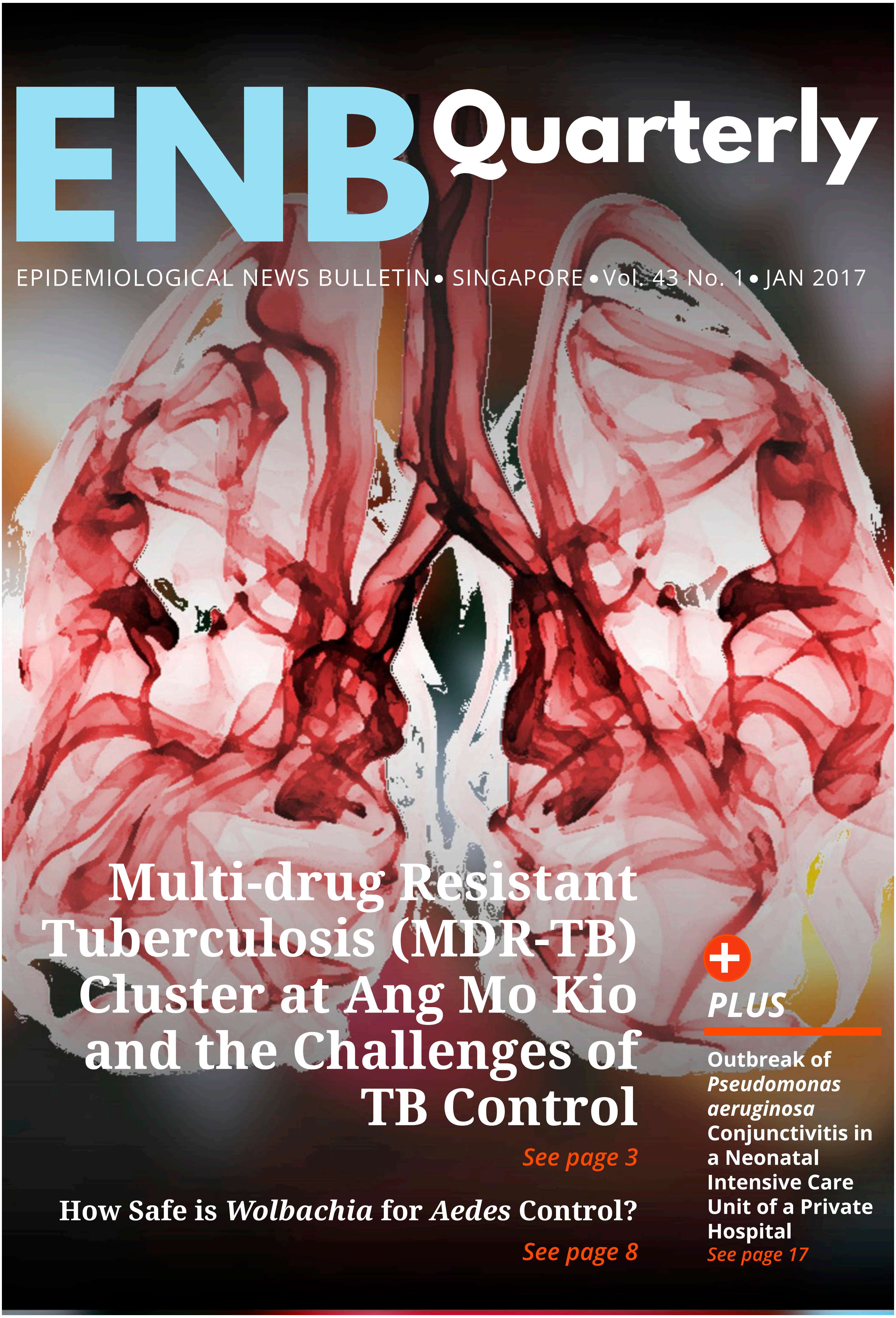

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Editor's note

Last October, we hosted the 20th BIMST Public Health Conference, incorporating our 3rd One Health Symposium in Singapore. This was a milestone event marking our close ties with the public health counterparts in neighbouring countries. In this issue of ENB Quarterly, we take stock of our regional collaboration in public health and report on some of the progress that we have made together in advancing cross-border matters of mutual importance.

TB in the community continues to be a public health concern. Our lead article puts the focus on an unusual geospatial cluster of multi-drug resistant TB at the mature housing estate of Ang Mo Kio. Besides describing the investigative findings, the authors have shared on the operational considerations of the TB screening exercise and on the challenges of TB control in a globally-linked city state.

When we think of dengue, mosquito control would come to mind. The use of *Wolbachia* to suppress *Aedes aegypti* populations is one of a new generation of vector control tools that could hold promise in combating dengue. The National Environment Agency has provided us with its risk assessment for the release of male *Wolbachia*-carrying mosquitoes in Singapore, addressing the potential consequences to ourselves and the environment.

We also have an article describing an interesting outbreak of *Pseudomonas aeruginosa* conjunctivitis among neonates in a private hospital. This scientific contribution highlights the importance of infection control measures involving a comprehensive multi-pronged approach with strong collaboration between the hospital management team and the public health authority.

Happy New Year to all our readers!

Steven

LEAD ARTICLE

Multi-drug Resistant Tuberculosis (MDR-TB) Cluster at Ang Mo Kio and the Challenges of TB Control

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INTRODUCTION

Tuberculosis (TB) is a major cause of morbidity and mortality in many countries. It continues to be a global public health problem even though highly efficacious treatment has been available since the 1940s.[1] In Singapore, the establishment of the National TB Control Programme in the late 1950s contributed to a marked decrease in the incidence rates of TB. The incidence rates decreased even further with the launch of the Singapore Tuberculosis Elimination Programme (STEP) in 1997.[2] Since 2002, incidence rates have been ranging between 35.0 to 42.0 per 100,000 population for both Singapore residents (i.e. citizens and permanent residents) and the total population (Singapore residents and long-staying foreigners) (Figure 1). This has led to Singapore having the second lowest incidence of TB in Asia, after Japan. The proportion of TB cases in Singapore with multidrug resistant TB (MDR-TB) has been less than 1% from 2013.[2]

Similar to other countries, the TB incidence rate among Singapore residents had been constantly higher in males and increased with age.[2] The higher rates of TB in those aged 65 years and above could be attributed to a "cohort effect" (i.e. there is a higher proportion of LTBI in this age group as they were born during the period of high TB incidence rates). Furthermore, the same group are also more likely to have reactivation of primary TB infection due to age-associated chronic diseases and weakened immune status.[3]

While the TB situation in Singapore has been relatively stable over the past 10 years, there have been a spate of incidents involving TB cases reported in 2016. Of those incidents, the MDR-TB cluster in Ang Mo Kio was the most significant outbreak due to its atypical nature. The cluster is described in details below.

METHODS

Epidemiology

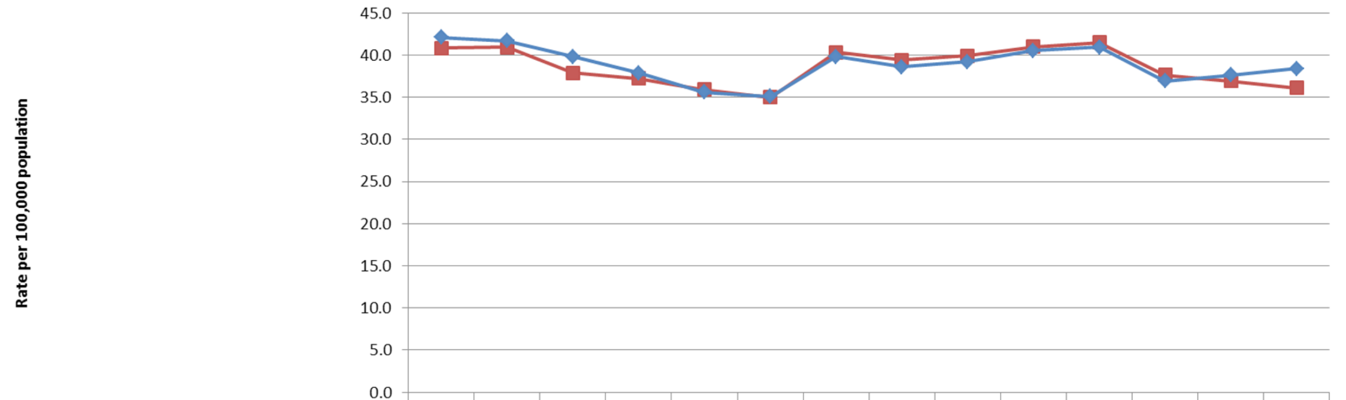
Contact screening was conducted for close contacts of laboratory confirmed TB cases (e.g. household members, close workplace colleagues, those with common social activity with close contact), which was aligned with established local contact investigation protocols and international practices. The TB Control Unit (TBCU) and Ministry of Helath (MOH) carried out further investigations to ascertain the possibility of epidemiological links among the cases.

Precautionary screening exercise

This cluster was unusual as it did not seem to fit the typical pattern of TB spread which is through close and prolonged exposure.[5,6] MOH proactively screened residents within the block and their close contacts as a precautionary measure to detect any previously undiagnosed TB cases. The identification of active TB cases would enable them to be treated immediately to reduce infectiousness, while latent TB cases could be monitored over time for early detection of active TB.

The precautionary screening measure consisted of an onsite screening at the void deck of the affected block from 16 to 19 June 2016, screening in the SATA CommHealth clinics across Singapore, General Practitioners (GP) clinics near the block and Ang Mo Kio Polyclinic, and door-to-door screening for those who missed the onsite screening.

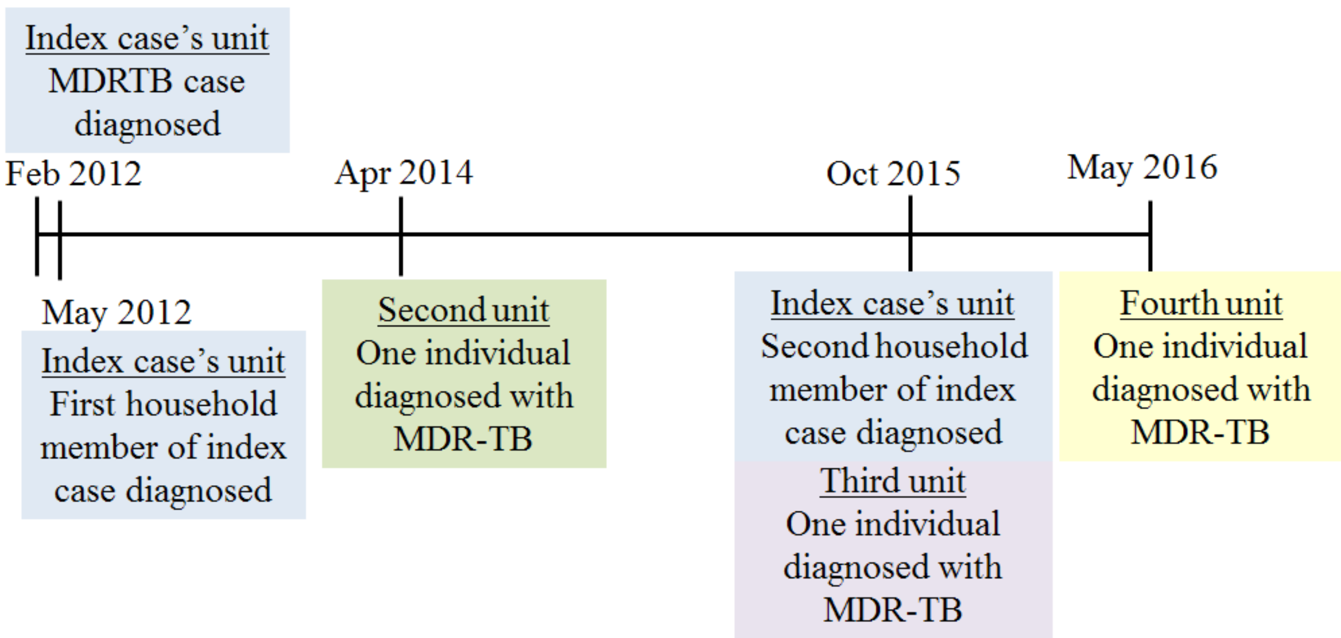
Figure 1. TB incidence rate among Singapore residents and long-staying foreigners, 2002-2015



	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Singapore residents and long staying foreigners	40.8	40.9	37.9	37.2	35.9	35.0	40.3	39.4	39.9	41.0	41.5	37.6	36.9	36.1
Singapore residents	42.1	41.7	39.8	37.9	35.6	35.1	39.8	38.6	39.2	40.5	40.9	36.9	37.6	38.4

Year of notification

Figure 2. Cluster of MDR-TB cases at Block 203 Ang Mo Kio Avenue 3



As the infectious period for persons with TB likely began three months before their onset of symptoms[7], the start of infectious period for this cluster based on the index case's onset of coughing was estimated to be July 2011. The complimentary screening was hence extended to all former and current residents who had lived in that block from July 2011 onwards.

Public communications

During the course of the investigation and screening exercise, it was observed that public fear and stigma of TB was still fairly common. This could hamper prevention and control efforts as persons with active TB might not see the importance of contact screening and/or be reluctant to divulge their close contacts for fear of being identified and stigmatised. Additionally, many people in Singapore also had the perception that TB is a disease found only in Singapore during yesteryear or in less developed countries. Public awareness and education on TB could hence be improved.

In anticipation of the residents' concerns and to better allay their anxiety, MOH worked closely with the grassroots advisor and leaders during our engagement and screening exercises. This aided MOH's interactions with the residents to reinforce public education messages and increase screening uptake. MOH also actively engaged the media to provide information and timely updates to the public. This incident underlines the importance of community mobilisation in the prevention and control of a disease.

RESULTS

The cluster involved six male and female residents of Block 203 Ang Mo Kio Avenue 3 who were between 20 and 70 years old. Three of the cases were household contacts while the remaining three cases were from different units in the block (Figure 2). The index case was first diagnosed in February 2012 and was part of the cluster traced to three internet cafes at Parklane Shopping Mall in 2013.[4] Two of his household members were subsequently diagnosed with active MDR-TB in May 2012 and October 2015 respectively. The remaining three cases living in different units within the same block were later diagnosed with MDR-TB between April 2014 and May 2016. The similarities in the cases' addresses were noticed by an astute doctor from TBCU who alerted MOH on this cluster of location-linked cases.

No further active TB cases linked to the cluster in Block 203 were detected. While there were some cases of latent TB infection (LTBI), it was within the expected range for that population when adjusted for socio-demographic and socio-economic factors. It was noted that some of the latent TB cases might not be linked to this cluster as TB is not uncommon in Singapore and some of these cases might have been infected elsewhere.

The cases were subsequently found to be genetically linked, i.e. infected with the same MDR-TB strain. Despite the investigations and repeated interviews, none of the cases reported knowing or interacting with one another, or congregating at common areas. The only common link was that they resided in the same block. While the lifts had been hypothesised to be a vehicle of infection, the probability that TB could be spread via this mode was low as persons using the lift would have had very short exposure times. Additionally, TB does not spread via surfaces touched by persons with TB (e.g. lift buttons).[5] The frequent opening and closing of lift doors and built-in lift ventilation would also have minimised residents' exposure to airborne pathogens. Hence the cluster was likely to result from an unknown factor along the chain of transmission and was further compounded by the long latency of TB.

Besides the MDR-TB cluster in Ang Mo Kio, there were also other reports of TB incidents reported in the media. These included the cases among SMRT staff[8], a case in a senior daycare centre[9] and cases in childcare centres.[10,11] Unlike the abovementioned cluster in Ang Mo Kio, the spread of TB in these instances could potentially be explained by the close and prolonged contact among cases and contacts. However, since active TB and LTBI are not uncommon in Singapore, cases could occur in various settings. There could also be instances where cases coincide in time and place but not necessarily the result of transmission between them. This was evident in the SMRT incident, where strains of affected staff were eventually found to be different from one another and cases were not directly linked.

DISCUSSION

Singapore is considered to be a country with intermediate TB incidence (defined by WHO as having TB incidence between 20 to 100 per 100,000 population).[12] Hence, TB remains a public health concern in Singapore and MOH needs to continue having a strong national TB programme to effectively tackle TB. In the recent few years, MOH had enhanced STEP e.g. increasing subsidises for patients, extending outreach Directly Observed Therapy (DOT) to frail and elderly patients, and issuing a set of clinical practice guidelines for TB prevention, diagnosis and management of TB. However unlike the sharp decrease in TB incidence rate following the launch of STEP in 1997 where the TB incidence was 54.8 per 100,000 to an all-time low time of 35.1 per 100,000 population in 2007, TB incidence appeared to have plateaued since then. Thus, new strategies are required to address the control of TB. One of the most critical ways to prevent and control the spread of TB is early diagnosis and prompt treatment of active pulmonary TB cases. However, the lack of understanding of TB resulted in less-than-appropriate responses such as delays in seeking treatment, reluctance to comply with treatment upon feeling clinically well after a few weeks of effective treatment.[13] If left untreated, persons with active pulmonary TB can potentially infect 10-15 other persons through close and prolonged contact over the course of a year.[6] Infectiousness decreases rapidly once the person is started on treatment, which is best achieved by DOT. This is the internationally recommended standard of care for persons with TB and has been shown to reduce the risk of relapse and development of drug resistance.[14] However presently not all persons with TB in Singapore are placed on DOT, and MOH is currently exploring ways to improve access to DOT services.

Being a global centre for trade and travel, Singapore is vulnerable to imported cases of infectious diseases. This is especially pertinent to Singapore with regard to TB, since Asia accounted for 61% of the global TB cases in 2015.[1] While the incidence of TB among the non-residents (long- and short-term pass holders) has remained stable over the past 5 years[2], there is still a burden of imported TB cases in Singapore. As such, it is important for non-residents with active TB to be effectively managed to minimise the likelihood of imported TB, and to avoid further spread within the local community.

The other area of concern is the increasing number of drug-resistant TB cases observed worldwide and regionally. Globally, in 2015, an estimated 3.9% of new cases had either MDR-TB or rifampicin-resistant TB (RR-TB). The countries with the largest numbers of MDR/RR-TB cases (45% of global total) are China, India and the Russian Federation[1]. Drug resistant TB is an outcome of ineffective treatment protocols and poor treatment compliance. Not only are drug resistance forms of TB harder to treat, treatment also takes longer. The more resistant the TB strain is, the harder it is to treat the person successfully. Hence, MOH is also strengthening DOT to minimise emergence of drug resistance, educating the public to seek medical attention early if they have symptoms of TB and expanding diagnostic testing for drug resistance.

Lastly, there is a need to increase public awareness and improve understanding of TB. This is important as Singapore has an increasingly ageing population[15] and increasing prevalence of persons with diabetes.[16] The lack of knowledge and proper understanding that TB is endemic in Singapore was particularly evident from the media attention and public interest in the sporadic TB incidents. As part of public education, MOH provided a background technical briefing to media on the TB situation in Singapore and MOH's control strategies towards TB in mid-November 2016. During that briefing, MOH also urged the media not to sensationalise sporadic TB cases as this could lead to breach of medical confidentiality, identification of cases, unnecessary panic among their contacts and stigmatisation. These coupled with the prolonged treatment required of patients may deter people from coming forward for diagnosis and treatment till its completion.

As with other infectious diseases, a multi-pronged approach is required in the prevention and control of TB, especially with it being a chronic infectious disease. MOH is continuing to overcome the challenges mainly in the management of both drug sensitive and drug-resistant TB cases through early detection and treatment, as well as compliance to treatment through DOT and increasing public awareness and knowledge of TB. With continued commitment and support of the healthcare family and community, the incidence of TB in Singapore can be further reduced.

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SCIENTIFIC CONTRIBUTIONS

How Safe is *Wolbachia* for *Aedes* Control?

A risk assessment for the use of male *Wolbachia*-carrying *Aedes aegypti* for suppression of the *Aedes aegypti* mosquito population

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INTRODUCTION

The global burden of dengue is estimated to be 50-100 million cases a year, and 40% of the world's population in more than 100 countries is at risk of dengue.[1] The infection is caused by the dengue virus (DENV), a single-stranded RNA virus with four immunologically related but distinct serotypes (DENV-1, DENV-2, DENV-3 and DENV-4). Infection with one serotype confers lifelong immunity against that serotype, but only transient immunity to the other serotypes.

Dengue is endemic in Singapore, with regular outbreaks.[3-9] Not unlike most major cities along the tropical and subtropical belt, Singapore is a vibrant travel hub that receives a continual influx of genetically diverse dengue virus strains.[10] Singapore's vulnerability is reflected in the 2013 outbreak, which is the worst recorded dengue epidemic in its history, with 22,170 cases and 7 deaths.[6]

Currently, in the absence of an effective vaccine, control of the mosquito vectors is the only effective method to prevent disease transmission. In Singapore, *Aedes albopictus* is ubiquitous, while *Aedes aegypti* is only present in built up areas. Localised dengue transmission (evident by the occurrence of two or more cases within 150m and with onset dates within 2 weeks of each other) co-locates with the presence of *Aedes aegypti*, a global primary vector of dengue [6] (Figure 2). The risk of dengue transmission increases with the ratio of *Aedes aegypti*:*Aedes albopictus* breeding uncovered during routine and outbreak inspections (unpublished data). Sentinel Gravitrap surveillance of adult *Aedes* mosquitoes also showed that a high population of *Aedes aegypti* (>6% positive traps per week) increases the probability of transmission by more than six times. Together, these data indicate the major vector role of *Aedes aegypti* in the transmission of dengue in Singapore and that *Aedes albopictus* likely plays a minor role. An approach that targets *Aedes aegypti* will likely make a significant impact on dengue transmission in Singapore.

Aedes aegypti, commonly known as the 'Yellow Fever mosquito', is a small, brownish black mosquito with conspicuous white markings on its body and legs. It is morphologically similar to *Aedes albopictus*, commonly known as the Asian Tiger mosquito. The two can be differentiated from each other based on the ornamentation found on the back of their thorax (Figure 3).

Female *Aedes aegypti* feeds almost exclusively on humans. The male does not bite and feeds only on plant juices for subsistence. This mosquito species bites predominantly during the day, with peak biting time at dawn and dusk. It is a highly domesticated mosquito that breeds primarily in artificial containers commonly found in and around residential premises. The eggs of this species can remain in a desiccated state and persist in the environment for up to 9 months. Once the eggs have hatched, the larvae will undergo four stages of larval development, before metamorphosing into pupae, from which adults will emerge. The life-cycle duration is 7 to 10 days under optimal conditions in Singapore's climate.

Figure 1. Global dengue risk map

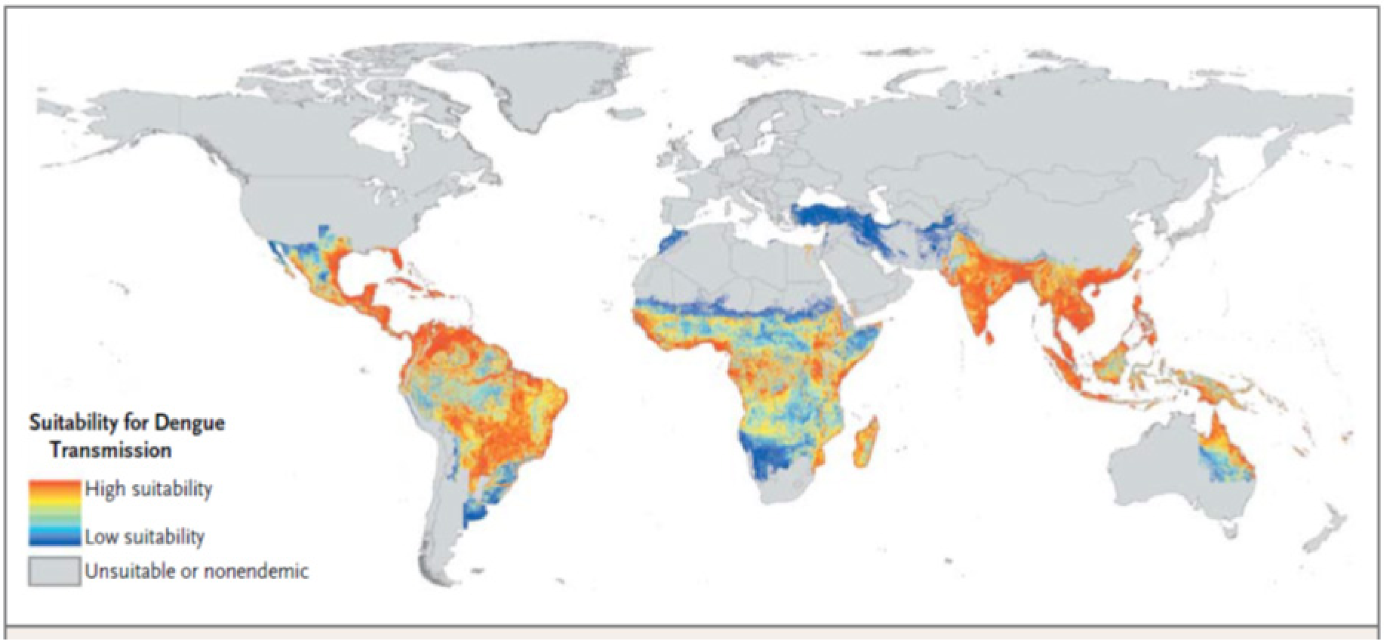
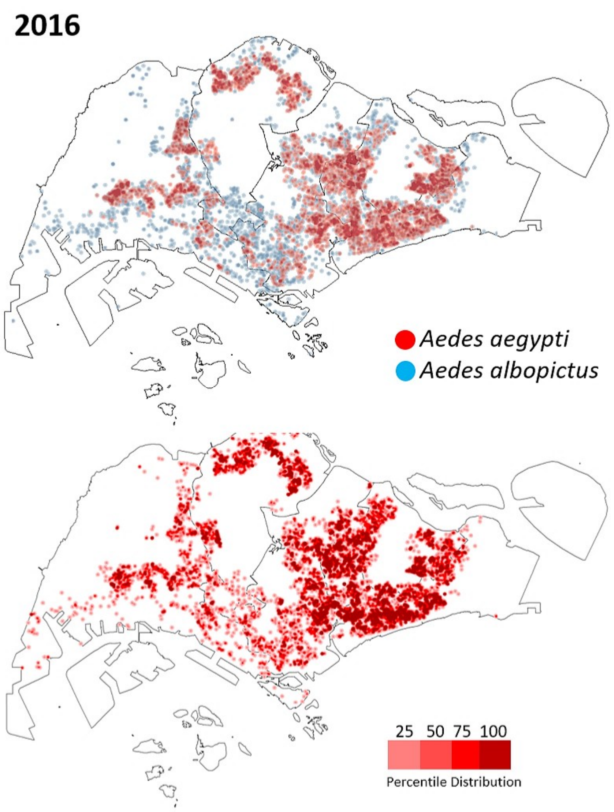


Figure 2. Co-location of dengue burden and *Aedes*

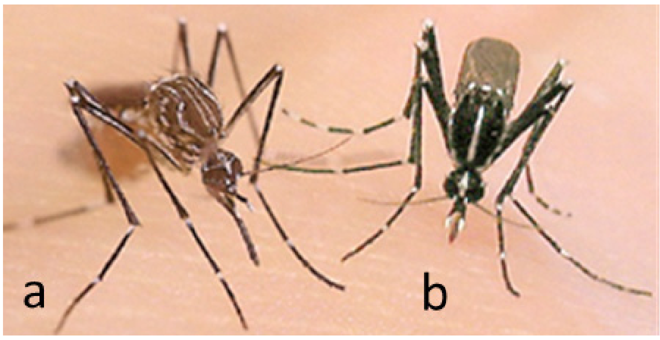


The high dependence of *Aedes aegypti* on humans to provide it with shelter, a blood meal and suitable breeding habitats, means that source reduction is the primary means of controlling this vector. However, finding, treating and/or removing *Aedes aegypti* breeding is becoming increasingly challenging, particularly when there are cryptic or inaccessible breeding sites. Furthermore, the increased reliance on insecticides to control dengue outbreaks, and the frequent use of household insecticides to control other household pests, have resulted in *Aedes aegypti* developing resistance to commonly used insecticides. *Wolbachia* is an obligate, intracellular, maternally-inherited, endosymbiotic bacterium that is commonly found in more than 60% of insect species, including mosquitoes, butterflies and dragonflies. It is also found in other arthropods such as spiders, mites, crustaceans.

In insects, *Wolbachia* is transmitted vertically, from a female mosquito to her progenies. *Wolbachia i*n insects render the insects resistant to viral infections, it has thus been postulated that *Wolbachia* confers fitness benefit to insects in nature.[11,12] When male *Wolbachia*-carrying mosquitoes mate with female mosquitoes that don't carry *Wolbachia* or carry different strains, all eggs laid by these females will not hatch due to incompatible mating. Together with the maternal transmission, this incompatible mating, termed "cytoplasmic incompatibility (CI)", gives an advantage to mosquitoes with *Wolbachia* and drives the spread of *Wolbachia* into the mosquito host population.[13]

Though some mosquito species such as *Aedes albopictus* and *Culex* species, carry *Wolbachia*, *Aedes aegypti* does not. While the discrepancy is not understood, its absence in *Aedes aegypti* could partially explain the excellent vector competency of *Aedes aegypti* for many viruses.

Figure 3. Comparing distinctive markings on the thorax between species: (a) *Aedes aegypti* with lyre-shape markings; (b) *Aedes albopictus* with median straight line



Wolbachia-based incompatible insect technique (IIT) takes advantage of the cytoplasmic incompatibility (CI) attribute of *Wolbachia* which causes a conditional sterility of male-*Wolbachia* mosquitoes. The incompatible mating between male *Wolbachia-Aedes* with uninfected females, or between mosquitoes harbouring different strains of *Wolbachia* will lead to non-viable eggs, hence the term "conditional sterility" (Figure 4). Because there will be no offspring from such matings, a constant release of male *Wolbachia Aedes aegypti*, to compete with male urban wild type *Aedes aegypti* for the urban females, could lead to a gradual decline in the field population. The goal of ITT is to suppress the *Aedes aegypti* population to a level that cannot sustain dengue transmission (Figure 5).

METHODS

The hazard identification process involved 4 years of critical reviews of existing knowledge and research; and consultations with various overseas and local experts and stakeholders such as academic researchers, medical and healthcare professionals, government agencies and non-governmental organisations such as the Singapore Nature Society. More than 80 sessions of engagement workshops and sessions were held.

Feedback and concerns were gathered and evaluated, no matter how unlikely the risk appeared to be. Both the severity and the likelihood of occurrence are scored from 1 to 5. The eventual risk is determined as depicted in the matrix below (Table 1).

RESULTS

Assessment of potential ecological and public health impact

The potential hazards identified are:
- negative impact on the environment;
- unintentional release of *Wolbachia*-carrying *Aedes aegypti* females into the environment;
- niche replacement by other mosquitoes; and
- ecological imbalance due to suppression of the *Aedes aegypti* population.

Figure 4. Mating between male *Aedes aegypti* with *Wolbachia* and urban females without *Wolbachia* results in non-viable eggs.

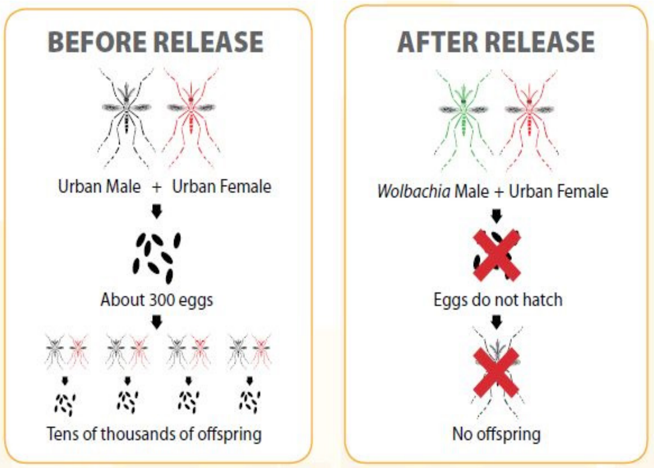
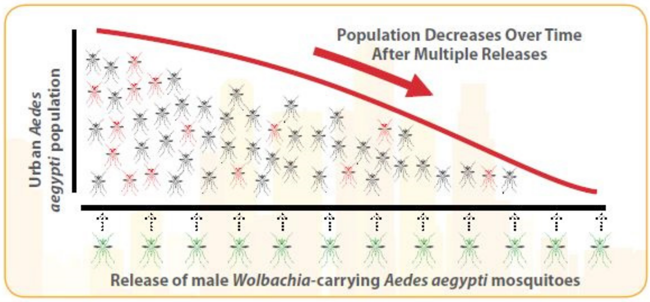


Figure 5. Regular release of *Wolbachia-Aedes aegypti* could theoretically reduce the population of urban *Aedes aegypti* in our environment.



Four potential hazards have been identified, and the ecological and public health risks associated with each of these potential hazards have been evaluated. The scores for the likelihood, severity and risk levels of the potential ecological and public health hazards are presented in Table 2.

Based on the risk matrix, the potential ecological and public health risks associated with the release of male *Wolbachia*-carrying *Aedes aegypti* into the environment, is negligible or low.

Table 1. Risk matrix of each hazard's likelihood and severity scores integrated to derive a risk score

Likelihood / Severity	Frequent (5)	Likely (4)	Occasional (3)	Unlikely (2)	Remote (1)
5	25 HIGH RISK Operation not permissible	20 HIGH RISK Operation not permissible	15 SERIOUS RISK Mitigation needed	10 LOW RISK Close monitoring needed	5 NEGLIGIBLE RISK Acceptable
4	20 HIGH RISK Operation not permissible	16 HIGH RISK Operation not permissible	12 SERIOUS RISK Mitigation needed	8 LOW RISK Close monitoring needed	4 NEGLIGIBLE RISK Acceptable
3	15 SERIOUS RISK Mitigation needed	12 SERIOUS RISK Mitigation needed	9 LOW RISK Close monitoring needed	6 LOW RISK Close monitoring needed	3 NEGLIGIBLE RISK Acceptable
2	10 LOW RISK Close monitoring needed	8 LOW RISK Close monitoring needed	6 LOW RISK Close monitoring needed	4 NEGLIGIBLE RISK Acceptable	2 NEGLIGIBLE RISK Acceptable
1	5 NEGLIGIBLE RISK Acceptable	4 NEGLIGIBLE RISK Acceptable	3 NEGLIGIBLE RISK Acceptable	2 NEGLIGIBLE RISK Acceptable	1 NEGLIGIBLE RISK Acceptable

Release of Male *Wolbachia-Aedes aegypti* having an impact on the environment

Can Wolbachia (wAlbB strain) become established in the environment, outside its intention host?

The transfer of *Wolbachia* (*w*AlbB strain) into the environment (outside its intentional host) is unlikely to occur. *Wolbachia* is a fastidious, obligate, endosymbiotic bacterium, which means that it can only survive only inside a host's cells. In vitro studies have shown that *Wolbachia* is only able to survive outside a host's cell if in a medium containing high amounts of amino acid. Thus, it is not expected to persist in the environment outside the host carrying it. *Wolbachia* will degrade together with the insect host's body when the latter dies, and the residue will not be different from that of natural organic detritus found in the environment.[14-16]

Can animals become infected with insect Wolbachia?

Nature has been continuously exposed to *Wolbachia* for millions of years. To date, there is no scientific evidence to show that *Wolbachia*-carrying mosquitoes are able to transfer the bacterium to vertebrate hosts during blood feeding. A recent study in Australia showed that human volunteers exposed to bites from *Wolbachia-Aedes aegypti* did not elicit an immune response – suggesting that *Wolbachia* or its parts are not transferred to humans through the bites of mosquitoes.

Can predators become infected with insect Wolbachia?

To date, there are no reports of mosquito predators (e.g. fish, lizards, frogs, spiders) becoming infected with *Wolbachia*, after ingesting insects that naturally carry *Wolbachia*. A recent study conducted in Australia showed that spiders could not become infected by insect *Wolbachia*, despite being continually fed with *Wolbachia*-carrying *Aedes aegypti.*[14]

Unintentional release of *Wolbachia-Aedes aegypti* females into the environment

Laboratory security, and thorough sorting of males and females have been put in place to prevent unintentional release of a large number of females. Male mosquito pupae are smaller than female pupae, thus male and female mosquitoes can be sorted by size in the laboratory, at the pupae stage. After sorting, the male *Wolbachia-Aedes aegypti* pupae are allowed to emerge as adult mosquitoes. Further screening by skilled entomologists will reduce the chance of females among the male population. A very small number of female *Wolbachia-Aedes* may be released along with the males. Current methodology results in 99.9% of purity of male *Wolbachia-Aedes*, thus the number of females released will be very small.

Will the urban wild type Aedes aegypti be replaced by Wolbachia-carrying Aedes aegypti?

The urban *Aedes aegypti* population may be replaced by *Wolbachia-Aedes aegypti* if a large number of female *Wolbachia Aedes* is unintentionally and continuously released. In our strategy, the number of females that could be released along with the males would be very small in comparison to the population in the environment, thus the female *Wolbachia-Aedes* mosquitoes will have no impact. The number would be too small to achieve any spread of the *Wolbachia* bacterium. It is highly unlikely that *Wolbachia-Aedes* aegypti will displace the WT *Aedes aegypti* population. Trials in Australia, Vietnam, Indonesia and other countries, that aim to replace WT population with *Wolbachia-Aedes* has shown that regular large scale release of females are required to achieve replacement.

Table 2. Scores for likelihood, severity amd risk level for ecological hazards.

No.	Potential Hazard	Risk	Impact	Risk Evaluation		
				Likelihood	Severity	Risk Level
i	Release of Male *Wolbachia Aedes aegypti* having an impact on the environment	*Wolbachia* (*w*AlbB strain) becomes established in the environment, outside its intentional host	Ecological	1	1	**1 NEGLIGIBLE RISK Acceptable**
		Animals become infected with *Wolbachia* (*w*AlbB strain)		1	1	**1 NEGLIGIBLE RISK Acceptable**
		Predators become infected with *Wolbachia* (*w*AlbB strain)		1	1	**1 NEGLIGIBLE RISK Acceptable**
		No potential public health risk identified				
ii	Unintentional release of *Wolbachia*-carrying *Aedes aegypti* females into the environment	WT *Aedes aegypti* replaced by *Wolbachia-Aedes aegypti*	Ecological	3	1	**3 NEGLIGIBLE RISK Acceptable**
		Wolbachia (*w*AlbB strain) becomes established in the environment, outside its intentional host		1	1	**1 NEGLIGIBLE RISK Acceptable**
		Animals become infected with *Wolbachia* (*w*AlbB strain)		1	1	**1 NEGLIGIBLE RISK Acceptable**
		Predators become infected with *Wolbachia* (*w*AlbB strain)		1	1	**1 NEGLIGIBLE RISK Acceptable**
		Increase in mosquito population, resulting in increase in biting pressure	Public Health	2	1	**2 NEGLIGIBLE RISK Acceptable**
		Contribute to increase in vector-borne disease cases (relative to current level), due to unintentional release in an area where vector-borne disease transmission is ongoing		1	1	**1 NEGLIGIBLE RISK Acceptable**
		Humans are infected with insect Wolbachia		1	1	**1 NEGLIGIBLE RISK Acceptable**

No.	Potential Hazard	Risk	Impact	Risk Evaluation		
				Likelihood	Severity	Risk Level
iii	Niche replacement by other mosquito species when *Aedes aegypti* is eliminated	*Aedes aegypti* replaced by *Aedes albopictus*	Ecological	2	1	**2** **NEGLIGIBLE RISK** **Acceptable**
		Aedes aegypti replaced by *Culex quinquefasciatus*		1	1	**1** **NEGLIGIBLE RISK** **Acceptable**
		Contribute to increase in dengue incidence (relative to current level)	Public Health	2	1	**2** **NEGLIGIBLE RISK** **Acceptable**
		Contribute to increase in chikungunya incidence		2	3	**6** **LOW RISK** **Close monitoring needed**
iv	Ecological imbalance due to suppression of the *Aedes aegypti* population	Density of the predator affected	Ecological	1	1	**1** **NEGLIGIBLE RISK** **Acceptable**
		Density of other insects		1	1	**1** **NEGLIGIBLE RISK** **Acceptable**
		Flowers that rely on mosquitoes for pollination are affected		1	1	**1** **NEGLIGIBLE RISK** **Acceptable**
		No potential public health risk identified				

However, should this happen, any possible damage to the ecosystem is considered negligible. *Wolbachia* is a naturally occurring in more than 60% of insects.

Will the increase in mosquito population result in an increase in biting pressure?

A very small number of female Wolbachia-Aedes may be released along with the males. The number would be very small in comparison to the population in the environment, thus increased biting would be negligible when compared to the original situation.

Will it contribute to increase in vector-borne disease cases (relative to current level) due to unintentional release in an area where vector-borne disease transmission is ongoing?

A very small number of female *Wolbachia-Aedes aegypti* may be released along with the males. The number would be very small in comparison to the population in the environment, thus the female *Wolbachia-Aedes aegypti* mosquitoes will have no impact. Moreover, virus transmission (e.g. Dengue, Chikungunya and Zika) will be largely blocked by *Wolbachia*, as reported by many laboratories, including studies performed at the Environmental Health Institute of NEA.

Can humans be infected with insect Wolbachia through mosquito bites?

Insect *Wolbachia* is not known to infect humans. A recent study has demonstrated that human volunteers exposed to periodic bites of *Wolbachia*-carrying *Aedes aegypti* do not show any immune response against *Wolbachia*[14]. In addition, humans are already regularly exposed to mosquitoes, such as *Aedes albopictus* and *Culex quinquefasciatus*, which naturally-carry *Wolbachia*. Despite this, there have been no reports of humans being infected with insect *Wolbachia*.

Niche replacement by other mosquito species when *Aedes aegypti* is eliminated

In Singapore, despite the presence of around 140 species of mosquitoes recorded in Singapore to-date, we have not observed other mosquito species taking over areas with low *Aedes aegypti* population.

Will Aedes albopictus take over the urban niche vacated by Aedes aegypti?

Though *Aedes aegypti* prefers urban spaces, and *Aedes albopictus* prefers greeneries, *Aedes aegypti* and *Aedes albopictus* are known to share some common habitats. E.g. they may breed in the same containers. Such replacement has been seen previously in Hawaii decades ago, when *Aedes aegypti* was eliminated in some of the islands.[17-20] However, in the local context, our experience and mosquito population data collected from our Gravitrap surveillance have suggested that the risk of *Aedes albopictus* taking over the vacant niche of *Aedes aegypti* is low, especially if the community continues to remove breeding habitats in our surroundings. Firstly, the population dynamic of the two *Aedes* population showed that a decrease in *Aedes aegypti* population does not coincide or lead to an increase in *Aedes albopictus* population. Secondly, the *Aedes aegypti* population in Singapore has already been reduced to relatively low numbers in the past few decades, with breeding found in less than 1 in 100 premise inspected. Despite this, we have not observed *Aedes albopictus* moving into indoor spaces and taking over the niche of *Aedes aegypti*. The ecological risk is low. Nevertheless, NEA's Gravitrap surveillance system will detect any unusual increase in the *Aedes albopictus* population.

Will Culex quinquefasciatus take over the urban niche vacated by Aedes aegypti?

There are occasional instances where both *Aedes aegypti* and *Culex quinquefasciatus* breeding have been found in the same habitat, but it is highly unlikely that *Culex quinquefasciatus* will occupy the niche of *Aedes aegypti*, as the requirements of these two species are quite distinct. *Culex quinquefasciatus* prefers to breed in more polluted and resource-rich habitats, such as in drains and larger water bodies, rather than in resource-poor breeding habitats such as household containers. The ecological risk is negligible.

Will other mosquitoes contribute to increase in dengue incidence?

The likelihood of niche replacement by *Aedes albopictus*, in Singapore's context, has been accessed to be low. Furthermore, *Aedes albopictus* is not as competent a vector as *Aedes aegypti*. This is evident internationally and locally, where places with presence of *Aedes albopictus* and absence of *Aedes aegypti* do not experience dengue outbreaks. Studies conducted at EHI have also shown that *Aedes albopictus* is less efficient at transmitting dengue compared to *Aedes aegypti*. Thus, even if *Aedes albopictus* takes over the niche vacated by *Aedes aegypti*, the dengue situation is still expected to improve.

Will other mosquitoes contribute to an increase in chikungunya incidence?

The likelihood of niche replacement in Singapore's context has been accessed to be low. However, in the unlikely event of *Aedes albopictus* taking over the niche and becoming the predominant *Aedes* vector in Singapore, there could be a slight increase in risk of chikungunya transmission. Some strains of Chikungunya virus are known to be more transmissible by *Aedes albopictus*. Close monitoring of the situation is needed. The existing NEA vector surveillance and community-based control strategies, which have been successful in tackling chikungunya outbreaks, will be able to address the low risk.

Ecological imbalance due to suppression of the *Aedes aegypti* population

Will the density of predators be affected with the removal of the Aedes aegypti population?

Reducing the *Aedes aegypti* population will not affect animals that feed on mosquitoes, because *Aedes aegypti* is an urban mosquito found in the built environment and typically not in natural settings (such as forests and parks). *Aedes aegypti* dwells in built up areas and breeds primarily in artificial containers in and around human habitats. The species thus has limited interaction with nature and does not make any significant contribution to the diet of animals that feed on insects. It also has low biomass.[21] There are insectivores (e.g. lizards, small animals) that feed on mosquitoes in the urban environment, but there is also an abundance of other mosquito species (e.g. *Aedes albopictus* and *Culex quinquefasciatus*) and other insect species, which they can feed on. There are around 140 species of mosquitoes in Singapore, found mainly in the forests. Together with other insects, they contribute to the diets of insectivores in nature.

Will the density of other insects be affected?

The approach is species-specific. Thus, the release of male *Wolbachia-Aedes aegypti* mosquitoes will only impact the *Aedes aegypti* population, and not other insects.

Will flowers that rely on mosquitoes for pollination be affected?

Though male mosquitoes feed on nectar, they are not known to play a role in the pollination of flowers.[22] Reduction in the mosquito population, especially in the urban setting, will not have an impact on the flowering of plants.

DISCUSSION

Overall, the potential ecological and public health impact for the release of male *Wolbachia-Aedes aegypti* males to suppress the *Aedes aegypti* population in Singapore are considered to be negligible. The only risk above negligible is the low risk of increased chikungunya, due to *Aedes albopictus* potentially taking over the urban niche should *Aedes aegypti* be eliminated. Our continued source reduction programme and close monitoring with Gravitrap surveillance system will be able to reduce the risk to negligible. When compared with the potential benefit of reducing the burden of dengue in Singapore, the associated low risk is deemed as very acceptable.

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Outbreak of *Pseudomonas aeruginosa* Conjunctivitis in a Neonatal Intensive Care Unit of a Private Hospital

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INTRODUCTION

Newborns in neonatal intensive care unit (NICU) are highly susceptible to nosocomial infections due to their immature immune system, underdeveloped protective barriers such as skin and mucosal membranes, as well as the exposure to various invasive procedures.[1] Gram-negative bacteria such as *Escherichia coli*, *Klebsiella*, and *Pseudomonas aeruginosa* are responsible for many nosocomial infections of neonates.[2] For example, *Pseudomonas* infection of the eye is common in patients who have been hospitalized longer than a week, and can be complicated or even life-threatening.[3] The clinical presentation of *P. aeruginosa* infection of the eye include pain, redness, swelling and impaired vision. Physical examination may reveal swelling of the eyelid, redness and swelling of the conjunctiva, and mucosal discharge.[4] Outbreaks of *P. aeruginosa* infection have been documented in intensive care units (including neonatal intensive care unit), burn units and haematology-oncology units in hospitals.[5-7] The source of these outbreaks involved the hospital water supply[8], sink, water taps contamination[9] and room humidifiers[10]. An epidemiologic and molecular investigation of endemic infection among infants in a neonatal intensive care unit found that it was associated with carriage of the organisms of the hands of health care workers.[3]

On 29 April 2016, the Ministry of Health (MOH) was notified of four cases of bacterial conjunctivitis among neonates in the NICU of a private Hospital. Affected neonates had developed symptoms of eye discharges between 20 and 29 April. This NICU was a 12-bed facility with two isolation rooms. Staff ratio ranged from 1:1 to 1:3 depending on the condition of the neonates. Laboratory tests showed *P. aeruginosa* and the isolates from two cases showed the same antibiotic sensitivity profile. We report herein our investigations into this outbreak.

METHODS

Epidemiological investigations were immediately conducted by the MOH Healthcare Epidemiology (HCE) Team to determine the extent of the outbreak, source of infection, and mode of transmission. The team comprised several field epidemiologists, a public health practitioner and a paediatric infectious disease physician who were part of the National Outbreak Response Team.[a]

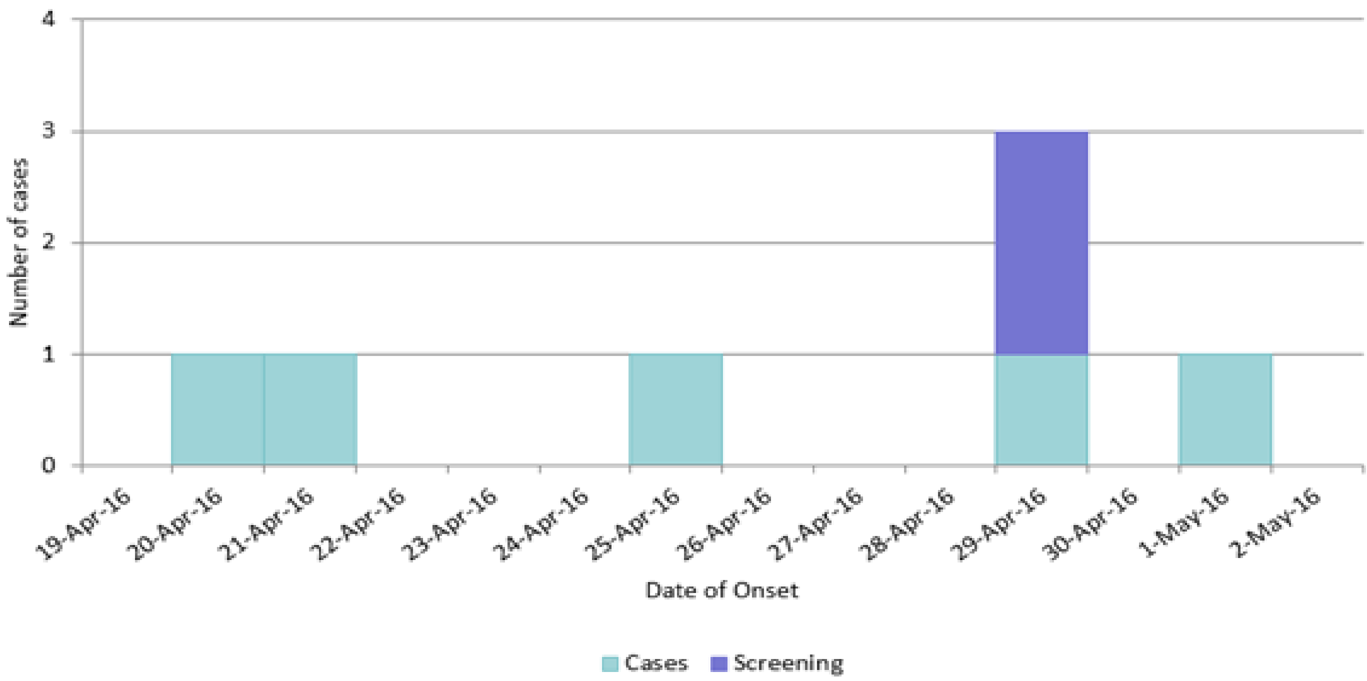
A case was defined as a neonate with culture-confirmed *P. aeruginosa* conjunctivitis, and had stayed in the NICU from 13 April onwards (one week before the onset of the first case). The age and gender of the cases were recorded together with presenting symptoms and laboratory results. Eye swabs were obtained from the affected neonates. Environmental samples were collected for bacterial culture and antibiotic sensitivity profiling, and tested by the hospital's laboratory. Further analysis was conducted on the positive isolates via pulsed-field gel electrophoresis (PFGE) at the hospital's contracted laboratory.

RESULTS

A total of seven affected neonates were identified (Figure 1). They comprised four males and three females. Six were premature births[b]; their gestational ages ranged between 29 and 39 weeks. There were a pair of twins among the affected neonates (gestational age of 31 weeks). Five cases were diagnosed clinically with eye infection/discharge, while the remaining 2

[a]National Outbreak Response Team was set up in March 2016 to draw on national resources and expertise to augment efforts in dealing with infectious diseases.

Figure 1. Outbreak of *P. aeruginosa* conjunctivitis in a private hospital NICU, 20 April to 1 May 2016 (N=7)*



*The two screening positive cases subsequently developed eye discharges.

were asymptomatic when their eyes swabs first tested positive during screening but subsequently developed eye discharges. One of the affected neonates had cleft lip and palate; and had Patent Ductus Arteriosus ligation done on 30 Apr (5 days after onset of illness). The remaining affected neonates did not have any underlying co-morbid conditions. Median days from NICU admission to onset of illness was 14 (range, 6–28 days), while median number of days hospitalized was 27.5 (range, 22-41 days).

Field visits to the NICU conducted by the team on 3 May identified the following: (a) while the normal saline ampoules were not shared among neonates, they were reported to be kept for up to 24 hours after opening (plugged with a syringe); (b) milk bottles of both well and affected neonates were kept in the same breast milk fridge; and (c) jugs for thawing breast milk, after sterilisation were shared among neonates (well and affected). One of the nurses shared that prior to the cluster of cases, one of the mother's breast milk storage bag had leaked into the jug on a few occasions.

The hospital taskforce chaired by the CEO had instituted the following control measures to stop the transmission since 30 April:

- Implement cohort nursing for the affected neonates in NICU
- Stop elective admissions to NICU
- Restrict visitors (only parents were allowed to visit)
- Conduct environmental cleaning (Note: NICU neonates were later transferred from NICU to another ICU, i.e. ICU2, on 1 May to facilitate cleaning and decontamination)
- Carry out contact tracing of the neonates who were in NICU one week before the onset of the first case
- Initiate contact precautions and strict hand hygiene (one staff, i.e. operations/nurse manager, was stationed at ICU2 during peak periods to audit and ensure compliance)
- Apply single-use eye toilet trays and consumables (milk bottles and gowns)
- Sterilise after every use all stainless steel basins used for bathing of babies, and jugs for thawing breast milk
- Use only boiled water that has been left to cool to clean babies
- Discard wastewater only into the sink located at the dirty utility room of ICU2
- Enhance environmental cleaning
- Inform all paediatricians, obstetricians and parents of babies in NICU of the current situation
- Offer to parents the transfer of their babies to NICU in another hospital (parents declined)
- Directly discharge them home once the neonates are clinically well

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[b]*Preterm birth defines as birth that occurs before the start of the 37th week of pregnancy.*

Table 1. Environmental testing for *P. aeruginosa* in NICU and Control area

Environment samples collected	Test results	Remarks
Water flow outlets of six sinks	All negative	Location at NICU
Drain outlets of six sinks	5 positive; one negative	
Six neonate monitors	All negative	
Three used glove boxes	All negative	
Three bottles of antibiotic eye drop	All negative	
Three curtains	All negative	
Doorbell button at the entrance of NICU	Negative	
Two telephones at nurses station	Both negative	
Three bath basins	All negative	
Two computer keyboards	Both negative	
Two mouse	Both negative	
Blood gas analyzer	Negative	
Light switches outside isolation room	All negative	
Six baby cots and frames	All negative	
Two water tanks supplying ICU2 and NICU	All negative	
NICU hepa filter air vents	All negative	
Breast milk sample from Twins' mother	Negative	
ICU 2 sink drains	All negative	Control area
ICU 1 sink drain	Negative	
Nursery sink drain	Negative	
Labour ward sink drain	Positive	
Paediatric ward sink drain	Positive	

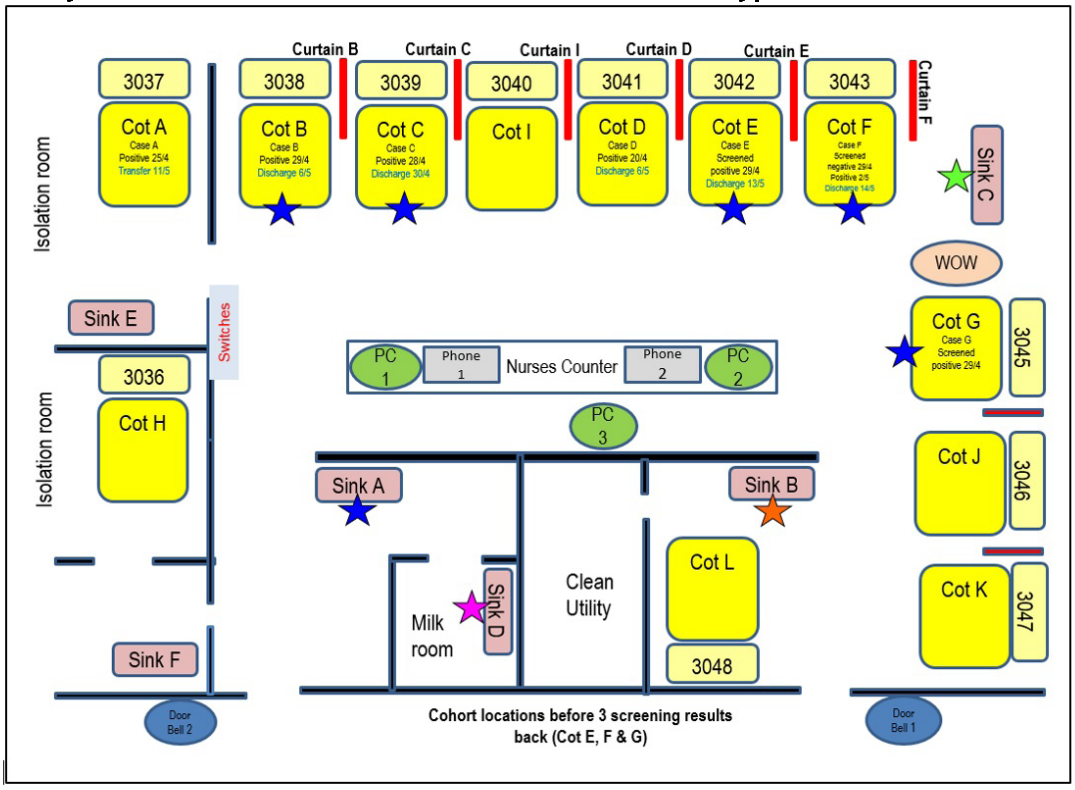
In addition, the hospital adopted the following recommendations by the MOH HCE Team:

- Stop the practice of keeping the normal saline for 24 hours after opening, and discard the ampule after use
- Review the cleaning procedures of the sterilisers for the milk bottles and jugs for thawing breast milk
- Review the case notes of all the cases to ascertain if any eye procedures were performed two weeks to onset of symptoms
- Ensure that the personal effects of well babies (e.g. breast milk storage, jug for thawing breast milk) were kept separated from the affected babies (to consider labelling and use dedicated jugs for thawing milk to per patient use, and eliminate any sharing that way)
- Check the health status (includes eye or ear infection) of all healthcare staff, including allied health professionals for the past two weeks
- Review *P. aeruginosa* trends in the hospital for the past 90 days
- Take environmental swabs from air conditioning vents in NICU, drains of sinks in other wards (for control group) and cultures from the mother's expressed milk samples
- Send positive isolates (patients and environmental samples) for further typing, in view that P. aeruginosa may be present in environment naturally
- Continue the care of the current admitted neonates in ICU2 and new admissions to NICU when NICU is re-opened
- Closely monitor the neonates that had developed eye and ear discharges for complications
- Prepare holding lines for media queries.

The antibiotic sensitivity profile of positive *P. aeruginosa* isolates from the cases showed the same antibiotic resistance pattern, i.e. resistant to amoxicillin, ampicillin, cefuroxime axetil, ceftriaxone, minocycline, nitrofurantoin, and trimethoprim. Environmental samples from a variety of areas in NICU were negative for *P. aeruginosa*, except for five samples from the drain outlets of the sinks. The breast milk sample from the mother which breast milk leaked into the jug also tested negative for *Pseudomonas aeruginosa*. Five samples collected from the NICU air vents showed no bacteria growth (see table 1).

Samples were also collected as controls from the drains from five other unaffected wards, i.e. ICU 2, ICU 1, Nursery, Labour ward, Paediatric ward. The sink drain cultures from the labour and paediatric wards also tested positive for *P. aeruginosa*, while the remaining wards were negative (see table 1). Sink drains that tested positive were treated with bleach. Further analysis was done on the five positive isolates from the cases and six environmental samples (including positive

Figure 2. NICU layout, with location of affected neonate and PFGE Type#



#Positive isolates with the same PFGE type were indicated as blue stars; and positive isolates with dissimilar PFGE types were indicated as green, orange and pink stars.

samples from the control group) via the PFGE method. The PFGE results showed that six isolates from five affected neonates and one environmental sample in NICU (i.e. sink drain A) had the same clone (indicated as blue stars in Figure 2). The remaining positive isolates including those from the control group had different PFGE clones.

The last case of conjunctivitis in this outbreak was reported on 1 May. All affected neonates were successfully treated with antibiotics, and were discharged home from the hospital, except for one neonate who was transferred to another hospital for care by a paediatric liver specialist due to his rising bilirubin level. The NICU was re-opened on 23 May after successful cleaning and decontamination.

DISCUSSION

In this rare outbreak of *P. aeruginosa* conjunctivitis in a neonatal ICU, 86% (6/7) of the affected neonates were preterm babies, while all of them had hospitalization days longer than a week. These findings are aligned to the common risk factors identified for nosocomial infection. Other risk factors like antimicrobial drug use and the number of days of antimicrobial therapy prescribed before positive blood culture, exposure to particular healthcare workers, and intravenous delivery of nutrients/electrolytes could not be tested due to unavailability of information.

The team considered several hypotheses for the source of the outbreak, including: (a) splash from water traps in NICU which contaminated hands and plastic bath basins during washing; (b) contaminated saline ampules either at source or after opening and re-use; (c) infected milk from twins' mother's ruptured milk bag; and (d) contaminated air-conditioning vents.

Laboratory analysis was conducted to help test the hypotheses. All isolates from the cases and one isolate from the NICU environment were found to have similar PFGE type. The other sink drains in NICU (i.e. Sink B-D) and control group were of different PFGE types. The NICU air vents and the breast milk of the twins' mother were tested negative. The saline ampules were not available for testing at time of investigation. While we were unable to ascertain a particular source for this cluster of cases, our PFGE analyses suggest that this cluster of cases possibly occurred from a single introductory event, followed by rapid horizontal transmission which may have been the result of existing inadequate infection control practices. A look back on the trend of *P. aeruginosa* infection in the hospital was conducted. The result was insignificant except for the cases in NICU in April.

Nonetheless, while the investigations into the possible hypotheses were ongoing, the work processes surrounding these hypotheses were tightened and the overall level of environmental hygiene and infection control in the affected NICU and the temporary NICU were stepped up, leading to the successful control of the spread of the disease. No further new infections were reported after 1 May.

This outbreak has highlighted the importance of multipronged infection control approach, support from the hospital's management, and open-minded collaboration in outbreak management. Early closure of the NICU to facilitate environmental cleaning, the availability of hospital resources to have a second backup ICU during the outbreak, increase vigilance in hand hygiene, and environmental cleaning were key to stopping the transmission of the disease quickly in this particular NICU.

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NOTES FROM THE FIELD

Taking Stock of Regional Collaboration in Public Health

A report on the 20th BIMST Public Health Conference and One Health Symposium, 13-14 Oct 2016, Singapore

The 20th BIMST Public Health Conference was held in Singapore from 13 to 14 October 2016. BIMST is an annual meeting of the public health authorities from the five member states - Brunei Darussalam, Indonesia, Malaysia, Singapore and Thailand.

Since its establishment in 1996, the BIMST meeting has served as an important platform to discuss public health matters in the prevention and control of communicable diseases. The meetings have also provided opportunities for public health officials of BIMST member states to collaborate and enhance cooperation on other public health matters, such as the prevention and control of non-communicable diseases, health promotion, environmental health, food safety, drug safety and human resource development. The development of policies and plans of action to overcome public health problems in border areas has also been discussed.

This meeting was attended by delegates from Indonesia, Malaysia, Singapore and Thailand. The Singapore delegation comprised of staff from the Ministry of Health (MOH), National Environment Agency (NEA) and Agri-Food and Veterinary Authority (AVA). The theme of this year's meeting was One Health, where human, environment and animal health authorities combine efforts to tackle complex public health threats that require an integrated, multi-sectoral response. During the conference, participating countries took turns to raise topics of public health interest for discussion, including vector-borne diseases, vaccine strategy, and the International Health Regulations (IHR).

Zika as an emerging disease

Thailand and Singapore presented on their Zika situation and control measures.

There has been serological evidence of Zika virus infection in Thailand since 1954, and the first confirmed case was reported in 2012. Since then, there have been reports of sporadic cases and small outbreaks from all regions in Thailand, with over 340 confirmed cases (including 33 pregnant cases with two microcephaly births) as of 3 October 2016. The Zika strain in Thailand is an Asian lineage strain, which is closely related to the Yap Islands, French Polynesia strain. Zika control in Thailand consists of prevention and detection (epidemiological and entomological surveillance, monitoring congenital malformations and neurological complications, expanding laboratory diagnostic services), treatment (case management guidelines), vector control and active case finding, and risk communications.

Singapore detected its first local case in late August 2016, as part of an investigation involving an unusual cluster of fever and rash amongst construction workers and residents seen at a General Practice (GP) clinic. A look back exercise was subsequently carried out, resulting in the detection of 52 more cases. Several clusters were detected, with over 300 confirmed cases (including 16 pregnant cases) as of end September 2016. Two strains from the first cluster of cases were similar to strains of Zika virus which have been circulating in South East Asia since the 1960s. To control the outbreak, Singapore's strategy was to first isolate the initial cases in hospital until virus clearance from blood. Infected patients were advised to take mosquito precautions, and intensive search and destroy vector control operations were carried out in affected areas to kill adult mosquitos and eliminate breeding. Subsequently, when there was evidence of community transmission, the strategy shifted to a mitigation approach akin to regular dengue control.

Delegates further discussed Zika surveillance in the region, Zika testing approaches, Dengue-Zika co-infection and vector surveillance and control. Countries welcomed open information sharing on various aspects of Zika surveillance and control, in the form of statistics, protocols, guidelines, reports and other online publications, leveraging on existing mechanisms as appropriate (e.g. Emergency Operation Centre network, IHR focal points).

Leptospirosis

Leptospirosis is an important public health issue and re-emerging disease for many countries in the region. Malaysia presented on its leptospirosis situation and control strategy. Since leptospirosis was made a notifiable disease in Malaysia in December 2010, the number of cases has been gradually rising from 2011 to 2015. Deaths from leptospirosis have also been on an uptrend. Studies had identified agriculture workers and municipal service workers as having higher occupational risk of leptospirosis. Awareness of the disease needs to be strengthened amongst the general public and medical professionals, for early and accurate diagnosis as well as prompt treatment. Laboratory capacity for leptospirosis diagnosis should also be enhanced. Moving forward, multi-sectoral cooperation (i.e. One Health approach) will be important for effective control, particular in the areas of surveillance, environmental sanitation and hygiene, and research.

Thailand and Singapore shared their respective country experience in leptospirosis control. In Thailand, there were approximately 2,000 leptospirosis cases in 2015 with 50 fatalities, mainly in rice growing areas. The Ministry of Public Health manages the rodent control in cities, while the Department of Livestock Development manages the rodent control in rural areas with livestock. Thailand's control strategy is focussed on clinical leptospirosis surveillance, diagnosis and treatment and active case finding in rural areas following flooding.

In Singapore, approximately 30 to 60 cases have been annually reported, mainly involving sporadic infections in foreign workers living in dormitories. Incidents of leptospirosis have been associated with poor housekeeping, contact with rodent urine or faeces, and with sightings of rodents in the vicinity. There has been an anecdotal increase in the rodent population. NEA has worked with town councils and pest control

Figure 1. Advocacy by the delegates from Indonesia

Figure 2. Malaysia's representatives at the conference table

operators over the years to implement rodent control programmes aimed at destroying rat burrows and controlling breading. On the animal health front, the AVA has ongoing leptospirosis surveillance in livestock, and responds to reports of leptospirosis outbreaks in domestic pets.

The conference called for improved awareness, prevention and control of leptospirosis through a One Health approach of inter-agency collaboration and core capacity building in BIMST member states.

New vaccine introduction as a strategy to reduce infant mortality

Indonesia presented on its progress in enhancing its national immunisation programme over the years to control vaccine-preventable diseases. The programme was initiated in 1974 and currently covers vaccination against six diseases - tuberculosis, diphtheria, tetanus, pertussis, poliomyelitis and measles. Indonesia was certified polio-free in March 2014 (together with other member states in WHO South-East Asia Region), and received maternal and neonatal tetanus elimination (MNTE) certification in September 2016. Its next priority is to introduce vaccines for Japanese encephalitis (JE), human papillomavirus (HPV), pneumococcal vaccine and rotavirus 3 (RV3) vaccine into the national immunisation schedule. In this regard, demonstration and pilot projects have been planned and will be progressively rolled out over the next few years. There are also plans to introduce the combined measles-rubella vaccine into the schedule and to conduct catch-up campaigns.

Indonesia shared some challenges it faces in improving immunisation coverage in its population. Although vaccination for children is mandatory by law, the government needs to respond to anti-vaccination movements that have arisen over fears that vaccines may be ‘unclean’ or ‘haram’. To this end, Indonesia called for renewed commitment among BIMST member states to improve immunisation coverage in the region for priority diseases, with the aim of reducing child mortality and morbidity.

IHR evaluation

Thailand shared its progress in implementing the International Health Regulations (IHR) 2005, since their adoption by the Thai cabinet in June 2007 and the approval of the National IHR Strategic Plan (2007 – 2016) in November 2007. Since 2009, Thailand has annually appraised its progress under the IHR Core Capacity Monitoring Framework, across multiple sectors of government (Epidemiology, Medical Services, Risk Communication, Medical Sciences, Communicable Diseases, Emerging Infectious Diseases, Food Safety, Occupational and Environmental Health, Energy). As of 2014, Thailand has implemented Global Health Security requirements at its border provinces, and has integrated IHR implementation plans into the ASEAN agenda. Moving forward, the country will be adopting the Joint External Evaluation (JEE) Tool to evaluate progress in implementing IHR from 2017 to 2021. BIMST countries were encouraged to share their experiences in the JEE in this regard, and to enhance cooperation in all hazards surveillance, prevention and control.

One Health Symposium

As part of the 20th BIMST meeting, the 3rd One Health Symposium was held in the afternoon of 14 October 2016. This is an annual symposium that provides a platform for stakeholders to interact and discuss public health topics of relevance to One Health. The 3rd symposium was attended by local and international participants from the animal health, environmental health and human health sectors, and included BIMST country delegates as well as staff from the Singapore MOH, NEA and AVA. Presentations centred on countries' experiences in applying the One Health approach to address cross-sectoral public health challenges.

Singapore - The city state established its One Health framework in 2012, which laid out a structure for inter-agency cooperation on priority public health issues for Singapore. The three key stakeholders involved are MOH (human health), AVA (animal health) and NEA (environmental health). The One Health Coordination Committee provides strategic direction and sets priorities on One Health issues, and is supported by the One Health Working Group and four project teams looking into: (i) common protocols for joint investigations; (ii) risk communications; (iii) capability building and joint training; and (iv) surveillance and risk assessment. Since the framework was established, Singapore has made progress in developing joint response protocols for priority diseases, training and capacity building (e.g. roll-out of Specialist Diploma in One Health), risk communications (e.g. developing travellers' health advisories for zoonotic diseases) and surveillance (e.g. vector-borne zoonotic diseases in birds and wild boars in Singapore). In recent times,

Figure 3. Comments from our AVA and NEA colleagues

Figure 4. Thai participants in the roundtable discussion

One Health cooperation has been instrumental in bringing local outbreaks under control (e.g. Zika and invasive Group B *Streptococcus* infection associated with consumption of raw ready-to-eat fish dishes). Some upcoming One Health initiatives include the development of joint preparedness plans for rabies, and the establishment of joint antimicrobial resistance control plans.

Thailand - One Health is a priority item for inter-ministry cooperation in Thailand, and commitment has been secured at Ministerial level. Thailand has developed a National Strategic Plan for Emerging Infectious Disease Preparedness, Prevention and Response, which employs a One Health approach in strengthening its IHR core capacity in zoonotic disease control. Multi-sectoral joint outbreak investigations and capacity building (both pre-service and in-service training) are part of the Plan. In 2008, Thailand developed a Field Epidemiology Training Programme (FETP) for Veterinarians, and subsequently conducted other multi-sectoral training courses in applied epidemiology and field investigations for emerging infectious diseases.

Indonesia - The country is putting in place policies to prevent and control disease transmission in animals so as to reduce zoonotic disease impact on human health, paying particular attention to protecting the health of native populations. It has secured high-level commitment from the Ministers of Health and Agriculture to tackle a list of priority zoonotic diseases. A National Commission on Zoonotic Disease Control has been established since 2011 as a platform for cooperation between stakeholder ministries and professional organisations at central, provincial and district/ municipality levels. Some key activities include (i) capacity building amongst healthcare workers (including joint outbreak investigations in the field), (ii) community education and (iii) information systems integration for better information sharing between the animal and human health authorities.

Malaysia - In response to outbreaks of zoonotic diseases (e.g. Nipah virus, H5N1, H1N1, Q-fever, brucellosis, rabies) in recent years, Malaysia has established several platforms for inter-Ministry collaboration in zoonotic disease control. At the top level, there is the Joint Inter-Ministerial Meeting between the Department of Veterinary Sciences (DVS) and the Ministry of Health (MOH). At the working level, a trans-disciplinary disease control and surveillance programme has been established, and the country is also investing in capacity building

Figure 5. A group photograph with logo of the 20th BIMST Public Health Conference

via the establishment of the One Health University Network. So far, the network has organised several seminars, workshops and joint simulation exercises. There have also been joint outbreak investigations and cross-sectoral collaborations in research and diagnostic testing services. Antimicrobial Resistance (AMR) control is a priority area for Malaysia. To this end, Malaysia has established a National Antimicrobial Resistance Committee (NARC) in 2016, jointly chaired by human and animal health, to build on earlier work done and to develop a National Action Plan on AMR with multi-sector stakeholder inputs.

The Symposium concluded on a fruitful note, with a panel discussion in response to audience questions on topics such as partnership and engagement with the private sector in tackling One Health issues.

A Walk Down Memory Lane – Singapore's School Dental Service

Drilling Down to our Roots

1950

Students queuing to get their teeth checked on the mobile dental bus (Source: Health Promotion Board (HPB))

Treatment at Tan Tock Seng Hospital Dental Clinic:
The School Dental Service (SDS) started with the only dental clinic in Tan Tock Seng Hospital and mobile dental vans for dental check-ups and treatment.

Dental Therapist Training: Dental nurses were trained in Penang and were then deployed to the dental clinics in primary schools.

1954

Prevention Measure:
Fluoride was added to our water supply as research by the World Health Organisation showed that fluoride is most effective in preventing low-level dental caries.

1960

Students brushing their teeth in schools as part of the 1960's Dental Health Campaign. Source: HPB.

1962

Dental Nurses' Training School established by Ministry of Health (MOH):
The 3-year Certificate in Dental Nursing programme trained all dental nurses locally to meet the manpower requirements of the SDS.

1980s-1990s

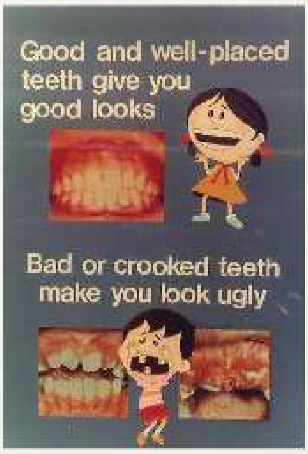
Dental clinics became available in all primary schools and the training of Dental Nurses was devolved to the SDS.

1969

Launch of Dental Health Campaign for all Primary One to Primary Three students:
Following a successful pilot scheme in 1968, the first Dental Health Campaign was introduced to all Primary One to Primary Three students as part of MOH's efforts to develop good dental hygiene habits from young.

The Ministry of Education (MOE) supported our efforts to improve oral hygiene in students by incorporating compulsory toothbrushing drills in the school curriculum. Students were provided with plastic mugs and toothbrushes, and were taught and supervised by teachers on proper toothbrushing techniques and dental care. Singapore was then the first country in the region to carry out a dental education programme of such a scale.

Past educational materials – pamphlets & models. Source: HPB.



Past educational materials – poster. Source: HPB.

Launch of Annual Dental Health Week:
Promoting dental care and prevention against dental diseases, some of the activities organised include dental health exhibitions, poster competitions, and contests for young people with the best teeth. Additionally, MOE included the provision of dental clinics in primary schools into their school development plan.

Reproduced from the Report of the Director of Medical Services 2014

The Continued Evolution of School Dental Service

2000

Dental Therapist Certification:
Dental Nurses were re-designated as Dental Therapists (DTs) and the Certificate in Dental Nursing Programme was renamed as the Certificate in Dental Therapy Programme.

Revamped oral educational messaging and materials. Source: HPB.

2001-2002

Extension of SDS to schools:
SDS continued to be a key pillar in ensuring better oral hygiene for children. HPB had stepped up their efforts to educate and provide quality oral healthcare to as many students as possible.

SDS reached all secondary schools with mobile dental clinics going on-site to provide basic preventive services, curative treatment and referral services. HPB also introduced oral health talks to kindergartens.

2003-2004

Dental Therapist Training:
The training of DTs was transferred to Nanyang Polytechnic (NYP) and the Diploma in Dental Therapy Course was launched at NYP in collaboration with HPB. A year later the course was modified to an integrated dental therapist / hygienist diploma programme.

2006

Development of Integrated Dental Electronic Assessment for Students (IDEAS):
It allowed for HPB clinicians and field staff to access and capture student records island-wide in real time.

2008

Launch of HaPpy Brush:
Invented by HPB, the HaPpy Brush is a specially designed toothbrush to make toothbrushing simple and fun for pre-schoolers and lower primary students. The brush features a specially customised brush head and bristles, enabling children to use the simple "scrub" technique when brushing to achieve the same results as more complicated techniques.

HPB's HaPpy brush and plaque disclosing toothpaste. Source: HPB.

2009-2010

Development of plaque disclosing toothpaste:
SDS collaborated with Oral Kare to develop the toothpaste which enables children to easily identify dental plaque when toothbrushing. It was incorporated into the P3 oral health promotion programme.

Forward Plans

A dental screening programme for 3-year-olds is slated to commence in 2017, and will reach out to all childcare centres by 2020.

2013-2014

Programme for ITE
An oral health programme was initiated at ITE College East (ITE CE) from October 2013, and extended to all 3 ITE colleges in 2014. A mobile dental clinic is deployed to provide on-site oral health screening and treatment to ITE students.

Introduction of daily toothbrushing programme with fluoride toothpaste to childcare centres:
Introduced by HPB, it aims to cover all the pre-schoolers within three years to reduce the present caries rate in children.

Importance of Water Fluoridation:
While Singaporeans today have access to more sources of fluoride such as fluoride toothpastes and mouth rinses, these products are not used by everyone. Water fluoridation remains to be the most cost effective preventive public health measure for tooth decay.

Health Zone exhibit on dental care. Source: HPB.

Reproduced from the Report of the Director of Medical Services 2014

SURVEILLANCE SUMMARY

Infectious Diseases Update

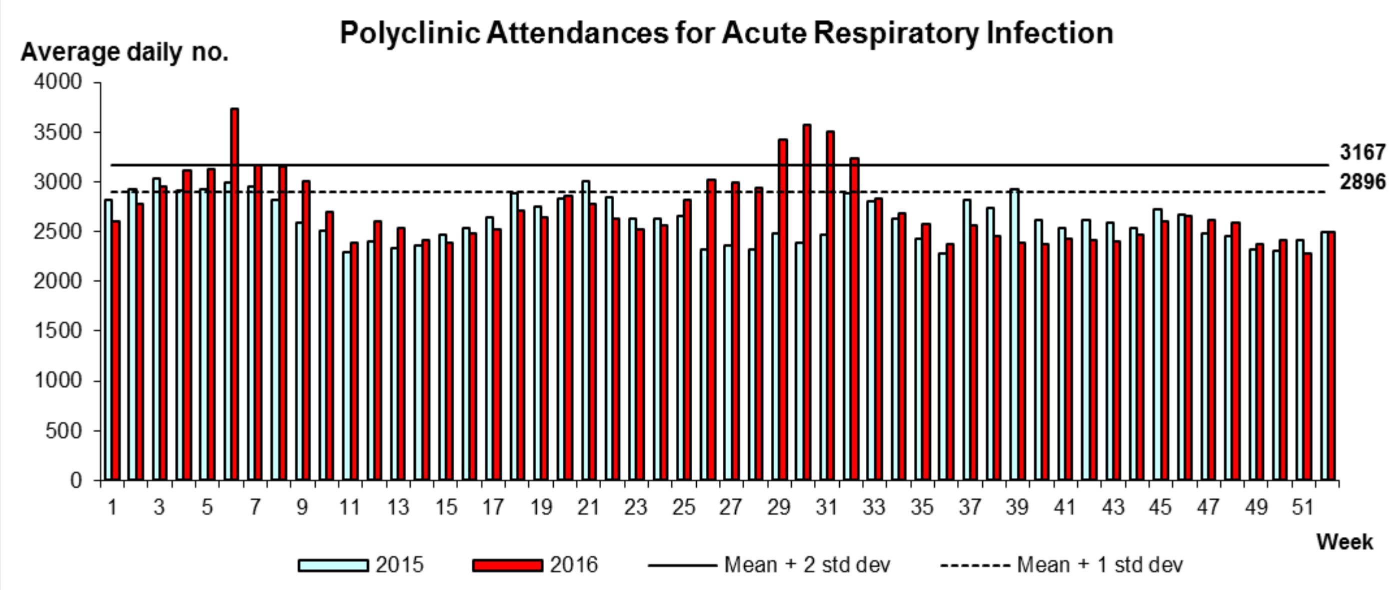
As of E-Week 52 (25 - 31 December 2016)

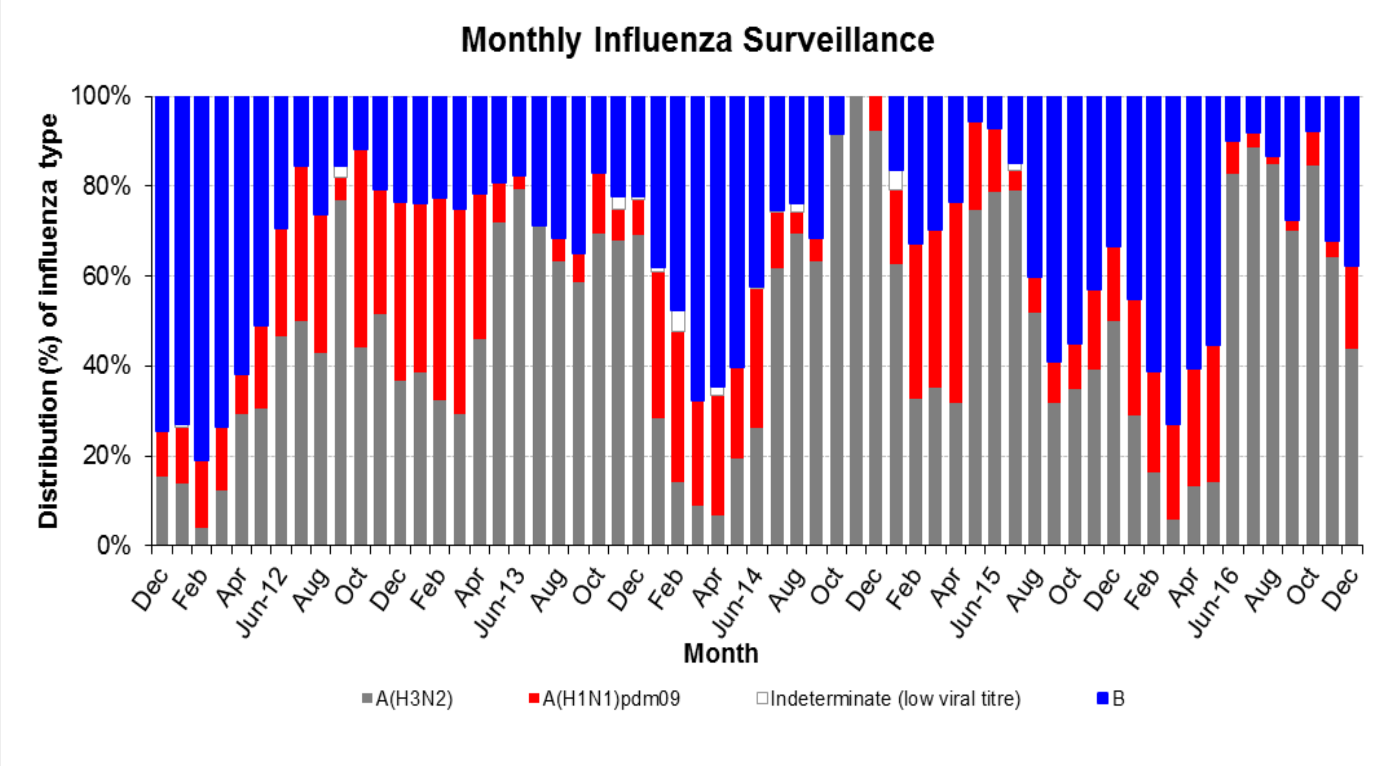
	E Week 52			Cumulative first 52 Weeks		
	2016*	2015	Median 2011 -2015	2016	2015	Median 2011 -2015
FOOD/WATER-BORNE DISEASES						
Campylobacteriosis	5	8	6	441	420	420
Cholera	0	0	0	2	3	2
Paratyphoid	0	1	1	19	27	27
Poliomyelitis	0	0	0	0	0	0
Salmonellosis (non-enteric fevers)	35	40	26	2213	1996	1735
Typhoid	1	0	0	51	49	71
Acute Hepatitis A	2	0	2	48	50	72
Acute Hepatitis E	2	3	1	85	60	66
VECTOR-BORNE DISEASES						
Chikungunya Fever	0	0	0	36	42	42
Dengue Fever	64	457	188	13091	11282	11286
Dengue Haemorrhagic Fever	0	0	0	24	12	22
Malaria	0	0	1	31	47	111
Nipah virus infection	0	0	0	0	0	0
Plague	0	0	0	0	0	0
Yellow Fever	0	0	0	0	0	0
Zika Virus Infection	1	0	0	458	0	0
AIR/DROPLET-BORNE DISEASES						
Avian Influenza	0	0	0	1	0	0
Diphtheria	0	0	0	0	0	0
Encephalitis	0	0	0	28	30	30
Haemophilus influenzae type b	0	0	0	3	3	3
Hand, Foot And Mouth Disease	512	370	363	42154	28216	28216
Legionellosis	0	1	1	12	17	24
Measles	3	0	1	137	42	46
Melioidosis	0	1	1	59	42	35
Meningococcal Disease	0	0	0	5	6	6
Mumps	12	7	7	540	473	495
Pertussis	1	0	0	85	57	24
Pneumococcal Disease (invasive)	3	2	3	131	139	148
Rubella	1	0	0	12	15	48
Severe acute respiratory syndrome	0	0	0	0	0	0
OTHER DISEASES						
Acute hepatitis B	0	0	1	47	52	57
Acute hepatitis C	0	1	0	23	46	4
POLYCLINIC ATTENDANCES - AVERAGE DAILY NUMBER***						
Acute upper respiratory infections	2493	2494	2605			
Acute conjunctivitis	98	97	92			
Acute Diarrhoea	458	468	420			
Chickenpox	12	15	NA			
HIV/STI/TB NOTIFICATIONS	**2016**	**Nov**		**Cumulative 2016**		
HIV/AIDS	30			341		
Legally Notifiable STIs**	677			7081		
Tuberculosis	118			1500		

* *Preliminary figures, subject to revision when more information is available.*

Influenza Surveillance

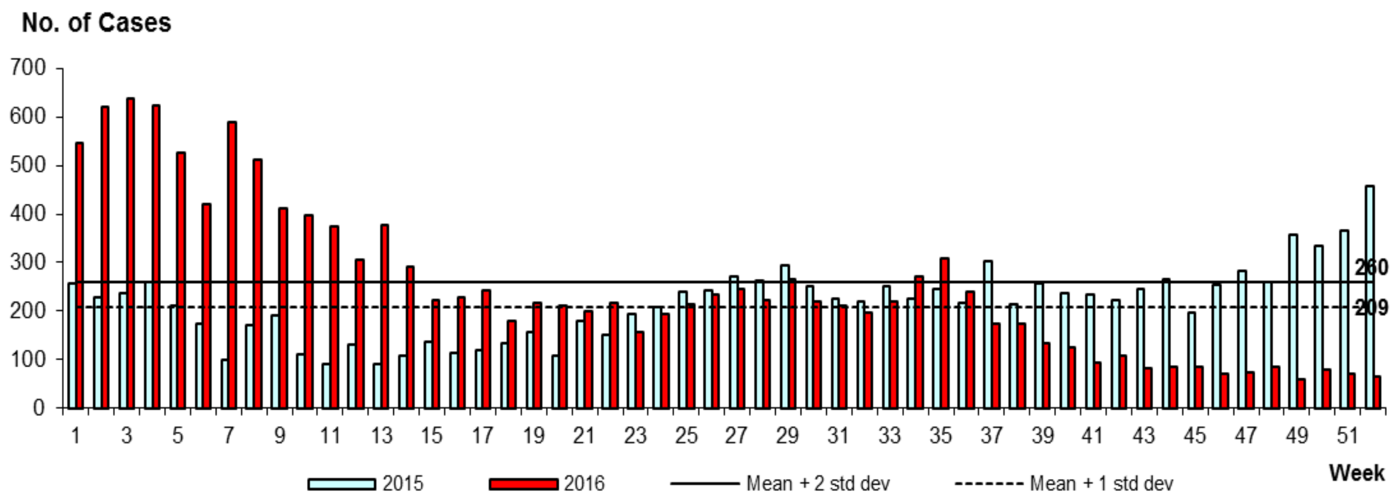
The average daily number of patients seeking treatment in the polyclinics for Acute Respiratory Infection (ARI) remained below the mean + 1 SD level since September 2016. The proportion of influenza-like illness (ILI) attendances among ARI patients remained low at approximately 0.8%. The overall positivity rate for influenza among samples taken from these ILI patients in the community was 36.7% in the past four weeks (E-weeks 49 – 52) and remained below the median level. Of the specimens tested positive for influenza in December 2016, these were positive for influenza A(H3N2) (44.4%), influenza B (38.9%) and influenza A (H1N1)pdm09 (16.7%).





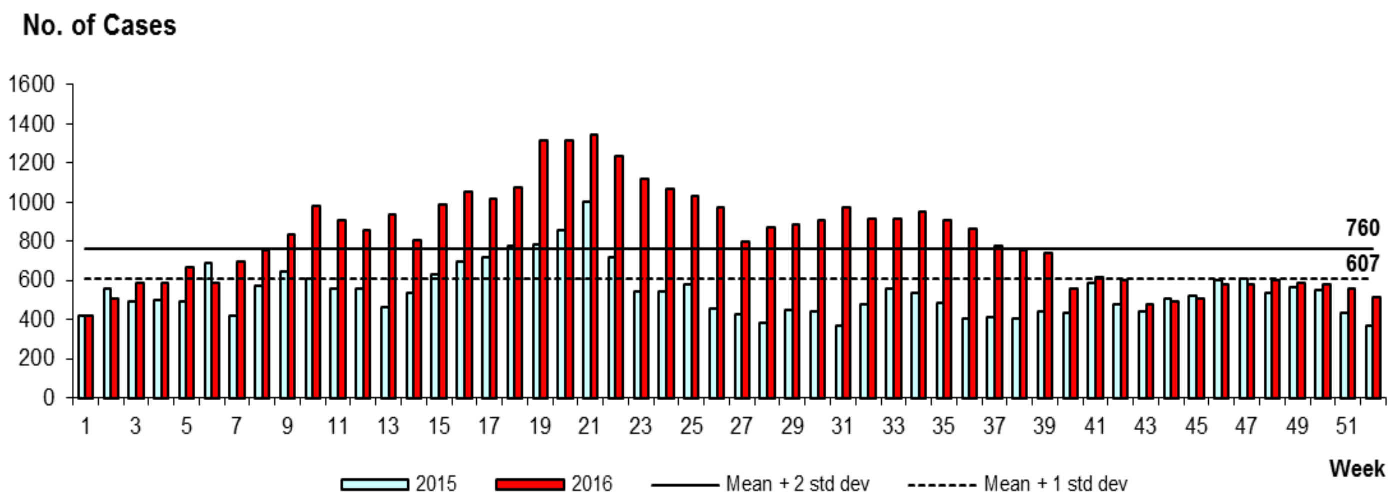
Dengue Surveillance

The number of dengue notifications decreased since September 2016 and remained well below the mean + 1 SD. Preliminary results of all positive dengue samples serotyped in December 2016 showed DEN-1, DEN-2, DEN-3 and DEN-4 at 48.1%, 25.0%, 23.1% and 3.8% respectively.

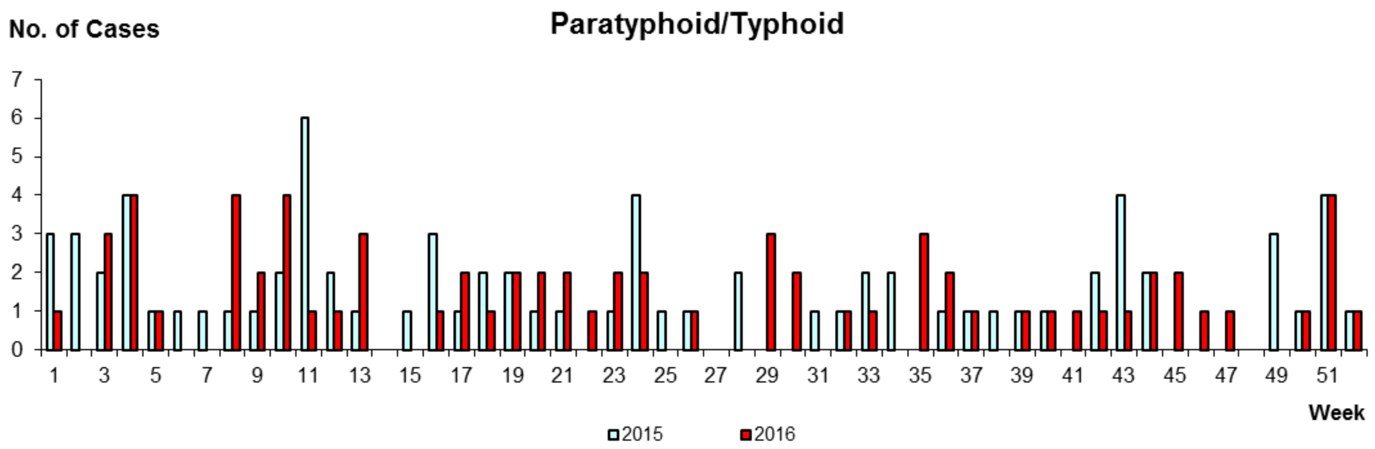


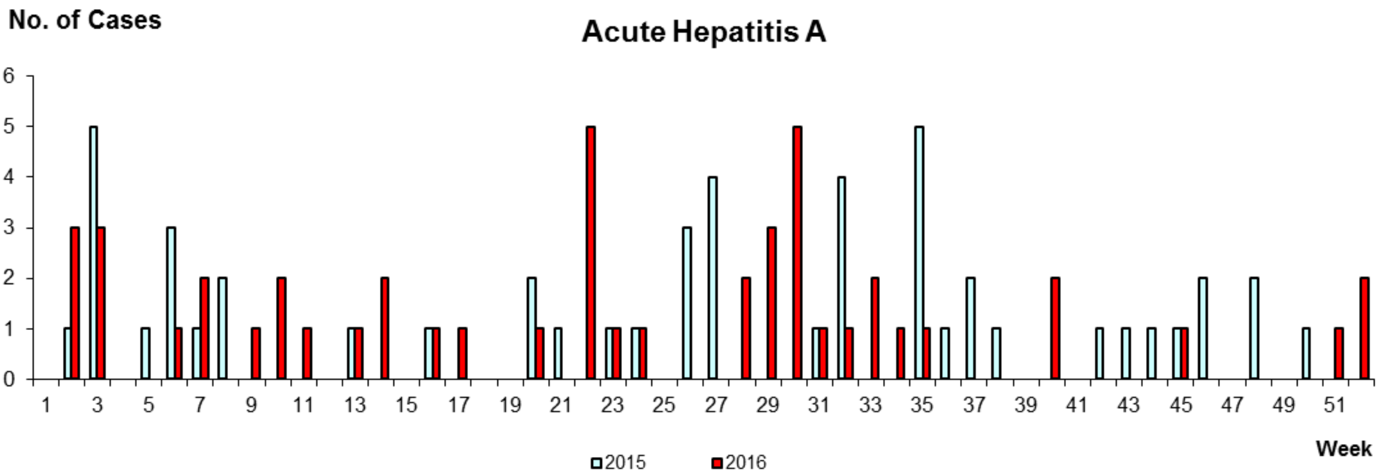
Hand, Foot and Mouth Disease (HFMD) Surveillance

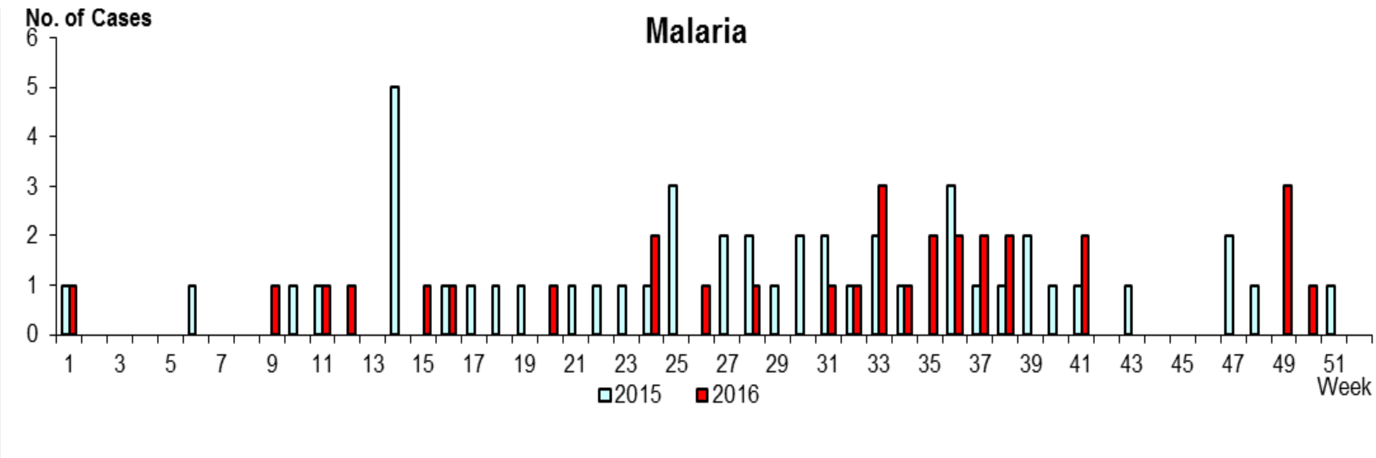
The number of HFMD notifications decreased and remained below the mean + 1SD since September 2016. In the past 4 weeks, none of the samples collected from KKH, NUH and GP clinics were positive for EV71.



Surveillance of Other Selected Diseases







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Do you have any ideas or suggestions?
Your views are important to us.

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