <li>Distribute dengue prevention pamphlets to residents.</li> </ul>
WHITE (2 cases)	1 team (2 officers)	<p><b>If case address is a HDB flat,</b></p> <ul style="list-style-type: none"> <li>Carry out source reduction at case address and 3 floors above and below.</li> </ul> <p><b>If case address is a landed property,</b></p> <ul style="list-style-type: none"> <li>Carry out source reduction at case address and houses within 50m radius</li> <li>All search-and-destroy operation should be completed within 2 days.</li> <li>Distribute sachets of sand granular insecticide.</li> </ul>	<ul style="list-style-type: none"> <li>Carry out ULV at case address and other houses found breeding mosquitoes.</li> <li>Carry out ULV at case address and neighbouring houses found breeding mosquito.</li> <li>Carry out outdoor fogging when ground breeding is detected.</li> </ul>	<ul style="list-style-type: none"> <li>Inform Member of Parliament /CCC and grassroots Chairman</li> <li>Advise MOH to inform doctors in cluster area</li> <li>Put up dengue alert poster/banner at block (if case address is a HDB flat) and railing or lamp post in private housing estate (if case address is a landed property).</li> <li>Engage help of grassroots to organize talk to residents on first Sunday</li> <li>Distribute dengue prevention pamphlets and dengue alert letters to residents with the help of grassroots members</li> <li>Serve letters to contacts for night/weekend inspection.</li> </ul>
WHITE (3 – 10 cases)	2 team (2 officers) + 1 pest control officer (PCO) team (5 workers)	<p><b>If case address is a HDB flat,</b></p> <ul style="list-style-type: none"> <li>Carry out source reduction at entire block where case address is reported.</li> <li>Deploy ovitraps (at least 2 per floor at common corridors).</li> </ul> <p><b>If case address is a landed property,</b></p> <ul style="list-style-type: none"> <li>Carry out source reduction at case address and houses within 50m radius</li> <li>All search-and-destroy operation should be completed within 2 days.</li> <li>Distribute sachets of sand granular insecticide.</li> <li>Deploy ovitraps at compound of house where breeding is detected.</li> </ul>	<ul style="list-style-type: none"> <li>Carry out ULV at case address and other houses found breeding mosquitoes.</li> <li>Carry out outdoor fogging when ground breeding is detected.</li> <li>Carry out ULV at case address and neighbouring houses found breeding mosquito</li> <li>Carry out outdoor fogging when ground breeding is detected.</li> </ul>	<ul style="list-style-type: none"> <li>Inform Member of Parliament /CCC and grassroots Chairman</li> <li>Advise MOH to inform doctors in cluster area</li> <li>Put up dengue alert poster/banner at block (if case address is a HDB flat) and railing or lamp post in private housing estate (if case address is a landed property).</li> <li>Engage help of grassroots to organize talk to residents on first Sunday</li> <li>Distribute dengue prevention pamphlets and dengue alert letters to residents with the help of grassroots members</li> <li>Serve letters to contacts for night/weekend inspection.</li> </ul>



SOA	Staff to be deployed	Source reduction	ULV/Outdoor Fogging	3P activities
<b>YELLOW</b> (11 – 20 cases)	Reinforce with 1 disease control (DC) team (specialize in mosquito surveillance & control)  OR 1 PCO team (5 workers)	<ul style="list-style-type: none"> <li>Extend source reduction to 100m around case address</li> <li>DC team to re-visit and check premises to make sure no lapses</li> <li>Continue to check inaccessible premises</li> <li>Operation should be completed within 4 to 5 days</li> </ul>	<ul style="list-style-type: none"> <li>Once a week fogging within 100m of case address.</li> </ul>	<ul style="list-style-type: none"> <li>Update Member of Parliament and grassroots Chairman.</li> <li>Work with grassroots to set up roving dengue prevention exhibition in the estates.</li> <li>Locate occupiers of inaccessible premises by working through the grassroots.</li> </ul>
<b>ORANGE</b> (21 – 30 cases)	Reinforce with another DC team	<ul style="list-style-type: none"> <li>Re-visit premises and intensify source reduction</li> <li>Operation shall be completed within 4 to 5 days</li> </ul>	<ul style="list-style-type: none"> <li>Increase to twice weekly fogging within 100m of case address.</li> </ul>	<ul style="list-style-type: none"> <li>Update Member of Parliament and grassroots Chairman.</li> <li>Continue to work with grassroots to educate residents through roving dengue exhibition and locate occupiers of inaccessible premises by working through the grassroots.</li> </ul>
<b>RED 1</b> (31 – 40 cases)	Reinforce with another team of 3-4 officers from RO	<ul style="list-style-type: none"> <li>Re-comb the entire cluster area</li> <li>Re-visit all problematic premises (with high breeding)</li> <li>Continue to check inaccessible premises</li> <li>Operation shall be completed within 4 to 5 days.</li> </ul>	<ul style="list-style-type: none"> <li>Continue with twice weekly fogging within 100m of case address.</li> </ul>	<ul style="list-style-type: none"> <li>Update Member of Parliament and grassroots Chairman.</li> <li>Continue to mobilize grassroots organisations and DPVG (if already formed) to help to reach out to residents.</li> <li>Update Minister</li> </ul>
<b>RED 2</b> (>41 cases)	Mobilise 1-2 teams of SVC officers from other ROs	<ul style="list-style-type: none"> <li>Continue to comb the entire cluster area and intensify operations</li> <li>Operation shall be completed within 4 to 5 days</li> </ul>	<ul style="list-style-type: none"> <li>Continue with twice weekly fogging within 100m of case address.</li> </ul>	<ul style="list-style-type: none"> <li>Update Member of Parliament and grassroots Chairman.</li> <li>Update Minister</li> </ul>



Figure 2  
Examples of dengue public education materials



Other outreach programmes that target on specific groups (e.g. residents in landed houses and elderly homes) included the dissemination of dengue educational kits to residents in landed property.

NEA has long realized that its efforts alone are insufficient to combat the threat of dengue fever, given that the *Aedes* mosquito, the carrier of the dengue virus, can lurk anywhere within our urban homes. As such, NEA has been actively engaging the members of the public as well as some other key strategic partners, in the common fight against the *Aedes* mosquito. Key achievements include the following:

#### *i) Dengue Prevention Volunteers (DPVG)*

Each group is led by a team leader. These enthusiastic volunteers have been out and about in their neighbourhoods to educate fellow residents in dengue prevention and to check their estates for potential

breeding sites. They have also organised more than 2700 dengue educational and prevention activities since 2003. Equipped with the relevant training and tool kits, these volunteers are crucial as they act as the ‘eyes, hands and legs’ of their estate in the fight against the *Aedes* mosquito.

#### *ii) Citizen Consultative Committee (CCCs)*

A Citizen Consultative Committee is constituted in each of the 84 electoral constituencies. Its function includes disseminating information to residents, receiving feedback on government policies and actions from residents, leading and coordinating projects and activities at constituency and national level. Updated monthly by NEA on the dengue situation in their estates, the CCCs have been actively engaging and encouraging their residents in removing potential mosquito breeding sites in their estates. Banners have also been put up to inform residents of the dengue





situation in their estates and to urge them to take proactive actions to deny the *Aedes* mosquito any further breeding grounds.

### iii) Community Development Councils (CDCs)

A Community Development Council is a committee that is appointed in each of the five districts in Singapore (each district comprising one or more electoral constituencies). Chaired by a mayor, it functions as a local administration of its district, initiating, planning and managing community programmes to promote community bonding and social cohesion. NEA has been working closely with the various grassroots organizations and CDCs on various new approaches in dealing with dengue. For some CDCs, even mayors have been stepping out personally to declare war against dengue. Some good examples include:

- The use of specially designed “dengue alert tags” by the South East CDC (Fig. 3). These tags are used by the grassroots leaders and volunteers to stick on to potential breeding sites that are found during their environmental patrol of the common areas. This is especially useful to reach out to residents who were not in at the time of environmental patrol. With these tags, it is hoped that

residents will be alerted to the potential breeding sites around their premises and take rectification remedies immediately.

- The use of the mosquito activity indicator (MAI) in the South East CDC. These ovitraps or MAIs as named by the mayor of SE District act as mini-monitoring stations. By monitoring the MAI on a weekly basis, NEA will be able to better ascertain the level of *Aedes* mosquito activity in the vicinity. The volunteers adopt the ovitraps, keep track of the MAIs and alert NEA if there is an increase in the number of larva collected.
- The launch of “My Environment Shines” campaign in the South West CDC in Apr 2005. The 3-year campaign involves the grassroots actively reaching out to residents in door-to-door visits to educate them in dengue prevention.

## Enforcement

The Control of Vectors and Pesticides Act is the main legislation dealing with propagation of conditions conducive for mosquito breeding. NEA typically enforces the law against recalcitrant persons who continually breed mosquitoes or do not remove potential mosquito breeding habitats in their premises despite having being told to do so.

**Figure 3**  
Sample of a dengue alert tag by South East CDC





Owners of residential premises found with mosquito breeding or potential breeding habitats are fined \$100 for the first offence and \$200 for repeat offences. For non-domestic premises (e.g. commercial buildings and temples) found with mosquito breeding or

potential breeding habitat, the owner of the premises will be fined \$200. The corresponding penalties for construction sites are heavier (\$1000 to \$5000 or Attend Court or Stop-Work Order), given the greater propensity for breeding to be found in these premises.

*(Reported by Tang C S, Pang F Y, Ng LC, Appoo SS, Environment Health Dept and Environmental Health Institute, National Environment Agency)*

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## Dengue surveillance in Singapore, 2005

A total of 14,209 laboratory confirmed cases of dengue fever (DF)/dengue haemorrhagic fever (DHF) (comprising 13,816 cases of DF and 393 cases of DHF) were reported in 2005, an increase of 50.2% from the 9,459 dengue cases reported in 2004. Of these, 14,046 were local residents, comprising 14 imported and 14,032 indigenous cases. The remaining 163 cases were foreigners not residing in Singapore and who reportedly acquired the infection overseas; majority of whom had come to Singapore for medical treatment. There were 25 reported dengue deaths, consisting of 23 indigenous cases, one imported case and one foreigner who sought medical treatment in Singapore (Preliminary figure from the Registry of Births and Deaths).

The incidence rate among indigenous cases was highest in the 15 – 24 year age group with a male to female ratio of 1.4:1 (*Table 3*). Among the three major ethnic groups, Chinese had the highest incidence rate, followed by Malays and Indians. Foreigners comprised 23.5% of the indigenous cases (*Table 4*).

Though concentrated in the central (29.1%) and south-eastern (21.1%) parts of Singapore, cases were reported from around the island [according to the boundary demarcated by the Community Development Council / National Environment Agency (NEA) Regional Office] (*Fig. 4*). About two-thirds of the cases occurred singly and sporadically. The number of clusters increased by more than two-fold compared to the previous year. Residents in Housing & Development Board (HDB) flats, compound houses and condominiums constituted 75.1%, 16.6% and 6.1% of the cases, respectively. However, the incidence rate of residents of compound houses (710.7 per 100,000) was over twice that of HDB residents (332.1 per 100,000).

The year began with a high incidence which had continued from the previous year, before a decline was observed in late February. It remained relatively low in March and April, before the number of cases began to increase again in May. This was followed by a sharp, unprecedented surge, showing a bimodal



**Table 3**  
**Age-gender distribution and age-specific incidence rates of indigenous<sup>#</sup> DF/DHF cases, 2005**

Age (yrs)	Male	Female	Total (%)	Incidence rate per 100,000 population*
0 – 4	101	83	184 (1.3)	88.4
5 – 14	941	808	1,749 (12.5)	329.8
15 – 24	1,834	1,244	3,078 (21.9)	469.6
25 – 34	2,030	1,223	3,253 (23.2)	369.9
35 – 44	1,690	1,072	2,762 (19.7)	353.2
45 – 54	818	769	1,587 (11.3)	256.5
55+	664	755	1,419 (10.1)	209.5
<b>Total</b>	<b>8,078</b>	<b>5,954</b>	<b>14,032 (100.0)</b>	<b>322.5</b>

<sup>#</sup>Cases acquired locally among Singaporeans, permanent and temporary residents.

\*Rates are based on 2005 estimated mid-year population.

(Source: Department of Statistics, Singapore)

**Table 4**  
**Ethnic-gender distribution and ethnic-specific incidence rates of indigenous<sup>#</sup> DF/DHF cases, 2005**

	Male	Female	Total (%)	Incidence rate per 100,000 population*
Singapore residents				
Chinese	4,560	3,907	8,467 (60.3)	315.4
Malay	777	665	1,442 (10.3)	297.6
Indian	306	213	519 (3.7)	167.8
Others	155	153	308 (2.2)	412.3
Foreigners	2,280	1,016	3,296 (23.5)	413.1
<b>Total</b>	<b>8,078</b>	<b>5,954</b>	<b>14,032 (100.0)</b>	<b>322.5</b>

<sup>#</sup>Cases acquired locally among Singaporeans, permanent and temporary residents.

\*Rates are based on 2005 estimated mid-year population.

(Source: Department of Statistics, Singapore)



activity. After the second peak in September, the incidence declined sharply and it continued to decrease for the rest of the year (*Fig. 5*).

### Laboratory surveillance

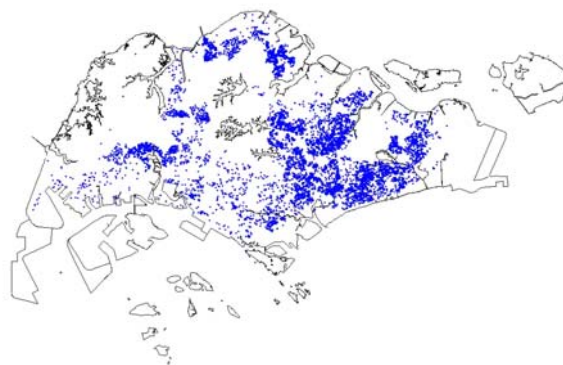
A total of 1,171 blood samples obtained from both inpatients and outpatients tested positive for dengue virus by polymerase chain reactions (PCR) at the Department of Pathology and Laboratory Medicine, Tan Tock Seng Hospital, National University Hospital Laboratory, the Department of Pathology, Singapore General Hospital, and Environmental Health Institute, NEA. All four dengue serotypes were detected, comprising DEN-1 (67.4%), DEN-2 (8.7%), DEN-3 (17.9%), DEN-4 (0.6%) and indeterminate (5.4%) (*Table 5*). DEN-1 continued to be the predominant circulating serotype in 2005, although an increase in DEN-3 was also observed (*Fig. 6*).

### Aedes surveillance

*Aedes* surveillance and source reduction are routinely carried out daily by NEA officers. The focus is primarily on areas that had historically high rates of dengue. In 2005, an average of 77,000 residential

premises and 4,000 non-residential premises were inspected every month. A geographical information system (GIS) was used for clustering and analysis of

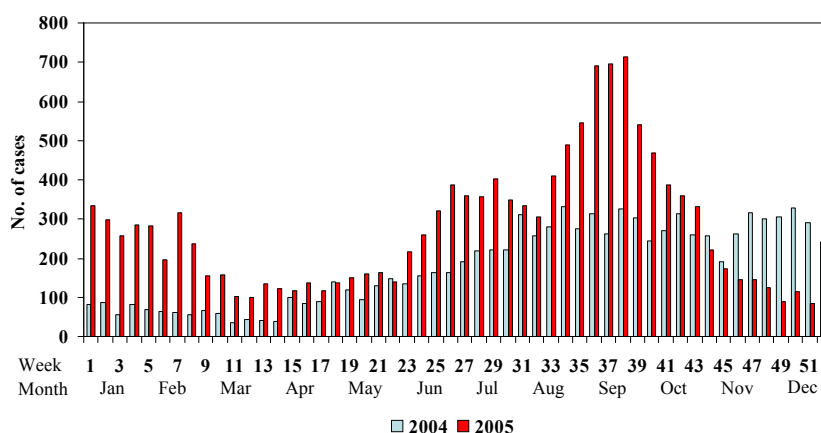
**Figure 4**  
Geographical distribution of dengue cases in Singapore, 2005



**Table 5**  
Surveillance of dengue serotypes in Singapore, 2005

Serotype	No.	%
DEN-1	789	67.4
DEN-2	102	8.7
DEN-3	210	17.9
DEN-4	7	0.6
Untyped	63	5.4
Total	1,171	100.0

**Figure 5**  
Weekly distribution of DF/DHF cases in Singapore, 2004 - 2005



mosquito breeding sites and dengue cases. In addition, 5,000 ovitraps were placed around Singapore for *Aedes* surveillance (Fig. 7). The distribution of dengue cases was more closely associated with *Aedes aegypti* than *Aedes albopictus* (Fig. 8).

The overall *Aedes* premises index was around 1.15%, with the highest percentage detected in compound houses (Fig. 9). The top five breeding habitats for *Ae. aegypti* were domestic containers (26%), ornamental containers (24%), discarded receptacles (7%), flower pot plates (4%), and roof gutters (3%) (Fig. 10). In the case of *Ae. albopictus*, the most common breeding habitats were discarded receptacles (21%), domestic containers (10%), ornamental containers (10%), gully traps (5%), and canvas/plastic sheets (5%) (Fig. 11).

## Outbreak control

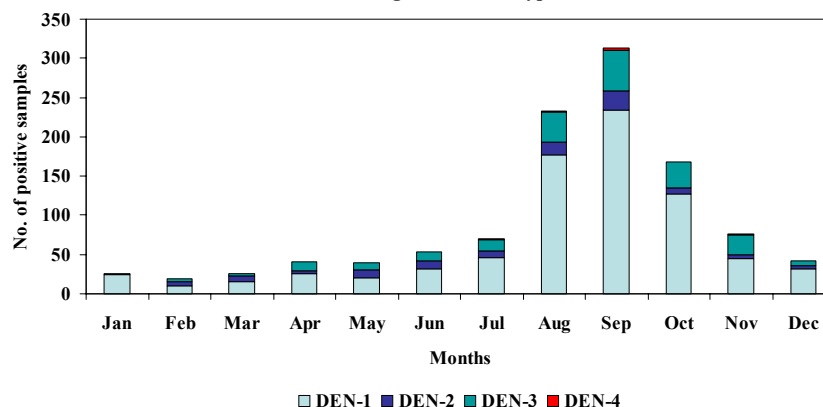
During the outbreak in 2005, NEA increased its manpower to more than 500 by recruiting more part-time helpers to assist in house-to-house checks and ground surveys. An intensive training course was given to these helpers to enable them identify common breeding habitats. With the increased manpower,

NEA stepped up surveillance and search & destroy efforts to reduce the *Aedes* mosquito population. In 2005, NEA inspected over 934,103 premises (an increase of 50% compared to 2004) and carried out more than 52,129 surveys on non-residential premises and public and private areas (an increase of 60 %).

In September, a ‘**carpet combing**’ exercise was initiated. In this exercise, NEA mobilised additional manpower with the help of government agencies, volunteers and town councils to thoroughly search and destroy mosquito breeding grounds in all residential housing estates. A total of 6 phases of carpet combing operations in all 84 constituencies and private estates were carried out.

Some 6000 volunteers were involved in the entire carpet combing exercise in 6 weekends. All 10,000 HDB blocks and its surroundings, as well as private estates were covered. Some 1,000 mosquito breeding habitats were found and destroyed, and another 8,400 potential breeding sites were removed. This had contributed to the reduction of the mosquito population which in turn led to a drop in dengue cases in the subsequent months.

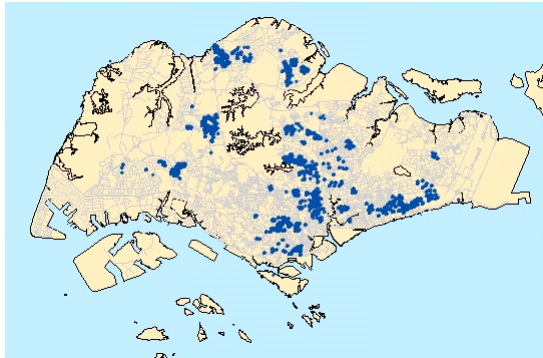
**Figure 6**  
Surveillance of dengue virus serotypes, 2005



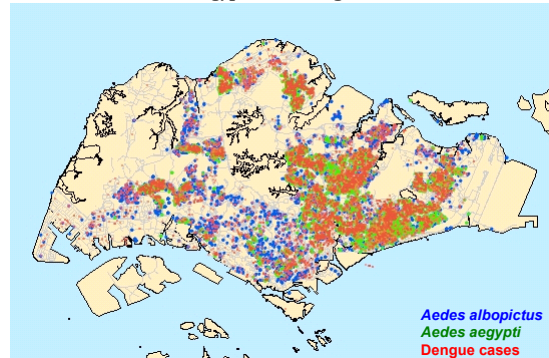
(Source: Department of Pathology, Singapore General Hospital, Environmental Health Institute, Department of Pathology and Laboratory Medicine, Tan Tock Seng Hospital, and National University Hospital Laboratory)



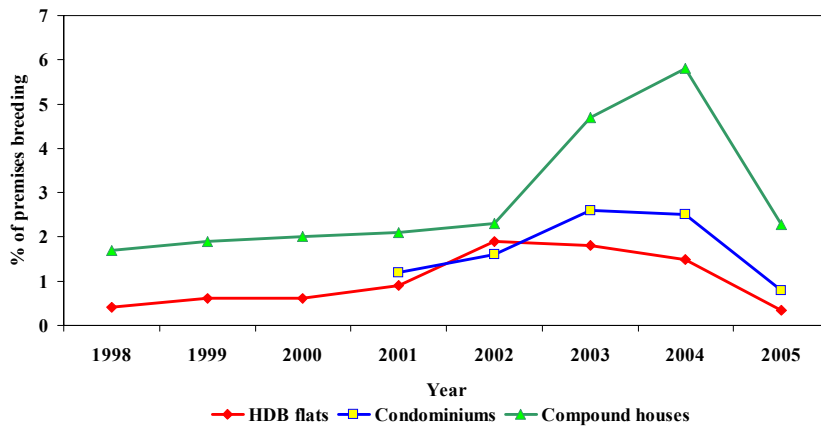
**Figure 7**  
Locations of 5,000 ovitraps used for *Aedes* surveillance



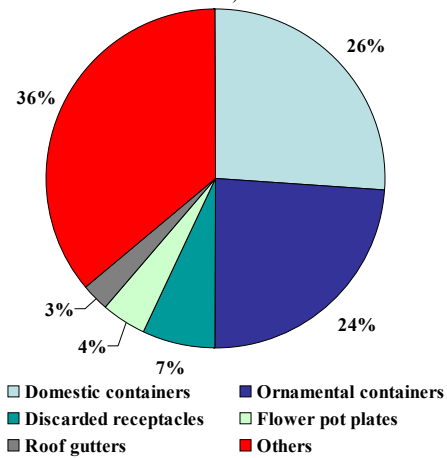
**Figure 8**  
Geographical distribution of *Ae. albopictus*, *Ae. aegypti* and dengue cases



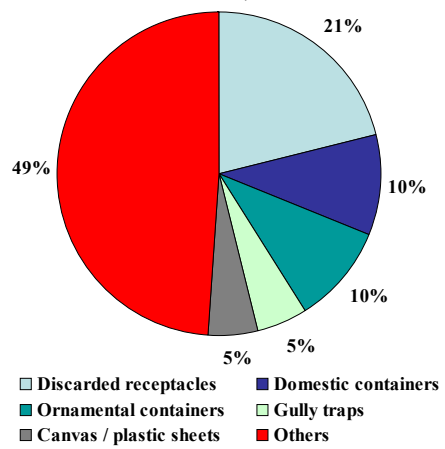
**Figure 9**  
Percentage of premises breeding *Aedes* mosquitoes 1998-2005



**Figure 10**  
Distribution of *Aedes aegypti* by top five breeding habitats, 2005



**Figure 11**  
Distribution of *Aedes albopictus* by top 5 breeding habitats, 2005



An **inter-agency dengue task force** was formed in Sept 2005 to enhance the communication and coordination on dengue control efforts among various government agencies and private organisations. Since then, the mosquito control regimes of the various government agencies and private organizations have been strengthened.

As a first step, the agencies and private organizations undertook a thorough sweep of all their infrastructures, properties and development sites under their charge. The mosquito control programmes and audit systems by each agency also underwent a review to ensure more source reduction efforts on the ground rather than just focusing on fogging.

Permanent solutions to eliminate potential sources of stagnant water like repairs to infrastructure, sealing up of cracks, backfilling of land and removal of roof-gutters were carried out.

Since its formation, the task force has helped to make communication and coordination on dengue con-

trol efforts among these agencies and private organizations more effective. NEA can now liaise directly with the person in charge and implement measures more swiftly, especially when there is a major dengue cluster.

The support from the community was equally important. Some 10,000 volunteers from the grassroots spent their weekends distributing the “10-minute Mozzie Wipe Out” pamphlet to some 880,000 homes to encourage residents to carry out a 10-minute mosquito prevention effort in their homes. Other stakeholders such as management of construction sites, factories, child-care centres, etc, were reminded to practise proper mosquito control measures. If 10-20% of these target groups were to take action to remove breeding or potential breeding habitats, it would have an impact on the mosquito population, thus, reducing dengue transmission.

Dengue hotlines were also set up by NEA and more than 16,000 calls on mosquito breeding and dengue fever were received. All calls were investigated within 24hrs and any breedings found were destroyed.

*[Reported by Kita Y, Communicable Diseases Surveillance Branch, Ministry of Health, and Tang CS, Environmental Health Department, National Environmental Agency]*

## Editorial comments

Dengue has reemerged in Singapore since the late 1980s with epidemic peaks occurring in 1992, 1998 and 2005. The incidence in 2005 was the highest ever recorded. Factors contributing to this resurgence include a combination of lowered herd immunity of the human population, virus transmission out-

side the home, an increase in the age of infection, and the adoption of a case-reactive approach to vector control. For prevention efforts to be sustainable in the long-term, vector control has to be based on carefully collected entomological and epidemiological data, while regional efforts in strengthening disease surveillance and control may be useful in reducing importation of dengue viruses<sup>1</sup>.

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## Epidemiology of *Campylobacter* enteritis in 2005

### Introduction

*Campylobacter* enteritis is an administratively notifiable disease in Singapore. The disease is characterised by diarrhoea, abdominal pain, malaise, fever, nausea and/or vomiting. The common causative agents are *Campylobacter jejuni* and *Campylobacter coli*, but the former accounted for all the notified cases of *Campylobacter* enteritis in Singapore. The incubation period ranges from two to five days. Infection can arise from the ingestion of partially cooked meat, contaminated food and water, or raw milk. It can also result from contact with infected pets or farm animals. This report describes the epidemiology of the locally acquired *Campylobacter* infections in 2005.

### Epidemiological findings

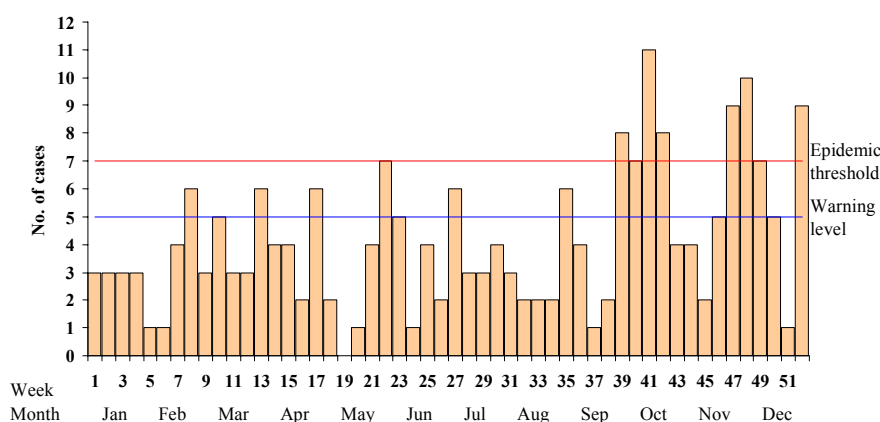
A total of 220 laboratory confirmed cases of locally acquired *Campylobacter* enteritis were reported (Fig 12). The mean number of cases per week based on their onset dates was 4.23 (range: 1-11).

From 25 Sep to 22 Oct (weeks 39-42), there was an increase in occurrence of *Campylobacter* enteritis cases, exceeding the epidemic threshold (mean + 2 SD) for four successive weeks. This was followed by another increase above epidemic level from 20 Nov – 10 Dec 05 (weeks 47-49).

The cases were aged from as young as 22 days to 93 years. Majority (82.3%) of the cases involved children aged 14 years and below, with approximately half of them (50.9%) aged 0-4 years (Table 6). More males were affected in comparison with females, with a male to female ratio of 1.72:1. The ethnic distribution of the cases did not mirror the Singapore population. More non-Chinese (Malays, Indians and other ethnic groups) were affected compared to the Chinese.

A comparison between the cases reported in weeks 39-52 (25 Sep – 31 Dec 05) and the other cases reported during the first 38 weeks of the year showed no significant differences in age and ethnicity. How-

Figure 12  
Weekly distribution of 220 reported cases of *Campylobacter* enteritis in Singapore, 2005



**Table 6**  
Demographic characteristics of *Campylobacter* enteritis cases reported in weeks 39-52 and weeks 1-38, 2005

	Cases (wks 39-52)	Cases (wks 1-38)	Total	p value
<b>All</b>	90 (40.9%)	130 (59.1%)	220 (100%)	
<b>Age group (years)</b>				
0 -4	48 (53.4%)	63(48.5%)	111(50.4%)	0.446
5 – 14	30 (33.4%)	39(30.0%)	69 (31.3%)	
15 -24	1 (1.1%)	2(1.5%)	3(1.4%)	
25 – 34	3 (3.3%)	2(1.5%)	5(2.3%)	
35 – 44	3 (3.3%)	4(3.1%)	7(3.2%)	
45 – 54	1 (1.1%)	4(3.1%)	5(2.3%)	
55 and above	4 (4.4%)	16(12.3%)	20(9.1%)	
<b>Gender</b>				
Male	64 (71.1%)	75(57.7%)	139(63.2%)	0.042
Female	26 (28.9%)	55(42.3%)	81(36.8%)	
<b>Ethnic group</b>				
Chinese	60 (66.7%)	89(68.5%)	149(67.7%)	0.830
Malay	13 (14.4%)	21(16.1%)	34(15.5%)	
Indian	11 (12.2%)	11(8.5%)	22(10.0%)	
Others	6 (6.7%)	9(6.9%)	15(6.8%)	

ever, more males were affected during this period as compared to the rest of the year.

The main clinical symptoms of the cases included diarrhoea, fever, abdominal pain and vomiting (Table 7). A large proportion of the cases (82.3%) had to be hospitalised for further treatment while the rest were given outpatient treatment.

Routine epidemiological investigations into *Campylobacter* enteritis cases include identifying the food items consumed by the cases five days prior to the onset of symptoms. Based on the food history of 120 reported cases, the five most common food items consumed were chicken, infant milk, fish, egg and pork. Consumption of eggs was significantly associated with the higher disease incidence in weeks 39-52 as compared to the rest of the year (Table 8).

**Table 7**  
Clinical symptoms of 220 cases of *Campylobacter* enteritis in Singapore, 2005

Symptom	No. of cases	%
Diarrhoea (watery)	198	90.0
Fever	167	75.9
Abdominal pain	114	51.8
Vomiting	79	35.9
Diarrhoea (bloody)	22	10.0
Loss of appetite	14	6.4
Nausea	14	6.4
Cough	11	5.0
Chills and rigors	10	4.5
General weakness/ malaise	9	4.1
Coryzal symptoms	6	2.7
Headache	4	1.8
Constipation	2	0.9
Giddiness	2	0.9
Others	7	3.2



Table 8

Comparison on frequency of food items consumed by *Campylobacter* enteritis cases, weeks 39-52 and weeks 1-38, 2005

Food item consumed within 5 days prior to onset	Cases (wks 39-52)			Cases (wks 1-38)			p value	Odds ratio	95% confidence interval
	Ate	Did not eat	% ate	Ate	Did not eat	% ate			
Chicken	30	29	50.8	26	35	42.6	0.367	-	-
Infant milk	26	33	44.1	23	38	37.7	0.478	-	-
Fish	19	40	32.2	20	41	32.8	0.946	-	-
Egg	19	40	32.2	8	53	13.1	0.012	3.147	1.251-7.916
Pork	11	48	18.6	12	49	19.7	0.886	-	-

## Comments

Despite the excess occurrence of cases in the last three months of the year, no epidemiological linkages could be found among the cases in terms of place of residence, educational institution or workplace. The cases also did not have any prior contact with any known cases of *Campylobacter* enteritis.

The male gender, which is a known risk factor in *Campylobacter* infection<sup>1</sup>, was typically more affected by the disease. The age distribution of the cases which tend to affect children under the age of 5 years, is similar to that reported in the industrialised countries<sup>2</sup>. A comparison with the *Campylobacter* enteritis cases reported in Singapore between 1994 and 1998<sup>3</sup> showed consistency in the gender and age predisposition to infection. However, while the proportion of cases aged 0-4 years in 2005 remained consistent with those in 1994-1998, there was a greater proportion of cases belonging to the 5-14 age group in 2005 (31.3%) as compared to the cases in 1994-

1998 (9.8%). Diarrhoea, fever, abdominal pain and vomiting were also reported to be among the main clinical features presented by the cases while chicken, infant milk, egg and pork remained as the food items most commonly consumed by the cases.

The consumption of eggs was found to be significantly associated with increased disease incidence observed from Sep-Dec 2005. However, a review of the published literature did not show any relationship between egg consumption and *Campylobacter* enteritis incidence. Studies have shown that the organism would not penetrate into the contents of the egg even though it could be occasionally isolated from the inner shell and membranes of refrigerated eggs<sup>4</sup>. A longer period of cooking is required for poultry and meat which provides greater opportunities for the pathogen to be destroyed in contrast to eggs which can be served partially cooked (soft boiled or scrambled) or raw. As the pathogen has a very small infective dose (fewer than 500 organisms)<sup>5</sup>, the organisms need not multiply to large numbers to cause infection.

(Reported by Nur Rasidah, Wong C, Low C, Lim S, Ooi PL, Disease Control Branch, Ministry of Health)



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## Risk of *Legionella* contamination in household water heating tanks

### Introduction

The *Legionellaceae* family consists of 48 species comprising 70 distinct serogroups. While the differentiation of species is derived using genetic homology, serogroups are identified based on antigenic properties. This genus of bacteria, in particular *Legionella pneumophila*, is well established as pathogens found in man-made water systems such as cooling towers. This bacterium is known to cause legionellosis, a disease which can manifest in two forms, namely; Pontiac fever which exhibits flu-like symptoms and legionnaires' disease which is a form of atypical pneumonia. Within the *Legionella pneumophila* species, 15 serogroups have been identified, with serogroup 1 accounting for majority of all reported legionellosis<sup>1</sup>.

Legionellosis is a problem worldwide. A recent outbreak in south eastern Norway in June 2005 affected 52 people, of whom 10 died<sup>2</sup>. Singapore sees sporadic cases<sup>3</sup> with the incidence rate of reported legionellosis shown in *Fig 13*.

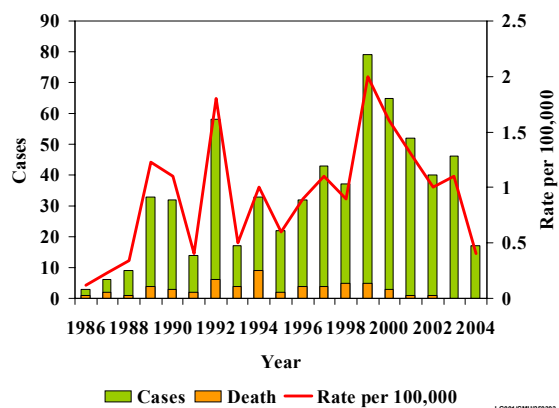
Despite epidemiological investigations of reported legionellosis cases, the source of infection is

usually not identified. Therefore, more environmental surveillance is necessary to strengthen the link between the disease and environmental source.

National surveys done in Singapore between 1988 and 2001 had identified potable water systems such as mist fans and showerheads, which have the potential to harbour *Legionella pneumophila*<sup>4</sup>. More surveys are being planned to identify other systems with similar potential.

Upon receiving a public feedback from a home on suspected poor indoor air quality (IAQ), an in-

**Figure 13**  
Reported incidence of legionellosis in Singapore, 1986-2004



investigation was conducted. Swabs were also obtained from the air handling unit (AHU) and air-conditioning duct and a water sample collected from the cooling tower for testing of *Legionella*.

It was also revealed during the investigation that there were two hot water systems with storage tanks that provided heated water to two separate locations. These systems were found to heat up very slowly, and usually did not heat up beyond temperatures about 50°C. Investigation on the possibility of *Legionella* contamination was thus initiated.

### Investigation methodology

A walk-through inspection, in conjunction with interviews with the affected individuals, was done, and water samples were collected from the water tanks for *Legionella* testing.

Water samples from the cold tanks were collected by first turning the shower tap on to release cold water. The cold water was left running for one minute before it was collected in the water container. The procedure for collection of water samples from the hot water tank was identical to that of the cold-water tank sampling; ie, by turning the shower tap to release hot water.

**Table 1**

***Legionella* testing on air supply and conditioning system**

Sample	<i>Legionella</i> count (CFU/swab or ml of water)	Type of sample
Sample 1 (AHU)	Not detected	Swab
Sample 2 (AHU)	Not detected	Swab
Sample 3 (Air con duct)	Not detected	Swab
Sample 4 (Cooling tower)	Not detected	Water

*Legionella* detection of water samples was performed in an approved laboratory, where 10 assays were conducted on the samples.

### Results

The IAQ survey showed that all the parameters tested were within the limits of local guidelines<sup>5</sup> *Legionella* test results revealed that the bacterium was not detected in the air supply and conditioning system (Table 1), but was detected in rather high level in the hot water system serving bathroom 1 and kitchen (Table 2). The results correlate with the feedback that the water heaters were malfunctioned.

### Comments

This investigation had surfaced a risk that may potentially affect Singaporean households, which have hot water systems with storage tanks. Subsequent to this investigation, five households with similar hot water systems were studied. The follow-up study revealed that 2 out of 5 hot water systems were contaminated with *Legionella*. Current investigation is ongoing to pin point the source of contamination. Possible sources include malfunctioned water heater tanks, water pipes, or water holding tank that serves a building.

**Table 2**

***Legionella* counts of water samples collected from the hot and cold-water tanks**

Sample	<i>Legionella</i> count (CFU/ml)	
	Hot water tank	Cold water tank
Sample 5 (Bathroom 1 shower)	32	Not detected
Sample 6 (Bathroom 2 shower)	Not detected	Not detected
Sample 7 (Kitchen tap)	29	4



In Singapore, water heater tanks are installed mostly to provide warm water for showers, and many households are not aware of the need to ensure proper heating of the water in the water heater tank. Some may limit the heating period to save energy and cost, thus resulting in insufficient heating of the water. Many apartments are also furnished with water heater tanks to supply hot water to the kitchen. However, the water from the tap in tropical Singapore climate is usually deemed warm enough for washings in the

kitchen. Therefore, many residents may not regularly turn on the heating system in the kitchen. We need to be vigilant in the maintenance of potable hot water systems such as the hot water system with storage tanks. Hot water storage system should be heated up to more than 60°C in order to minimize the risk of *Legionella* growth. Education of the public, based on the results from scientific surveys is imperative in minimizing risks of *Legionella* infection from such systems.

(Reported by Kek R, Yap J, Goh V and Ng LC, Environmental Health Institute, National Environment Agency)

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