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Editor's note

You can see from the front cover that our focus for this issue of ENB Quarterly is on foodborne diseases. We have lined up three features, starting with a *Lead Article* describing epidemiological investigations into an outbreak of salmonellosis at a boarding school, followed by *Notes From the Field* sharing insights from a case study of *Bacillus cereus* food poisoning, including Singapore's One Health protocol, and *Fast Facts* highlighting the importance of food safety with emphasis of the importance on good practices for food processing and storage.

This year, ASEAN Dengue Day falls on 15 June 2018 - a day when the region recognises national efforts in the fight against dengue and reminds the public, people and private sectors on the value of working together. To mark this important event, we share an article by the National Environment Agency which provides an assessment of our current dengue situation and local outlook for the rest of the year.

We also have, under *Scientific Contributions*, two special articles of topical interest- one on novel field epidemiology training methods and the other on public health crisis management. In the former, we document the experience from Thailand and Singapore in the use of novel training methods while in the latter, the lead author who was with the Singapore field epidemiology training programme in 2010, relates his lessons for Singapore from his stint in WHO supporting the Ebola outbreak response. Their perspectives are helpful, for we must develop cross cutting skills in management and training as well.

There, you have it. Enjoy!

Steven

LEAD ARTICLE

Investigation into a *Salmonella* Enteritidis Outbreak Among Students and Staff of a Boarding School

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INTRODUCTION

In Singapore, food poisoning is caused by a variety of microorganisms and the symptoms are typically not severe. Most of the affected patients recover within a few days without treatment. In 2017, there were 347 notifications of food poisoning incidents involving 1,833 cases reported to the Ministry of Health (MOH). The number of notifications classified as outbreak (defined as two or more cases epidemiologically linked to a common source) in 2017 was 328, an increase from 192 outbreaks in 2016. The most common agents are *Salmonella*, *Shigella*, *Vibrio*, *Campylobacter*, norovirus and rotavirus.[1] Some bacteria such as Shiga-toxin producing *Escherichia coli* (STEC), *Bacillus cereus* and *Clostridium perfringens* produce toxins which cause the classic symptoms of gastroenteritis. These toxins are heat resistant and are not destroyed by reheating.[2]

Salmonella Enteritidis is one of the most common serotypes that causes *Salmonella* infections in humans. It has been widely reported that consumption of contaminated food, water and/or undercooked and raw poultry products is associated with human salmonellosis.[3] Food may become contaminated by infected food handlers, by cross contamination as a result of poor hygiene or faecal contamination of an infected animal or a person.[3] About 40-60% of food poisoning cases could be attributed to poor food handling practices.[4] We report herein our investigation into a *Salmonella* Enteritidis outbreak in a boarding school, associated with the consumption of a common meal.

METHODS

On 23 February 2017, MOH was notified of a cluster of 33 individuals from a local boarding school who developed gastroenteritis symptoms after consuming dinner provided at their school canteen on 22 February 2017. The next day, the total number of affected had increased to 75 individuals comprising 66 students and nine staff.

A case was defined as any previously well individual who attended or worked at the boarding school, and had diarrhoea at least twice within 24 hours and/or vomiting between 22 and 26 February 2017 after consuming the catered food in the school. By 27 February, a total of 86 individuals who met with our case definition were identified, comprising 80 students and six staff. In addition, there was an unverified report of a secondary transmission within the family of an affected staff.

Public health officials from MOH, National Environment Agency (NEA) and Agri-Food and Veterinary Authority (AVA) collaborated to conduct an environmental and hygiene inspection at the kitchen premises of the boarding school on 23 February 2017. Officials from Public Utilities Board (PUB) were also present to test the potable water sources for contamination. The school campus, including the boarding school, comprised of four 4-storey blocks and one 13-storey block. There were a total of 262 students and 22 adults (12 staff and 10 teaching assistants) in the boarding school.

The students ranged from 15 to 18 years of age, with the 15-year-olds forming the majority. All students and staff of the boarding school were provided with two meals (breakfast and dinner) on weekdays, and three meals (breakfast, lunch and dinner) on weekends and public holidays. The food was prepared by a catering company in the boarding school's kitchen. There were no special celebrations or events with congregation of students and staff between 20 and 23 February 2017. All the affected cases were found to have consumed food provided in the non-halal menus.

A structured, focused supplemental questionnaire was developed to collect detailed information on cases' clinical symptoms, onset of illness, movement and contact history, and exposure to specific meal and food items consumed. A total of 156 students (80 cases, 76 controls) were interviewed using the questionnaires about their exposures and food history in three days prior to the illness onset. After the interviews, 19 questionnaires were withdrawn because of incomplete data and case-control analysis was performed for 66 cases and 71 controls.

Seven stool samples from cases, seven food handlers at the kitchen premises, three food samples and four environment swabs, and water samples from two water sources were collected and sent to the National Public Health Laboratory (NPHL), the National University Referral Laboratories Pte Ltd (NRL), the AVA laboratory and the PUB laboratory respectively for bacteriological and viral analysis. Genotyping of *Salmonella* isolates from positive stool cultures was performed at NPHL, applying multiple-locus variable number of tandem repeats analysis (MLVA)[5] method. Seven variable number of tandem repeats (VNTR) loci selected for MLVA were amplified in a single multiplex PCR. The PCR products were then directly analysed using the QIAxcel High Resolution Kit, in combination with QIAxcel instruments.

RESULTS

The dates of onset of illness among 86 affected individuals ranged between 22 and 26 February 2017. Of the 86 cases, 11 were hospitalised and the remaining cases had either sought outpatient treatment or recovered without treatment. The reported symptoms included watery diarrhoea (97%, n=83), abdominal pain (88%, n=76), headache (73%, n=63), fever (59%, n=51), nausea (58%, n=50), and vomiting (41%, n=35). The epidemic curve is shown in Figure 1.

Two practices were observed to be unsatisfactory during inspection – (i) improper storage of ready-to-use condiments in an unutilised toilet; and (ii) faulty temperature gauge of a chiller. All food handlers including a part-timer were reported to be well in the week prior to the incident. The duration between cooking finished and food being served was found to be within four hours which is the time range for safe consumption. The process timeline for preparation, cooking and serving of each meal is shown in Table 1.

Figure 1. Epidemic curve of gastroenteritis symptoms among individuals from a boarding school from 22 to 26 February 2017 (N=86)

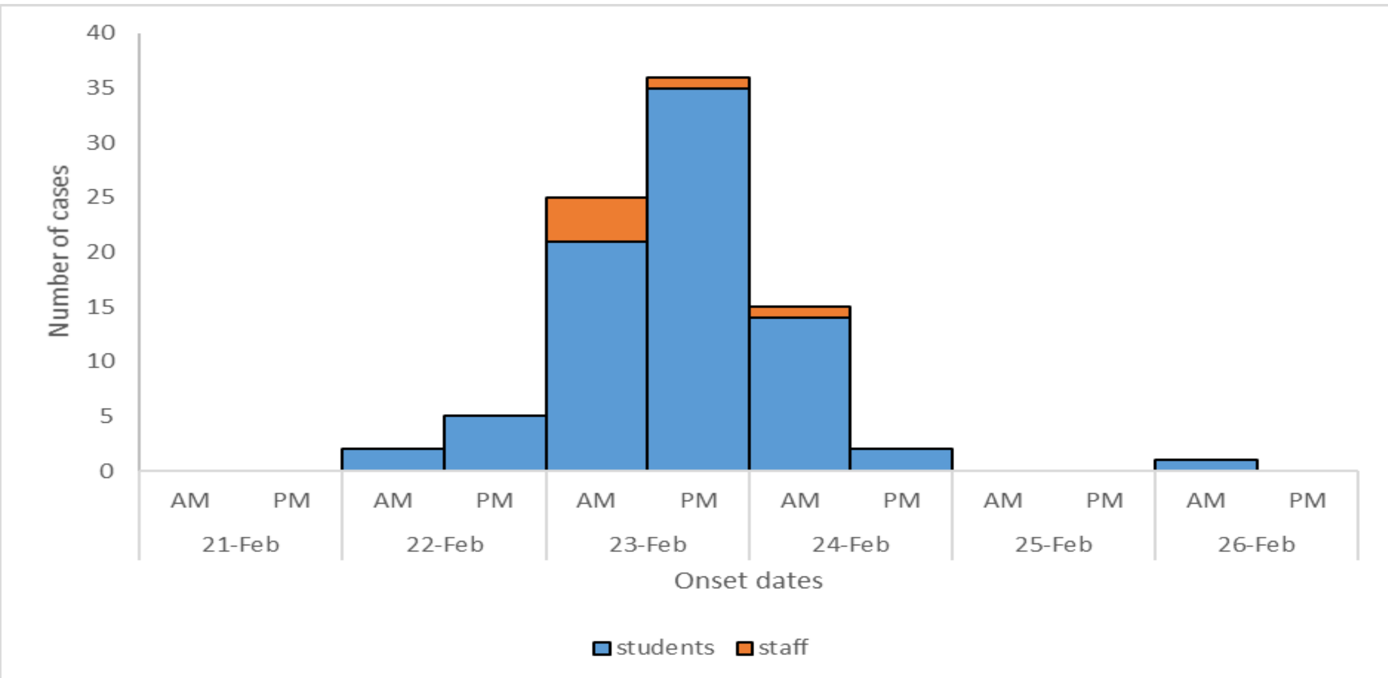

Figure 2. MLVA typing results of seven positive isolates

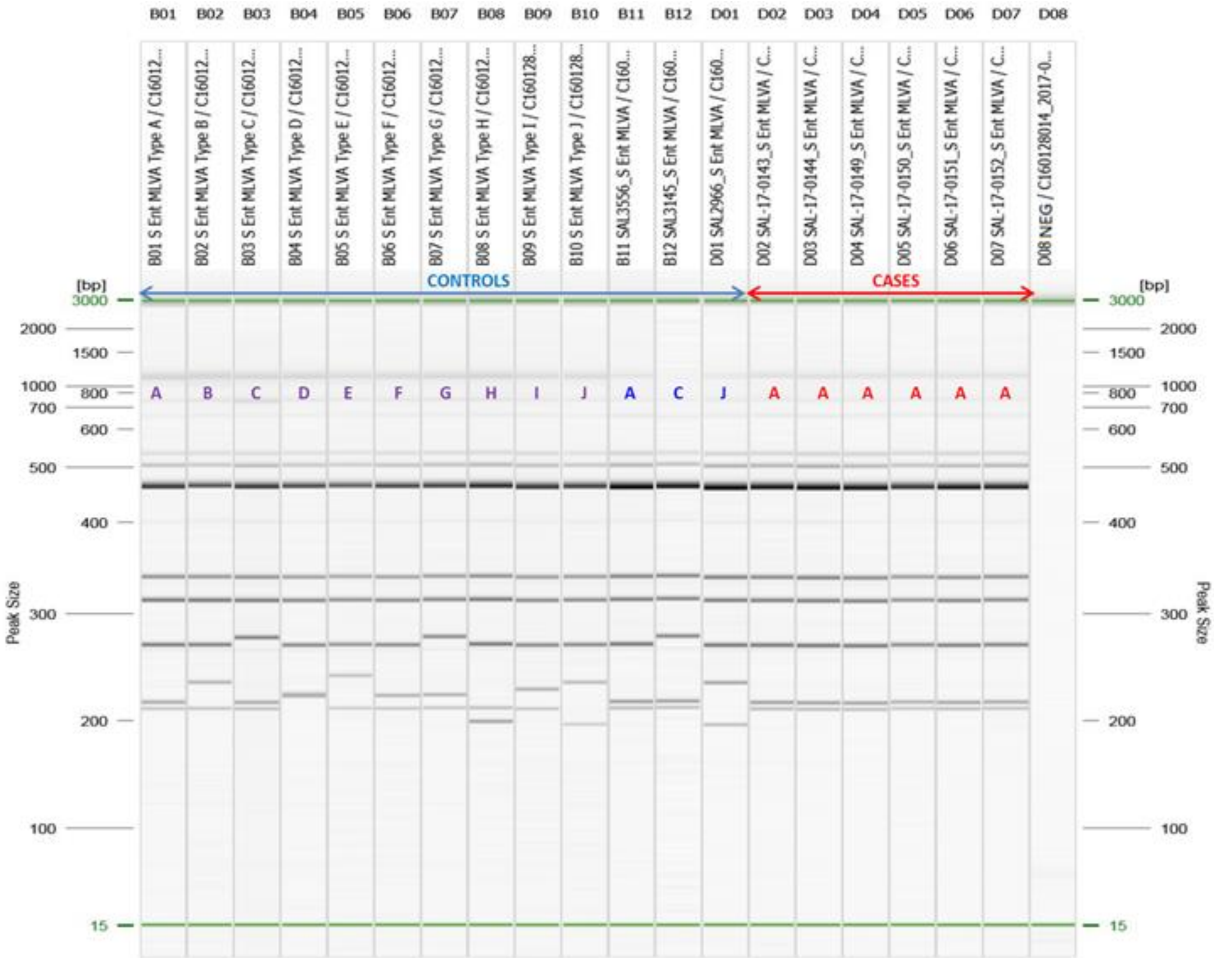

Table 1. Process timeline for the meals provided at the boarding school

Meals	Preparation	Finished cooking	Time served
Breakfast	0500h	0600h	0600 – 0730h
Lunch	1030h	1130h	1200 – 1330h
Dinner	1400h	1600h – 1700h	1730h – 1930h

Table 2. Laboratory results of food samples and environmental swabs

S/N	**Food samples**	**Results by AVA**
1	Fish Fillet with black bean sauce	Unfit (*Bacillus cereus* count 2.0×10^2 cfu/g)
2	Braised chicken with mushrooms	Satisfactory
3	Fragrant white rice	Satisfactory
S/N	**Swabs**	**Results by AVA**
1	Swab of cooked food cutting board	Unfit (*Bacillus cereus* count 9.9×10^3 cfu/g)
2	Swab of knife for cutting cooked food	Satisfactory
3	Swab of cutting board used for green vegetable	Satisfactory
4	Swab of cutting board used for raw meat	Satisfactory

Stool samples collected from seven cases were positive for *Salmonella*, including one case who also tested positive for *Campylobacter*. Further genotyping of the positive isolates showed that seven of the cases had *Salmonella* Enteritidis MLVA type A and were likely to be clonally related. Retrospective whole genome sequencing analysis corroborated with the MLVA findings and confirmed the clonal relationship within the cluster (Octavia et al., publication submitted). Figure 2 shows the gel electrophoresis image of the MLVA typing results.

All seven food handlers tested negative for food poisoning pathogens, *Clostridium perfringens*, norovirus and rotavirus. Water samples collected from two locations, high level water tank and kitchen tap points at the school canteen, were found to be chemically and bacteriologically satisfactory. The results of the food samples and four environmental swabs are summarised in Table 2.

In our case-control study, mean age and gender distribution were comparable between cases and controls. Our analysis showed that while all meals (except 21 February breakfast) consumed in three days prior to 23 February were significant, consumption of dinner on 22 February had the strongest association with the illness. The odds of being a case was higher for individuals who had consumed dinner on 22 February 2017 than those who did not (OR: 19.3; 95% CI: 5.54 – 67.2). The findings are provided in Table 3.

Table 3. Meals consumed by cases and controls between 20 and 22 February 2017

	Cases (n = 66)	Controls (n = 71)	Odds Ratio	95% C.I.
Age range	14 - 23	14 - 21	-	-
Mean Age	16	16	-	-
Gender	62 males 4 females	67 males 4 females	-	-
Date and meal consumed				
Breakfast on 20 Feb (Mon)	52 (79%)	44 (62%)	2.28	1.07 to 4.87
Dinner on 20 Feb (Mon)	60 (91%)	44 (62%)	6.14	2.33 to 16.13
Breakfast on 21 Feb (Tues)	50 (76%)	44 (62%)	1.92	0.92 to 4.02
Dinner on 21 Feb (Tues)	57 (86%)	42 59%)	4.37	1.87 to 10.21
Breakfast on 22 Feb (Wed)	50 (76%)	41 (58%)	2.29	1.10 to 4.76
Dinner on 22 Feb (Wed)	63 (95%)	37 (52%)	19.30	5.54 to 67.24

DISCUSSION

Our investigation identified an outbreak of *Salmonella* Enteritidis among individuals from the boarding school, which was strongly associated with the consumption of meals prepared by an external catering company at the school premises. Seven cases were positive for *Salmonella* Enteritidis MLVA type A and the presence of clonally related strains pointed towards a common source infection among the cases. The incubation period of 6 – 96 hours and reported symptoms of diarrhoea, abdominal pain and fever by the cases were compatible with salmonellosis.

Common food sources of *Salmonella* are meat, poultry, eggs and dairy products. Cross-contamination between handling of raw and cooked food and/ or consuming partially cooked food are often the common causes of transmission and outbreaks. Cross contamination events from poor handling practises such as use of the same cutting board for poultry meat and ready-to-eat food without immediate cleaning, or spreading of pathogens via contact with the kitchen environment seem to be of greater risk than the risk associated with undercooking of poultry meat or eggs.[6]

While there were no major hygiene lapses noted, one food sample and environmental swab had failed food hygiene standards (*Bacillus cereus* detected) which were suggestive of poor food handling practices and hygiene. Moreover, keeping a trolley of condiments in an unutilised toilet was indicative of unhygienic storage practices of food items. Fried eggs and curry chicken, common sources of *Salmonella*, were among the food items served during dinner on 22 February. However, a significant number of cases did not complete the information on the individual food item consumed for each meal, we were unable to draw any meaningful conclusion on the implicated food item(s).

There were a number of limitations to our study. Some cases were unable to recall the type of food items consumed during the period of interest in our survey, potentially introducing recall bias. While we had acted promptly during this investigation, the food items sampled were not from the implicated meals and served as a proxy for food and environment hygiene practices of the food handlers. In addition, there were no retention/ residual food samples from the possible implicated meals between 20 and 22 February 2017.

As the caterer had been informed of this incident by the school, the kitchen premises might have been cleaned thoroughly prior to our inspection.

In conclusion, this is a common source outbreak of *Salmonella* Enteritidis involving individuals from the boarding school who had consumed meals prepared on 20-22 February 2017 at the premises.

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SCIENTIFIC CONTRIBUTIONS

Review of the Dengue Situation in Singapore

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INTRODUCTION

A total of 2,772 dengue cases were reported in 2017, which was one fifth of the number of cases in 2016. In spite of the improvement in diagnostics and the increase in notifications over the years, the number of dengue cases reported in 2017 was the lowest in 16 years since 2001 when 2,374 dengue cases were reported. The low dengue incidence observed in 2017 may have been contributed by a combination of factors, namely 1) herd immunity towards the predominant serotypes dengue virus 1 (DENV-1) and dengue virus 2 (DENV-2) after several years of outbreaks since 2013; 2) a low dengue baseline in the beginning of the year; 3) removal of adult *Aedes aegypti* from community through islandwide Gravitrap surveillance; and 4) low virus diversity. Based on the Environmental Health Institute's (EHI) dengue model, we anticipate that 2018 may see a similar number of dengue cases as with 2017. However, although 2017 ended with a relatively low number of dengue cases, we have been observing a persistently high *Aedes aegypti* population as we enter 2018. Efforts in arresting the escalation of *Aedes aegypti* population is critical in avoiding a surge in cases.

DENGUE SITUATIONAL REVIEW

Low number of dengue cases in 2017 part of cyclical epidemic pattern

2017 was a lull year for dengue in Singapore following several outbreak years, and this is consistent with historical trends. Since 2013, Singapore has been experiencing a similar epidemic pattern as the decade before. Comparison of the epidemiological trend of 2004-2012 (1st cycle) and 2013-2017 (2nd cycle) showed a cyclical epidemic pattern that oscillated between DENV-1 and DENV-2 as predominant serotype.[1] As illustrated in Figure 1, the DENV-1 outbreaks in 2013 and 2014 coincided with that of 2004 and 2005. Following the DENV-1 outbreaks was a period of lull year in 2006 and 2015 respectively, probably due to cross protection caused by the earlier outbreaks.[2] In 2007 and 2016, there was a switch in the predominant serotype from DENV-1 to DENV-2 which resulted in DENV-2 outbreaks. Following the epidemiological trend of the first cycle, 2017 was expected to be a DENV-2 lull year with low dengue incidence like in 2008. The high seroprevalence of IgG antibody against the predominant serotype - DENV-2, could be a contributing factor to the low number of dengue cases. Studies conducted in collaboration with Health Science Authority in 2009 and 2013 have shown that Singapore population (age between 16 and 60 years) had the highest seroprevalence towards DENV-2, amongst the four dengue serotypes[3] (Table 1). The serotype specific seroprevalence for DENV-2 was 47.8% in 2009 and 42.4% in 2013.

A low base of dengue cases in the beginning of the year

Singapore experienced hotter than usual weather in 2016 due to the effects of a very strong El Niño in 2015. The sustained high maximum temperature in the first of half of 2016 coincided with a drop in mosquito population.[4] Coupled with the early launch of the annual "Mozzie Wipeout" campaign in February, there was a steady decline in dengue cases from 2,429 cases in January to 1,015 cases in June (Figure 2). Dengue cases were further suppressed to lower levels following the Zika outbreak in September when a second national campaign was carried out and intensive vector control measures were stepped up. As a result of the concerted efforts made by all stakeholders, 2016 ended with a low dengue baseline and hence, allowed 2017 to start with a low base of dengue cases at a weekly average of 68 cases between E-weeks 1 and 8. This was significantly lower than in the same period in 2015 and 2016 when the average weekly number of cases was 205 and 559, respectively.

Figure 1. Weekly serotype distribution and number of dengue cases, 2014 to 2017

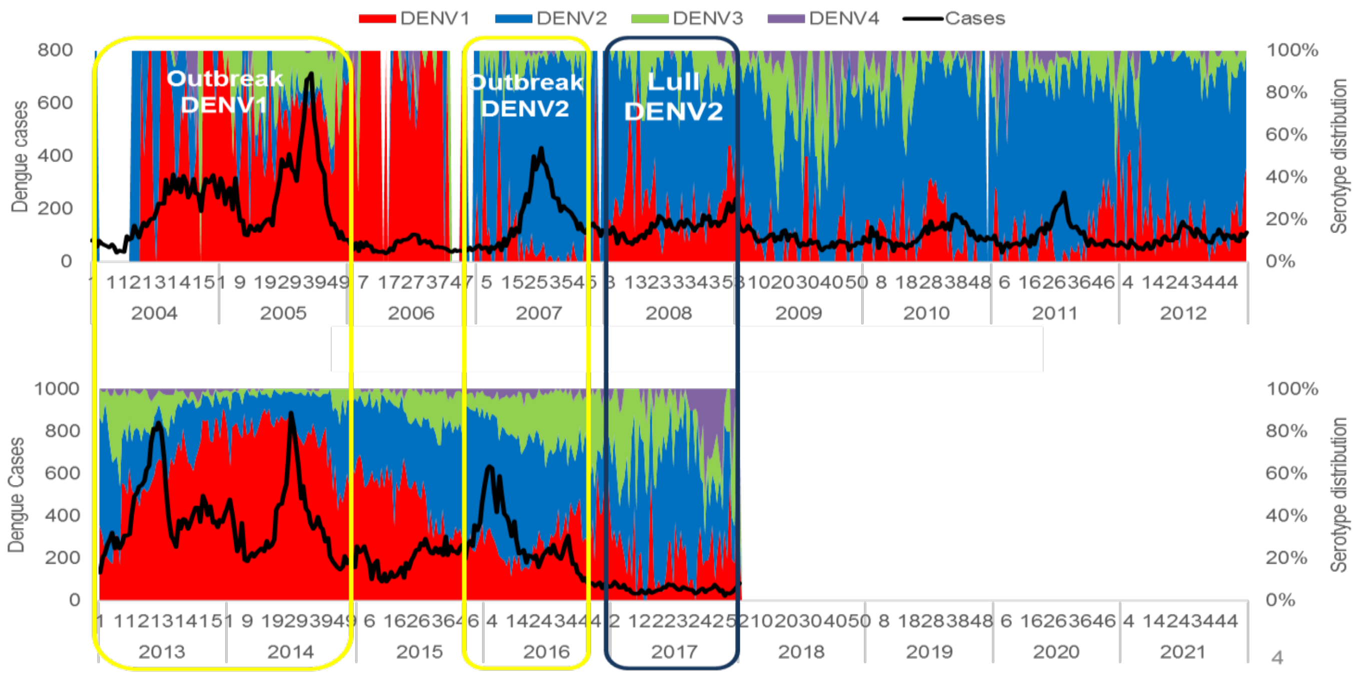


Table 1. Dengue serotype specific prevalence in 2009 and 2013

	DENV-1	DENV-2	DENV-3	DENV-4
Estimated for age group 16 to 60 years old				
2009	41.90%	47.80%	24.70%	16.00%
2013	39.00%	42.40%	14.00%	7.10%

Note: Prevalence to each DENV serotype was adjusted to the Singapore resident population of the respective new year.

Source: Low SL, Lam S, Wong WY et al. Dengue seroprevalence of healthy adults in Singapore: serosurvey among blood donors, 2009. Am J Trop Med Hyg 2015; 40-45.

Removal of adult *Aedes aegypti* through islandwide Gravitrap surveillance

Designed and developed by EHI, Gravitraps, which lure and trap gravid female *Aedes* mosquitoes, are used as a surveillance tool by the National Environment Agency (NEA) to monitor the spatio-temporal variability of the adult *Aedes* population in Singapore.[5] Since September 2015, NEA has progressively deployed Gravitraps across all high-rise apartments (HDB) in Singapore under the islandwide Gravitrap surveillance programme. As of 2017, more than 50,000 Gravitraps were deployed across 8,000 HDB blocks. The implementation of the islandwide Gravitrap surveillance programme has removed a substantial amount of Aedes mosquitoes from the community. In 2017, over 170,000 adult female *Aedes aegypti* were removed through NEA's network of Gravitraps deployed across the island, twice the amount in 2016 (Figure 3). Prior to the nationwide deployment, pilot deployment of Gravitraps was first carried out at 34 sentinel sites across the island to assess its effectiveness. Analysis of 3 years of data from the sentinel sites showed that there were significantly fewer dengue cases in the 34 sentinel sites after Gravitraps were deployed. Based on Before-After Control Impact[6] (BACI) analysis, there was a 30% reduction ($P < 0.05$) in case burden in the sentinel sites (EHI, unpublished data), when compared with control sites. The removal of *Aedes* mosquitoes by NEA's network of Gravitraps may therefore be a contributing factor to the low dengue incidence in 2017.

Lower virus diversity and importation of new strains

DENV surveillance programme was enhanced in 2015 to include samples from polyclinics and private laboratories, in addition to those received

Figure 2. Weekly number of dengue cases in 2016 and 2017

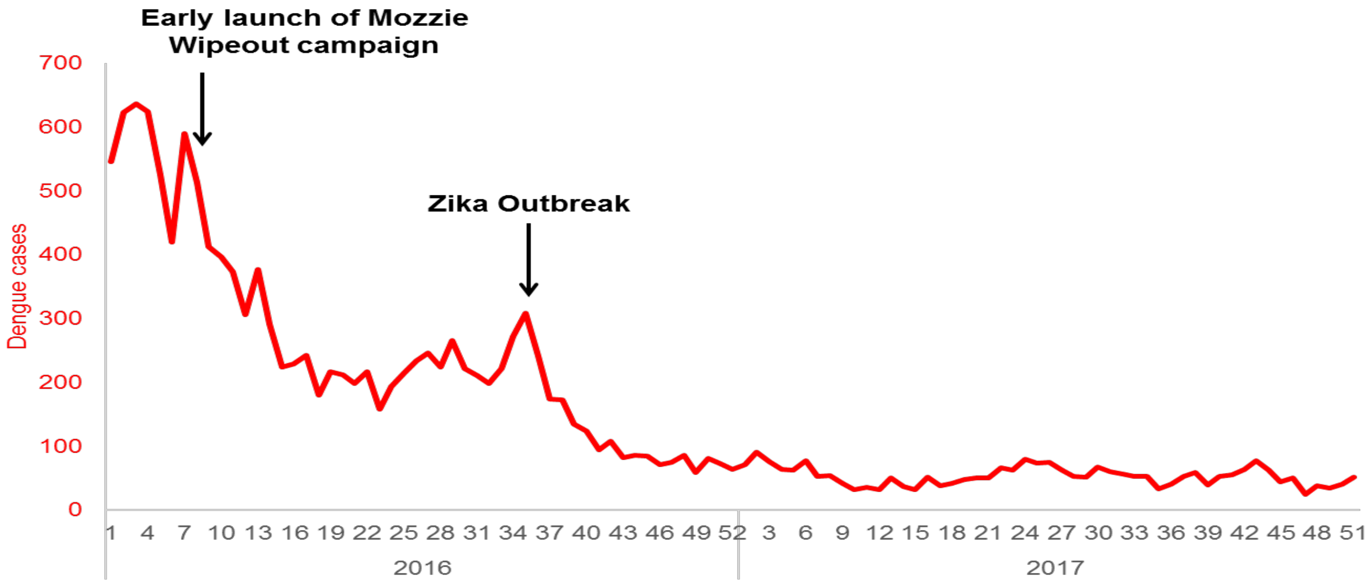
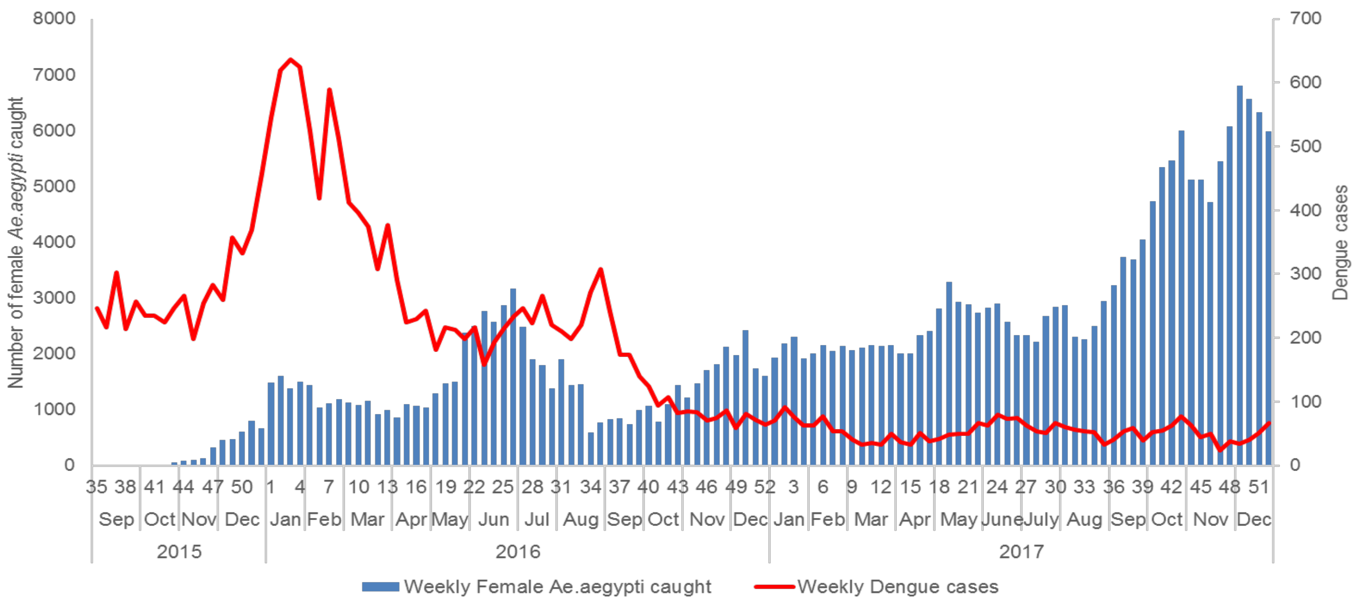


Figure 3. Monthly dengue cases and female *Ae.aegypti* caught, September 2015-December 2017



through an islandwide general practitioners' network operating since 2006. Since then, annual DENV genotyping coverage has increased to approximately 20% of total reported cases. In comparison, annual genotype coverage before 2015 was below 8% of total reported cases. Despite having higher coverage of cases, genotype surveillance showed 83% and 108% reduction in the overall virus diversity in 2017 as compared to 2015 and 2016 respectively (Figure 4). Moreover, the number of new strains detected in 2017 (n=80) dropped by 88% and 113% as compared to those recorded in 2015 and 2016 respectively. The number of uncommon virus strains in 2017 was around 40% less than that detected during the 2015-2016 period, indicating a substantial reduction in virus introductions. This was even more obvious in DENV-2, the dominant serotype since 2015. DENV-2 population in 2017 was highly homogeneous, with 86.2% dominance of cosmopolitan clade Ib lineage. Based on the observations made during the 2013 epidemic, we have previously shown that virus diversity, especially within the dominant serotype, strongly and positively correlated with dengue incidence in Singapore.[7] Therefore, it is plausible that reduced viral diversity and introductions are one of the contributing factors for the low dengue case load in 2017.

Figure 4. Annual numbers of circulating viruses and new viral strains, 2011-2017

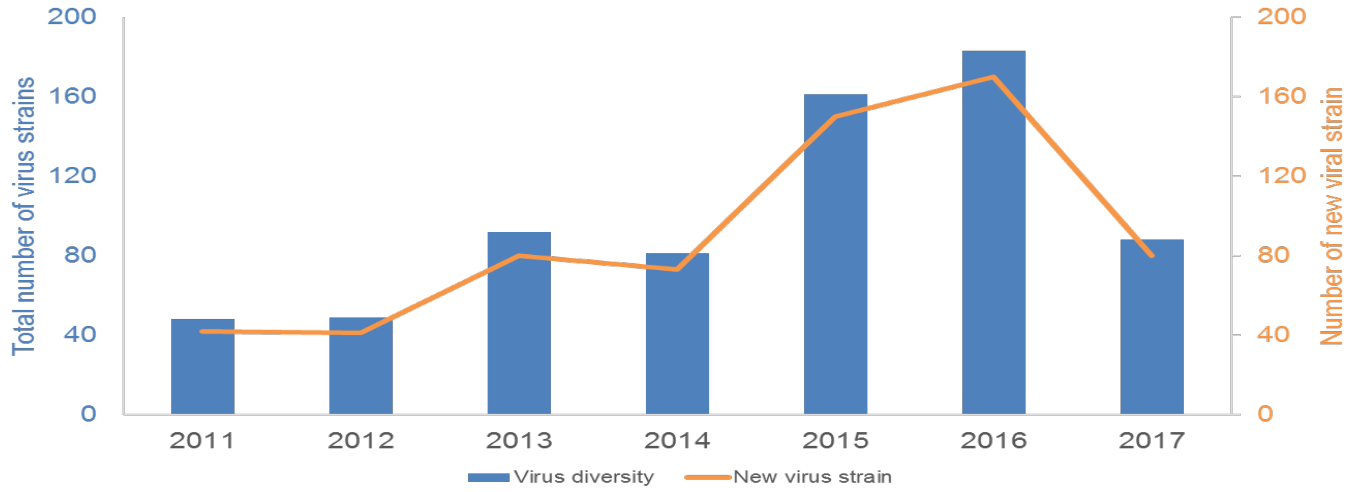
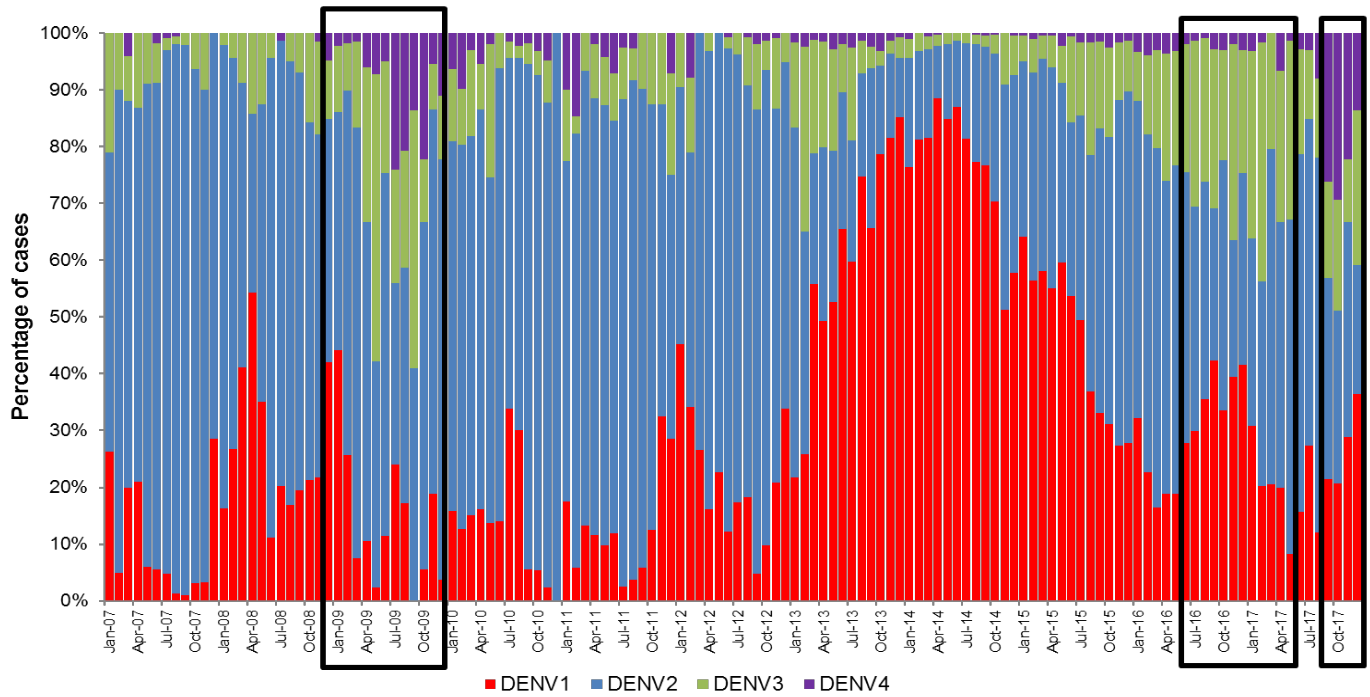


Figure 5. Monthly distribution of dengue serotypes, January 2007-December 2017



DENGUE OUTLOOK FOR 2018

There is no signal of an outbreak in 2018. Fluctuation in the serotypes distribution has been observed since September 2017. The lack of serotype dominance observed is typical of lull periods. Singapore experienced a similar situation in 2009, between December 2011 and February 2012, and from May 2016 to May 2017 (Figure 5). Figure 6 shows the dengue forecast for 2018 based on EHI/National University of Singapore (NUS)'s dengue model.[8] The dengue model was developed using historical dengue cases, vector surveillance data, meteorological data, population-based national statistics. The seasonality and trend of DENV-2 years (2008-2012) were used to generate the forecast. The dengue model indicated that if there were no serotype switch in 2018 (i.e. following the epidemiological pattern of post outbreak years of 2008-2012) and if Gravitraps remained effective in removing mosquitoes, the total number of dengue cases in 2018 may be similar to 2017.

However, there is a key concern over the persistently high vector population seen in the last few months. The

Figure 6. Projection of dengue trend for 2018

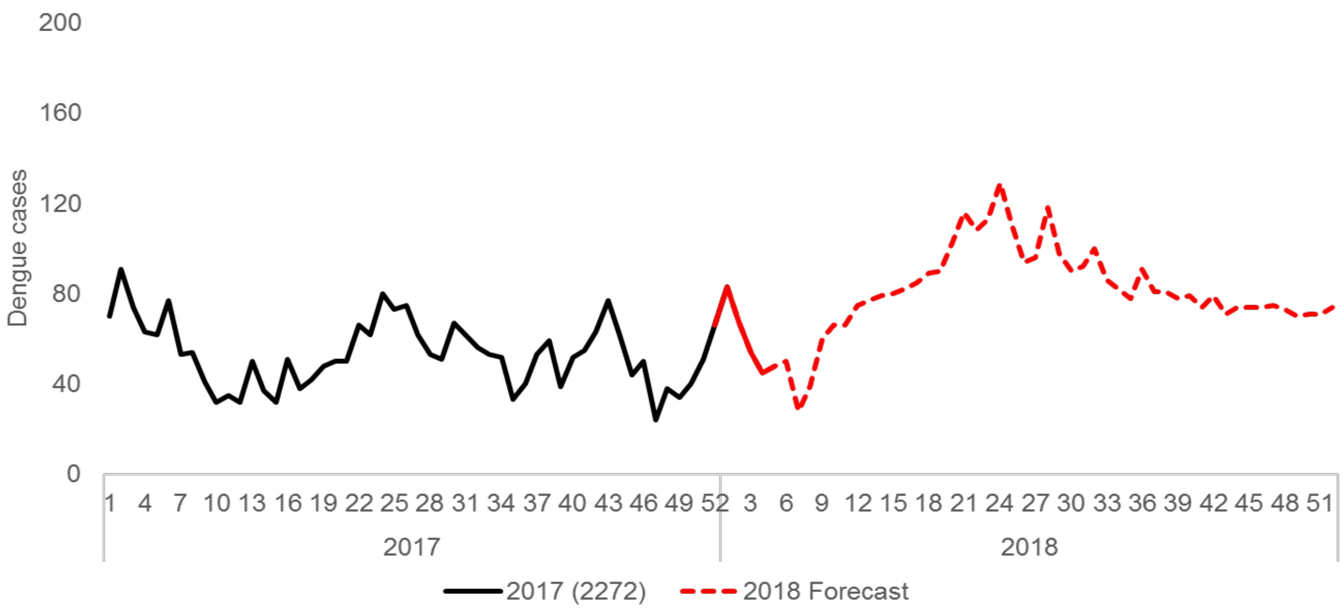
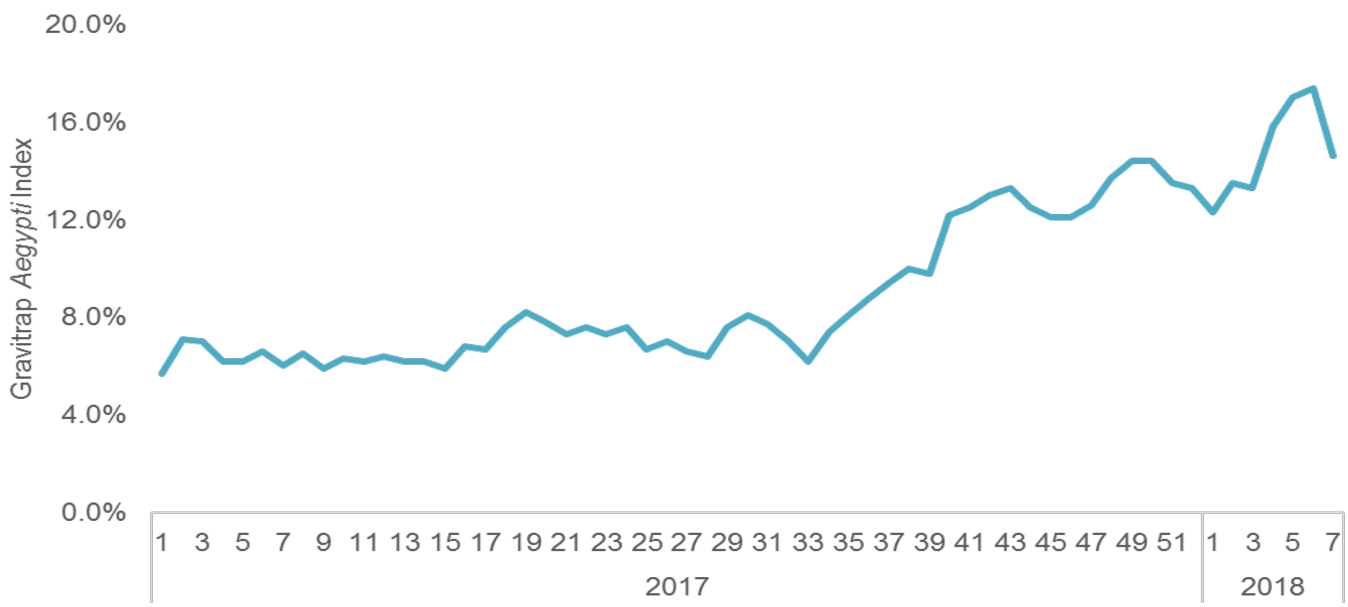


Figure 7. Weekly nationwide Gravitrap *aegypti* index from week 1 of 2017 to week 7 of 2018



islandwide Gravitrap surveillance detected an upward trend in the *Aedes aegypti* population since E-week 33 of 2017 (Figure 7). Since E-week 1 of 2018, the Gravitrap *aegypti* index has been hovering around 14%. This was more than twice that of the same period in 2016 (6.0%) and 2017 (6.4%), indicating a high abundance of vector population within the community.

While the current number of dengue cases is relatively low, and we are cautiously optimistic about the dengue situation in 2018, concerted efforts are needed to reduce or prevent the further rise of the *Aedes* mosquito population.

CONCLUSION

Our risk analysis suggests that there is no signal of an outbreak in 2018. Though dengue cases are currently low, the risk of a dengue outbreak still remains. *Aedes* mosquito population and transmission of vector-borne diseases are sensitive to weather and climatic conditions. The projected changes in our climatic conditions may further favour the breeding of *Aedes* mosquitoes which poses a threat not only to dengue, but also to the transmission of other arboviruses like chikungunya and Zika. Since 2017, NEA has put in place an adult mosquito surveillance system using

Gravitraps. This is part of an enhanced dengue control programme which includes risk based pre-emptive checks where NEA focuses its inspections on areas with high *Aedes* mosquito population.[9] As Singapore continues to face further challenges related to factors such as climate change and population density, the *Wolbachia* technology is being explored to complement current dengue prevention and control strategies.[10]

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SCIENTIFIC CONTRIBUTIONS

Regional Experience in Use of Novel Field Epidemiology Training Methods

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INTRODUCTION

In response to the growing threat and complexity of public health emergencies of international concern in the Western Pacific and Southeast Asian regions, the Association of South East Asian Nations (ASEAN) Plus Three Countries (China, Japan, Korea) formed a network known as the Field Epidemiology Training Network to build both national and regional capacity in field epidemiology through strengthening skills training.[1] Many field epidemiology training programmes (FETPs) have evolved systems independently[2-4] and a dearth exists in documentation on the effectiveness of learning methods used to meet our respective practical needs.[5]

At the eighth Steering Committee meeting of the ASEAN+3 Field Epidemiology Training Network in May 2017, members proposed inclusion of thematic sharing of capacity building lessons and innovations in training as part of the exchange of learning experiences in our annual meetings. This is to address the challenging task of future-proofing public health and training a new millennial workforce in surveillance, epidemiology and response.[6,7] Novel training methods have been introduced and we report our early findings in case study examples.

APPROACH

With the mandate to strengthen our training methods, the authors began a twinning project between the Singapore and Thailand FETPs to exchange insights on how to create the conditions for an engaging and captivating learning experience.[8] An FETP trainee is typically expected to learn field epidemiologic methods in investigating outbreaks, evaluating the surveillance system, conducting simple studies, and being competent with public and scientific communications. To support the conventional training, we introduced edutainment, a mix of education and entertainment that harnessed multimedia such as movies, comics, games and cosplay to make the encounters less burdensome and more enjoyable.[9,10]

Our experimental methodology could be applied in five basic steps:

- Step 1: Determine the learning needs of the audience and understand their demographic and professional background
- Step 2: Set up the immersive experiences that best fit their learning needs, and deploy appropriate multimedia that suit the audience profile
- Step 3: Establish balanced groups that optimise participation and exchange of different viewpoints (by profession, age, gender, etc.)
- Step 4: Build in the experiential learning through interactions and robust discussion
- Step 5: Conclude with the takeaway messages on the learning experience

In delivering each module, we had to recognize that the trainees possessed varied learning styles.[11] They include: the pragmatist who is keen to try out new ideas to see if they work in practice; the activist who is open-minded and enthusiastic about anything new; the reflector who likes to stand back to ponder experiences from all perspectives before coming to conclusion; and the theorist who integrates observation into theories and thinks problems through in a logical way. From their feedback, we continue to learn about the pros and cons of each module.

CASE STUDY FINDINGS

We established a virtual public health Survivor School and presented the FETP curriculum as a two year Survivor course. The emphasis on experiential learning was put forward in creative ways, such as having a minifigure assistant named Debby (Figure 1) bring trainees on a "L.E.G.O." journey which focuses on four key themes:

- **Leadership perspective** – acquiring the right leadership values and attitude
- **Environmental public health** – understanding physical and behavioural determinants
- **Global health matters** – responding to emergencies and regional threats
- **Outbreak management** – developing disease control and communication skills.

Along the journey, we used lego bricks ("building capacity, block by block"), catchy themes such as SARS Wars and Leadership by Comic Books, and were also not averse to our course Survivors morphing into heroes (Figure 2).

As examples of experiential learning, trainees might study surveillance evaluation through an immersive game of Snakes-and-ladders! in which they have to participate in group work and answer epidemiology questions as well as face penalties (eg, stand under a filled balloon and prick it) in a mad scramble to the finish. In another game, Heads-up! which encouraged reading, each team chooses a leader who must read and describe subjects to the team without mentioning any of the words (Table 1). Based on these descriptions, the winning team has a minute to come up with the most correct answers. True to our use of multimedia, we made available handouts in the form of newsletters, and supplementary lessons online through e-mails from Debby.

Figure 1. Debby, our training assistant

Figure 2. Clockwise: Trainee superheroes from Thailand and Singapore; enjoying a foodborne fun exchange; learning through a *Snakes-and-ladders!* game

More home-grown creative ideas are being incubated, including public health discovery trails (e.g. food-borne fun exchange), a survey on what values field epidemiologists embody, and the Survivors reality show. To be critical, these methods are much more resource intensive than the didactic approach. Moreover, if not administered with good takeaway messages, participants could get carried away by the fun factor. As intangible benefits, we noted change in some trainees, such as overcoming of shyness, strong teamwork and respect for each other, and trust-building. We were also encouraged by the fact that ASEAN+3 steering committee members observed some of our learning methods and have endorsed our superhero training motto ("saving millions through public health, one life at a time"). More scientific

Table 1. Subjects used in the reading material game of *Heads-Up!*

1. Specific Precautions • *Personal protective equipment* • *Contact precautions* • *Hand hygiene* • *Environmental cleaning* • *Negative pressure room* • *Sterilization* • *Droplet precautions* • *Universal precaution* • *Isolation room* • *Airborne precautions*	**2. Diseases** • *Tuberculosis* • *Chickenpox* • *Zika* • *Measles* • *Avian flu* • *Hepatitis* • *Dengue* • *Nipah* • *AIDS* • *Rabies*
3. Infection Prevention & Control Practices • *Hand hygiene* • *Prophylaxis* • *Surveillance* • *Disinfectants* • *Audits* • *Vaccination* • *Respiratory etiquette* • *Contamination* • *High touch areas* • *Cohorting*	**4. Multi Drug Resistant Organisms** • *Vancomycin resistant Enterococcus* • *Antimicrobial stewardship* • *Carbapenem resistant Enterococcus* • *Carriers* • *Gram positive cocci* • *Extended spectrum β-lactamases* • *Penicillin* • *Methicillin resistant Staphylococcus aureus* • *Meropenem* • *Hand hygiene*
5. Prevention of Dialysis-associated and Surgical Site Infections • *Catheter associated urinary tract infection* • *Antimicrobial therapy* • *Hospital acquired pneumonia* • *Intubation* • *Colonization* • *Decontamination* • *Debridement* • *Chlorhexidine* • *Staphylococcus aureus* • *Surgical site infection bundle*	**6. Outbreak Management** • *Incubation period* • *Surveillance* • *Notification* • *Epidemiologist* • *Attack rate* • *Monitoring* • *Outbreak* • *Post exposure prophylaxis* • *Contact tracing* • *Isolation*

Table 2. Participant responses on pros and cons of novel methods used

Thailand

- *"Can achieve learning objectives through fun activities."*
- *"Fully engaged to the learning activities."*
- *"Checked own understanding through group discussion and easily corrected own understandings."*
- *"Generation gaps may affect the novel training methods e.g. baby boomer need longer time for ice-breaking and sharing in group discussion."*

Singapore

- *"Unconventional teaching methodology."*
- *"Creative lessons that can surprisingly stick in students' memories without a need to learn hard."*
- *"My horizons were broadened."*
- *"The whole module was so fun and the learning experience extremely pleasant."*

ASEAN+3

- *"My thanks to 'Debbie' for taking the lead on developing this."*
- *"We really felt the energy of you and your FETP team."*
- *"May your tribe increase."*
- *"Your high quality work is highly appreciated."*

evaluation of results is needed but early responses to our novel methods have been anecdotally promising (Table 2).

COMMENTS

We have reported preliminary findings from our unique experiments with inclusion of novel training methods to augment the teaching of field epidemiology. This report comes within a year since our twinning project started and it is still too early to conclude on any outcomes without proper study design and evaluation. Nonetheless, the findings suggest that our trainees have benefited from experiential learning which is more immersive than the conventional hearing, seeing and doing. We are exploring how best to help them retain more knowledge and skills easily because it's not so much what we teach but what they actually pick up that is important. Public health education need not be humourless and should rightly be viewed as a lifetime process which involves understanding of our core values and becoming responsible for our own progress.

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Short Report:

Practical Lessons for Singapore in Public Health Crisis Management

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INTRODUCTION

The World Health Organization (WHO) declared the 2014 Ebola Virus Disease (EVD) outbreak in West Africa as a Public Health Emergency of International Concerns (PHEIC) on 6 August 2014.[1] The EVD outbreak, which began in December 2013 in Guinea, West Africa, was the largest, longest, most complex EVD outbreak on record.[2] Widespread and intense transmission devastated families and communities, compromised essential civic and health services, weakened economies and isolated affected populations. The outbreak also put enormous strain on national and international response capacities, including WHO's outbreak and emergency response structures. WHO called upon experts from international partners, including Global Outbreak Alert and Response Network (GOARN) to support the affected countries' outbreak control measures. In October 2014, Dr Margaret Chan, then-WHO Director-General made a request to Singapore for technical assistance in WHO's led EVD outbreak response efforts.

Given the uncertainty then over how the EVD outbreak would evolve globally and to demonstrate Singapore's continued commitment to global health security, the Ministry of Health (MOH) seconded one staffer (JT) to WHO Headquarters in Geneva, Switzerland to be part of the Ebola Response Team in 2015-16. JT's role as a Technical Officer was to provide assistance and technical input, supporting the EVD outbreak response in the area of laboratory data management, epidemiology and surveillance. The international impact, rapid widespread transmission, and reporting delays during the EVD outbreak highlighted the need for a global, centralized database to inform outbreak response.[3] We report herein learning points from the secondment focusing on the International Health Regulations (IHR) (2005), and organisational and crisis-management lessons for Singapore's public health system.

INTERNATIONAL HEALTH REGULATIONS (IHR) (2005)

The IHR (2005) is an international legal instrument that governs the response of Member States of WHO during public health emergencies, including infectious diseases outbreaks, both within a country and across international borders.[4] The objective of the IHR is "to prevent, protect against, control and provide a public health response to the international spread of disease in ways that are commensurate with and restricted to public health risks, and which avoid unnecessary interference with international traffic and trade." This is binding on all WHO Member States and requires them to achieve IHR core capacities in surveillance, preparedness and response to public health threats, as well as to report such events to WHO in a timely manner. WHO can only officially respond to an outbreak if it is kept informed through the IHR platform. Since IHR entered into force in 2007, the track record has not been optimal. Three main reasons have been identified: (i) States Parties' poor compliance with building of core capacities; (ii) States Parties' imposition of measures, such as restrictions on travel or trade, that go beyond temporary recommendations issued by the IHR Emergency Committee, and the lack of a mechanism for WHO to promote compliance with recommended measures; and (iii) the absence of a formal alert level of health risk other than declaring an event a PHEIC.

A Review Committee appointed by the WHO Director-General in 2015 evaluated the role of the IHR in the EVD outbreak and response. In its report to the 69th World Health Assembly (WHA) in May 2016,[5] the Committee highlighted that deficiencies in the global response towards the Ebola outbreak were reflective of those identified in the review conducted in 2010, post influenza pandemic H1N1 (2009).[6] The Committee pointed out that many of the recommendations put forth in the 2010 review were not implemented to-date. As a Member State, Singapore has been compliant to the IHR obligations. While we continue to honour our commitment to international health, we must not forget that not all Member States have the capacity or are willing do so. We should keep abreast of the limitations of IHR and be cognizant that it is unlikely the global health security situation will improve significantly in the near term without countries making an effort to instil changes.

ORGANISATIONAL AND CRISIS MANAGEMENT LESSONS

#1: Beware mission creep without resources

Since its inception in September 1948, WHO has progressively expanded its role from an agency coordinating technical guidelines and standards to providing technical assistance and limited aid to countries with health and humanitarian emergencies. However, the additional tasks entrusted upon WHO have for a long time, exceeded the budget that Member States were willing to provide. As a result, WHO has had to rely increasingly on voluntary contributions. The 2014 EVD outbreak started at a time when WHO was and still is struggling with the effects of budget slashes and staff reduction. This is notwithstanding that WHO was also simultaneously dealing with the Middle East respiratory syndrome coronavirus (MERS-CoV), avian influenza A(H7N9) and poliovirus responses at the same time. With barely adequate resources, mission creep became a glaring constraint. An organisation cannot be expected to fulfil ever-increasing mandates, no matter how well-intended they may be, if these are not backed with resources provided in a timely manner.

#2: Establish clear lines of accountability

WHO consists of the headquarters in Geneva, Switzerland and six regional offices across the world. The Regional Director (RD) is elected through a regional committee composed of Member States. This unique organisational structure does not work well in reality; the independence of regional offices demonstrated through Member States nominating its RD has been singled out as one of the issues holding WHO back in terms of effectiveness, efficiency and coherence as an organisation, observed as early as in 1993.[7]

As an organisation expands in size, the issue of command and control becomes increasingly important, particularly during crisis. For context, WHO has 149 offices in different countries, territories and areas, six regional offices and the headquarters in Geneva. This makes WHO the largest network of all United Nation (UN) agencies. Parallels can be drawn for Singapore in terms of an organisation characterised by a headquarter overseeing its 'branches' and ultimately being held accountable for their actions. In outbreak response, proper accountability in command and control is one important cornerstone of the crisis management framework.

#3: Expect surprises during crisis management

WHO's value-add during the control of epidemic and pandemic lies in its ability to mobilize experts internationally and to provide evidence-based advice during outbreaks and emergencies. WHO grades protracted emergencies into four levels according to the level of operational response required, and the levels are: (i) Ungraded, (ii) Grade 1, (iii) Grade 2 and (iv) Grade 3.[8] At its peak, WHO was handling six Grade 3 emergencies (conflicts in Syria, Iraq, South Sudan and Central Africa, Ebola outbreak in West Africa, earthquake in Nepal) and two Grade 2 emergencies (conflicts in Yemen and Ukraine)[8]. In its current form, WHO is finding it difficult to perform adequately as an operational response agency to so many major emergencies. WHO had in place an Emergency Response Framework but this was severely stressed in the unprecedented nature of an EVD outbreak and several concurrent emergencies.[8] The reasons for WHO's inability to cope included: (i) the framework being more humanitarian emergencies-oriented, (ii) inadequately resourced and (iii) command and control issues mentioned above.

The 2014 EVD outbreak has shown once again that outbreaks and predictability do not go hand-in-hand. We will and should plan and be prepared for pandemics; informed by science and tempered with judgement on the degree of contingency/'surge' acceptable. We cannot take for granted that the systems we have in place will be able to meet all future crises. We can expect surprises but continuous vigilance and preparedness together with rapid response can prevent further escalation.

CONCLUSION

Global health today is volatile and complex in an increasingly ambiguous environment. As public health practitioners and policy makers, we must develop cross cutting skills, going deep and yet also wide because there are so many opportunities for productive work in disease prevention and control. Our approach to problem solving needs to shift away from avoiding uncertainty to actively engaging uncertainty and demonstrating higher levels of leadership agility. The views shared here are merely our perspectives on the problem and do not reflect any official consensus. Nonetheless, we hope the lessons for us here can help in a world where many threats to public health exist.

Editor's Note: Our lead author of this article, Junxiong Teo, was a trainee with the Singapore field epidemiology training programme in 2010. He was seconded for one year to the WHO from January 2015 to January 2016.

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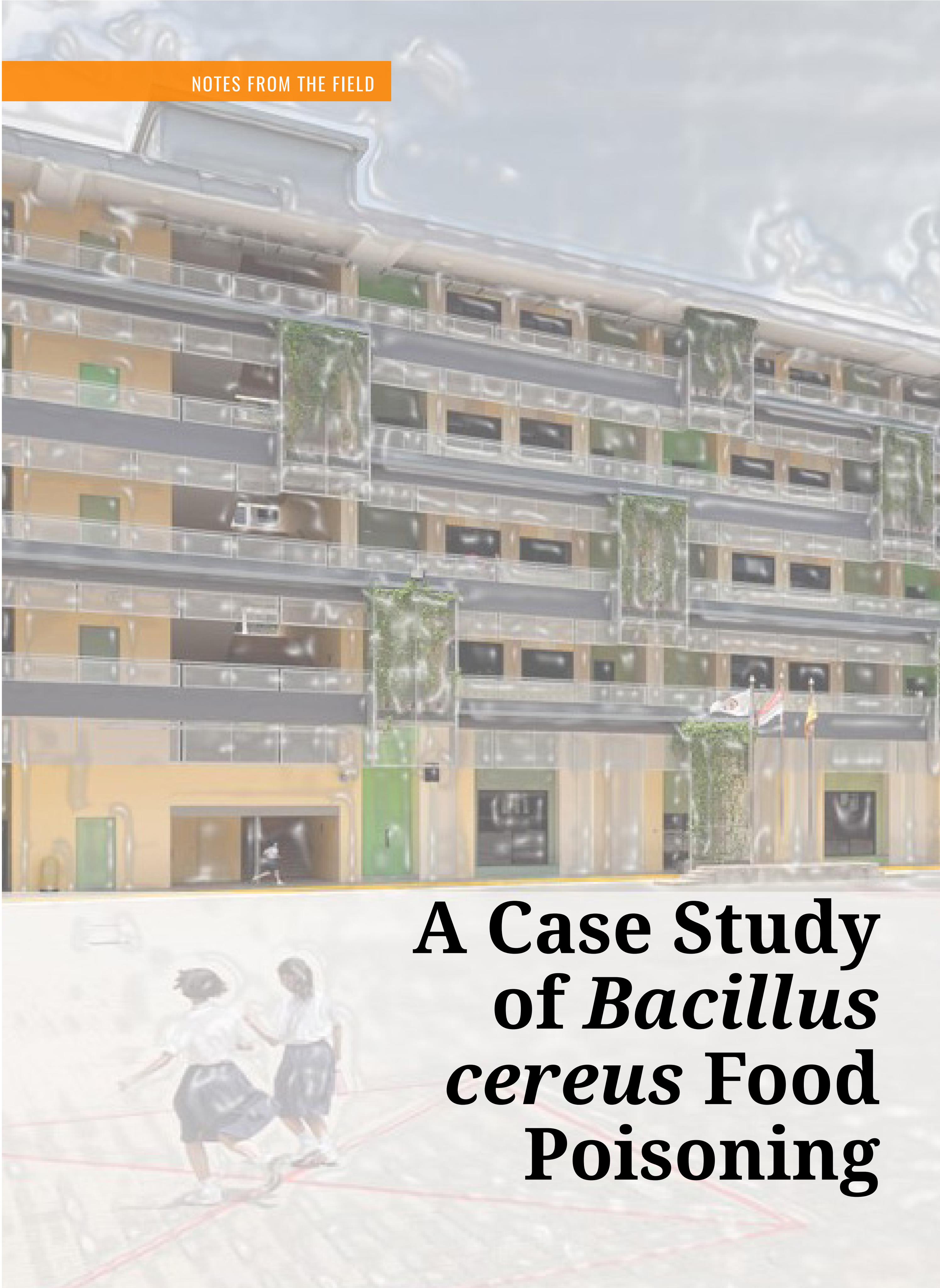
NOTES FROM THE FIELD



A Case Study of *Bacillus cereus* Food Poisoning

NOTES FROM THE FIELD

Reported by Georgina Yue Hui Lim, Xinyi Peh, Nigel Wu Chen Chong, Minn Thu, Wee Siong Tien, Hwi Kwang Han

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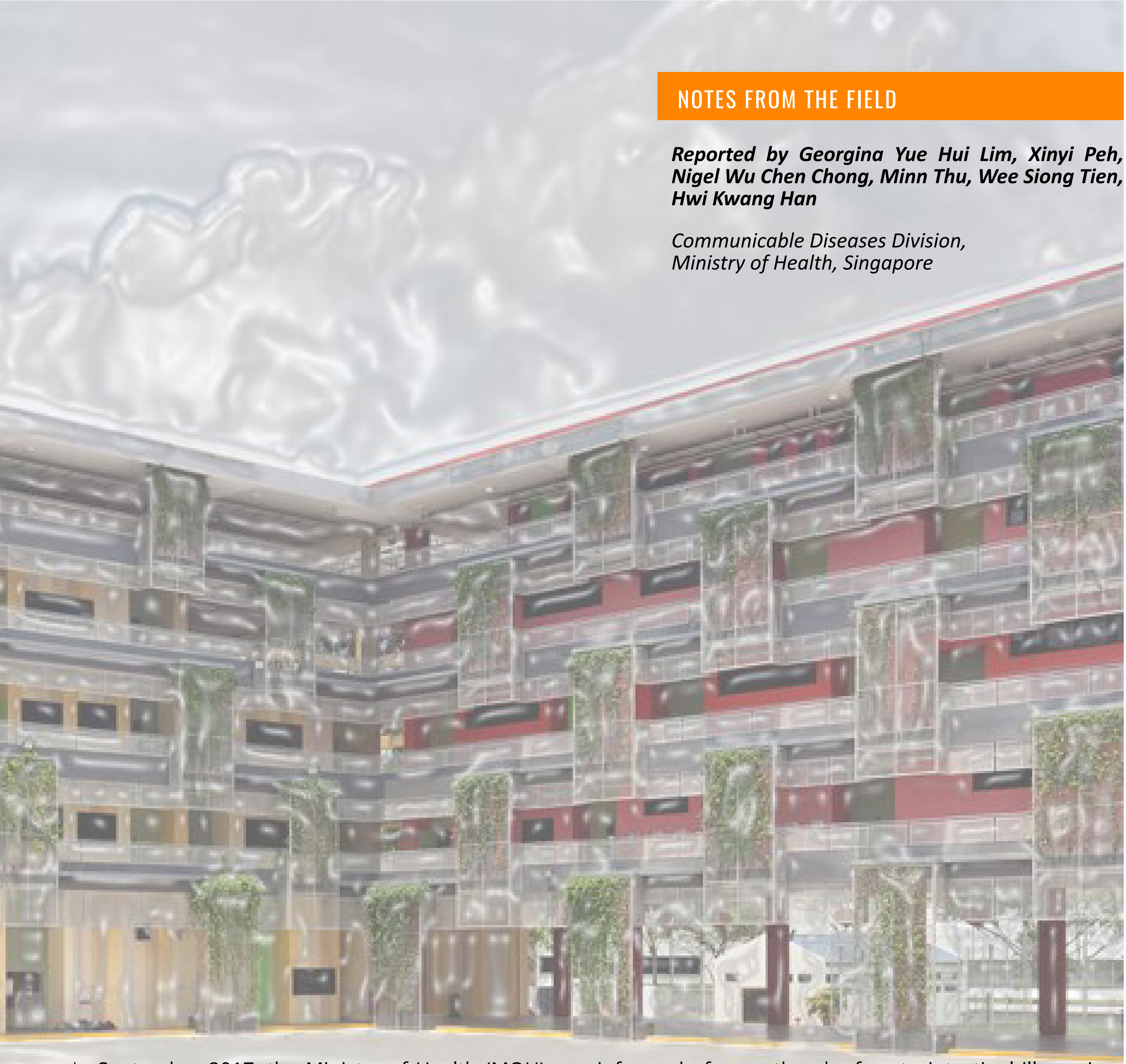


In September 2017, the Ministry of Health (MOH) was informed of an outbreak of gastrointestinal illness in a school in the northwest region. Together with its institutional partners, National Environment Agency (NEA), Agri-Food and Veterinary Authority (AVA) and Public Utilities Board (PUB), it conducted a joint inspection at the implicated school canteen.

The incident involved 14 students from different levels who had developed a sudden onset of vomiting and nausea after consuming fried rice from a food stall in the school canteen during recess time. None of the cases were hospitalized. The mean incubation period was 1-2 hours. Epidemiological investigation determined this to be a point source outbreak of *Bacillus cereus* food poisoning linked to consumption of contaminated fried rice from the school canteen.

Bacillus cereus had been isolated from a remnant sample of fried rice. Once introduced into food, this organism is unique in that neither its spores nor toxins are destroyed in the process of frying or reheating. According to the interview with the food handler, rice was boiled three hours prior to recess and was kept warm in the rice cooker. The rice was then fried with egg and crabmeat two hours before recess and kept in insulated container at ambient temperature prior to serving during recess time. This storage condition might have provided a conducive environment for the germination and outgrowth of *Bacillus cereus*.

What is *Bacillus cereus* food poisoning?

It is caused by the toxins of *Bacillus cereus* which produce two different clinical syndromes – diarrhoeal or emetic. The diarrhoeal syndrome (with average incubation period of 10-12 hours) is associated with a heat-labile toxin elaborated by the bacterium while the emetic syndrome (with average incubation period of 1-6 hours) is associated with a heat-stable toxin from *Bacillus cereus*.

Bacillus cereus food poisoning is generally a mild and self-limiting disease, though more severe and fatal forms of the illness have been reported.

Where is *Bacillus cereus* commonly found?

Bacillus cereus is a gram-positive, endospore-forming bacterium which is ubiquitous in the environment. *Bacillus cereus* is readily isolated from soil, dust and vegetation. A wide variety of food including rice and other starchy products, food mixtures such as sauces and soups, meat, milk and vegetables have been reported to be associated with *Bacillus cereus* food poisoning. It thrives and forms spores in room temperature, thus ensuring its survival against all stages of food processing and subsequent temperature/ time abuse.

How does the emetic form of *Bacillus cereus* poisoning occur?

The emetic syndrome is often associated with consumption of cooked rice and other starchy products that have been stored at room temperature for prolonged hours, allowing it to form spores that would survive the cooking process and produce toxins. As the toxins produced cannot be destroyed by subsequent heating, ingestion of the toxin in the food would lead to symptoms such as vomiting and nausea.

How can we prevent *Bacillus cereus* food poisoning?

Bacillus cereus food poisoning is often associated with long storage time of cooked food at inappropriate temperatures. Cooked food should be cooled as quickly as possible to prevent proliferation of bacteria and to be refrigerated within two hours if it is not consumed immediately. Food that is to be stored longer than two hours should be kept refrigerated at less than 4°C or kept warm at above 60°C.

Please follow the four simple steps recommended by the U.S. Food and Drug Administration to reduce the risk of food poisoning:

- CLEAN - wash hands and surfaces often;
- SEPARATE - separate raw meats from other foods;
- COOK - cook to the right temperature; and
- CHILL - refrigerate foods promptly.

How are field investigations for food-borne outbreaks carried out?

Upon receiving the notification of an outbreak, MOH conducts a rapid preliminary assessment based on the available information provided by the feedback provider. The local One Health protocol will then be

Figure 1. Potential source of *Bacillus cereus*

activated when the preliminary assessment confirms the existence of an outbreak.

Under the One Health protocol, multiple public health agencies work together to investigate foodborne disease outbreaks from different aspects of the outbreak investigation. MOH investigates the clinical and epidemiological aspects; AVA is responsible for food safety at upstream as well as food and environmental sampling; NEA checks the environmental hygiene of food establishments; and PUB ensures water safety and quality. Investigating officers from the relevant agencies will meet at the implicated food establishment to conduct food and environment hygiene inspections and a joint outbreak investigation.

Joint investigations under the One Health protocol include, but are not limited to, the following measures:

- Epidemiological investigation of the source and mode of outbreak transmission;
- Hygiene inspection at the implicated premises;
- Interview of cases for detailed food history and symptoms.
- Stool screening of the affected individuals and food handlers from the implicated food establishment; and
- Collection of food, water and environment samples for laboratory testing.

What are the challenges in managing outbreaks?

One major challenge in foodborne disease outbreak investigation is that affected individuals often could not remember the food items they consumed prior to the illness. In certain instances, a long period of time has elapsed from symptoms onset to the reporting of incident. A detailed food history is important in the identification of the possible source(s) and vehicle(s) of the outbreak.

In addition, affected individuals often decline to provide their stool samples for laboratory testing

Figure 2. Improper placement of consumables above bin at implicated food stall

as many of them may have recovered at the time of investigation. However, laboratory identification of a causative agent is important as signs and symptoms of most foodborne diseases are non-specific. The detection of a particular causative pathogen is helpful in determining the likely period of exposure or a suspected meal, together with the information on the date and time of symptoms onset.

At the time of the outbreak investigation, the actual food items consumed by the individuals are often no longer available for testing. Only in few instances of foodborne outbreaks, retention samples of suspected food items are available for testing. Detecting the same pathogen in both the actual food items and the affected individuals provides a definitive evidence towards the source and the vehicle of the outbreak.

This food poisoning incident highlighted the importance of good practices for food processing and storage to prevent foodborne outbreaks. Particular to *Bacillus cereus* food poisoning, hot food should be cooled as quickly as possible for storage and should not be allowed to remain at room temperature for more than two hours. Ideally, hot food should be kept above 60°C and cold food should be kept below 4°C. Our experience also signified the effectiveness of the multi-agency coordinated approach under the One Health protocol.

Figure 3. School canteen setting

Reproduced from http://www.who.int/foodsafety/areas_work/foodborne-diseases/infogrpahics_wpr_en.pdf?ua=1

Infectious Diseases Update

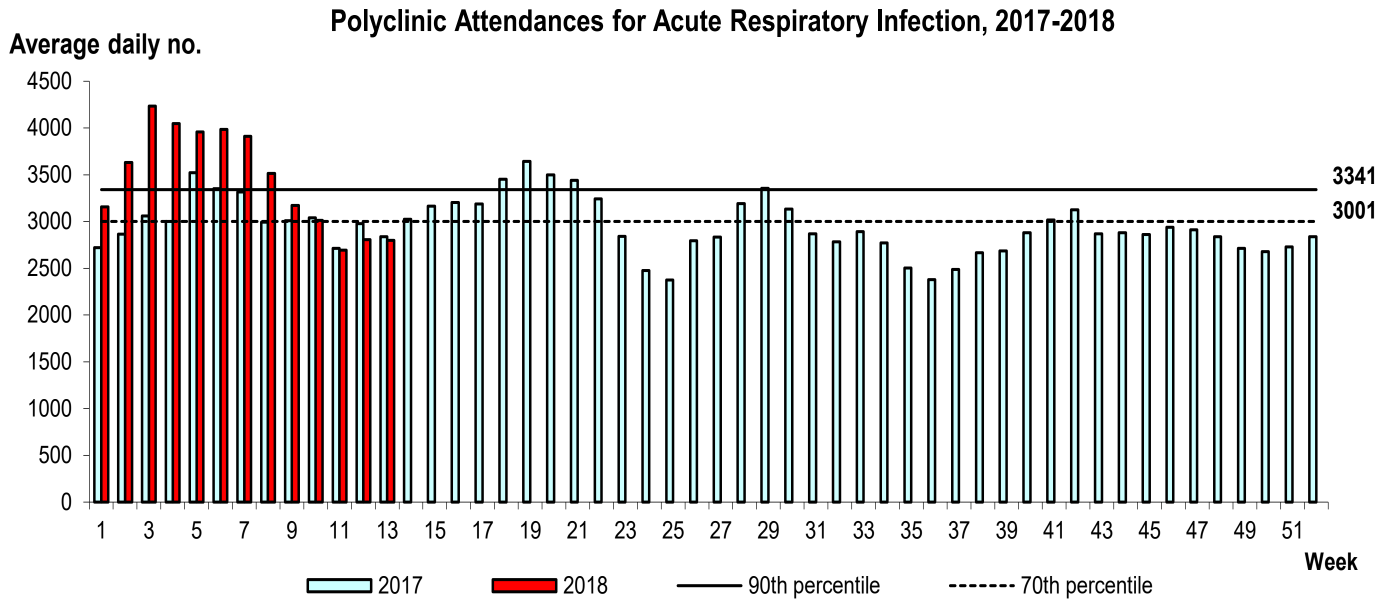
As of E-Week 13 (25- 31 Mar 2018)

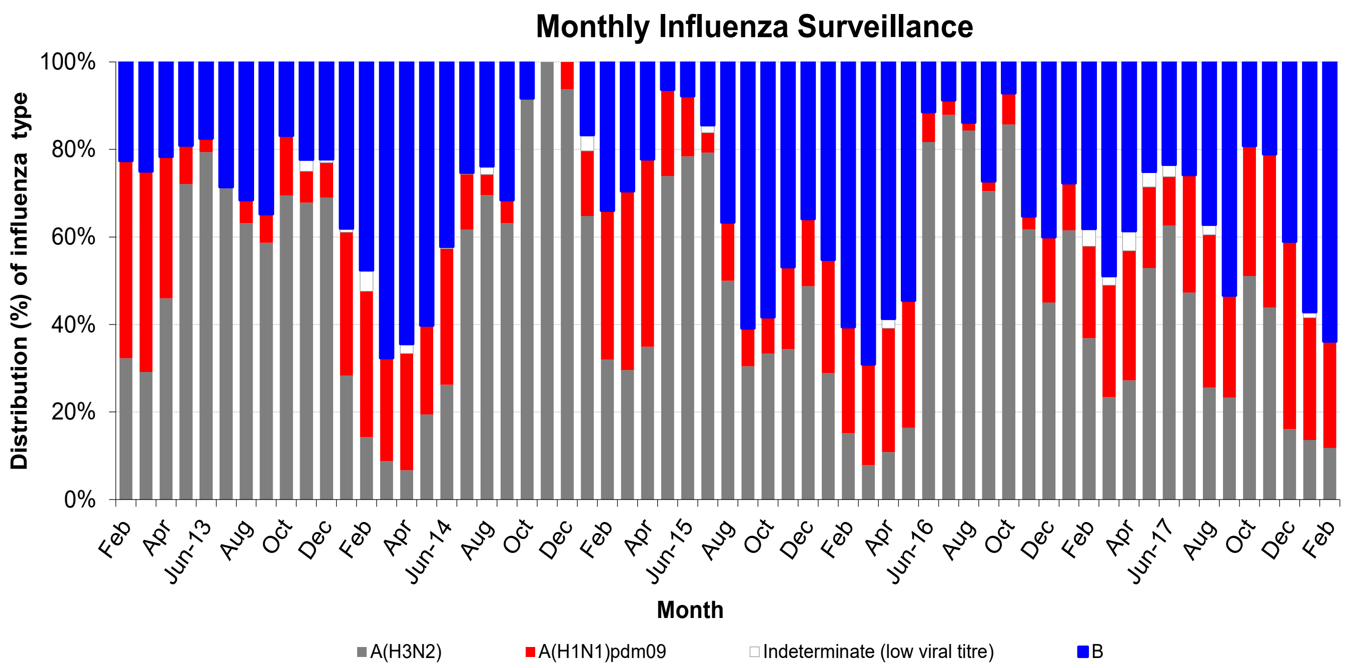
	E Week 13			Cumulative first 13 Weeks		
	2018*	2017	Median 2013 -2017	2018	2017	Median 2013 -2017
FOOD/WATER-BORNE DISEASES						
Acute Hepatitis A	1	3	1	16	20	20
Acute Hepatitis E	1	2	1	10	16	14
Campylobacteriosis	11	7	7	100	94	104
Cholera	0	0	0	1	0	0
Paratyphoid	0	0	0	5	6	9
Poliomyelitis	0	0	0	0	0	0
Salmonellosis (non-enteric fever)	22	45	39	343	526	400
Typhoid	0	0	0	9	24	20
VECTOR-BORNE DISEASES						
Chikungunya Fever	0	0	0	1	3	9
Dengue Fever	24	49	225	599	728	3413
Dengue Haemorrhagic Fever	0	1	1	3	6	6
Japanese Encephalitis	0	0	NA	0	0	NA
Leptospirosis	1	0	NA	8	11	NA
Malaria	0	0	0	7	4	4
Murine Typhus	0	0	NA	0	0	NA
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	0	2	NA	1	8	NA
AIR/DROPLET-BORNE DISEASES						
Avian Influenza	0	0	NA	0	0	NA
Diphtheria	0	0	0	0	0	0
Ebola Virus Disease	0	0	NA	0	0	NA
Haemophilus influenzae type b	0	0	0	0	3	1
Hand, Foot And Mouth Disease	843	663	463	9318	8923	6973
Legionellosis	0	2	1	2	5	5
Measles	1	4	2	13	29	15
Melioidosis	0	1	2	8	15	12
Meningococcal Disease	0	1	0	3	3	1
Mumps	10	12	12	127	142	131
Pertussis	1	0	0	27	19	16
Pneumococcal Disease (invasive)	2	5	2	34	40	35
Rubella	0	0	1	0	3	4
Severe acute respiratory syndrome	0	0	0	0	0	0
Tetanus	0	0	0	1	0	NA
OTHER DISEASES						
Acute hepatitis B	2	0	1	13	13	13
Acute hepatitis C	0	0	0	4	4	4
Botulism	0	0	NA	1	0	NA
POLYCLINIC ATTENDANCES - AVERAGE DAILY NUMBER						
Acute upper respiratory infections	2797	2839	2343			NA
Acute conjunctivitis	109	113	83			NA
Acute Diarrhoea	532	486	452			NA
Chickenpox	21	16	NA			NA
HIV/STI/TB NOTIFICATIONS	2018 Feb			Cumulative 2018		
HIV/AIDS	26			50		
Legally Notifiable STIs	784			1676		
Tuberculosis	117			276		

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

Influenza Surveillance

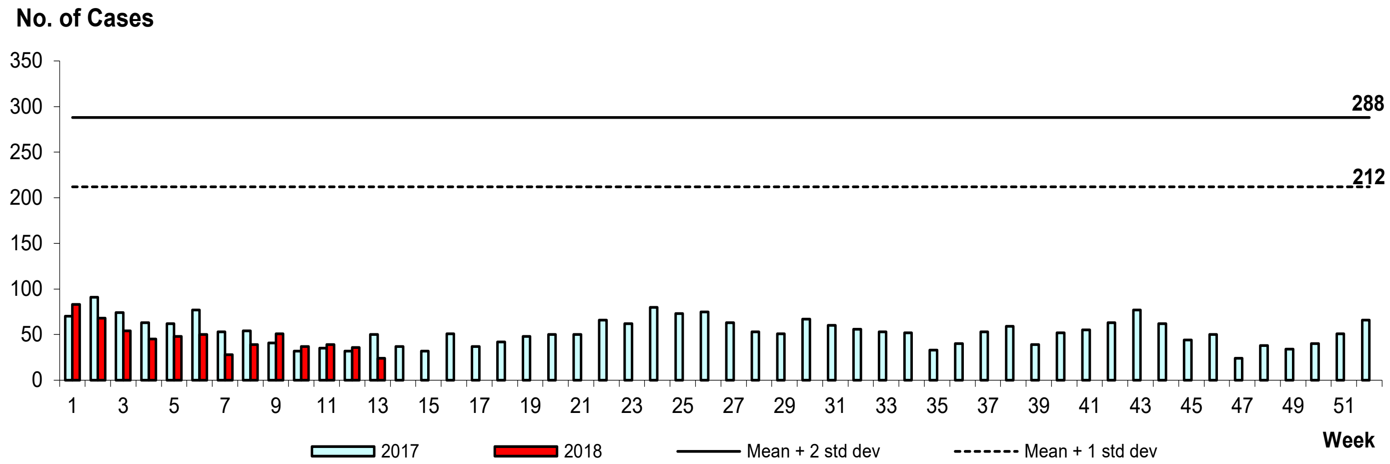
The average daily number of patients seeking treatment in the polyclinics for Acute Respiratory Infection (ARI) peaked in February and declined to below the 70th percentile in March. The proportion of patients with influenza-like illness (ILI) among the polyclinic attendances for ARI is 2.1%. The overall positivity rate for influenza among ILI samples (n=304) in the community was 22.7% in the past 4 weeks. Of the specimens tested positive for influenza in March 2017, these were positive for influenza B (52.3%), influenza A (H1N1)pdm09 (34.9%) and influenza A (H3N2) (12.8%).





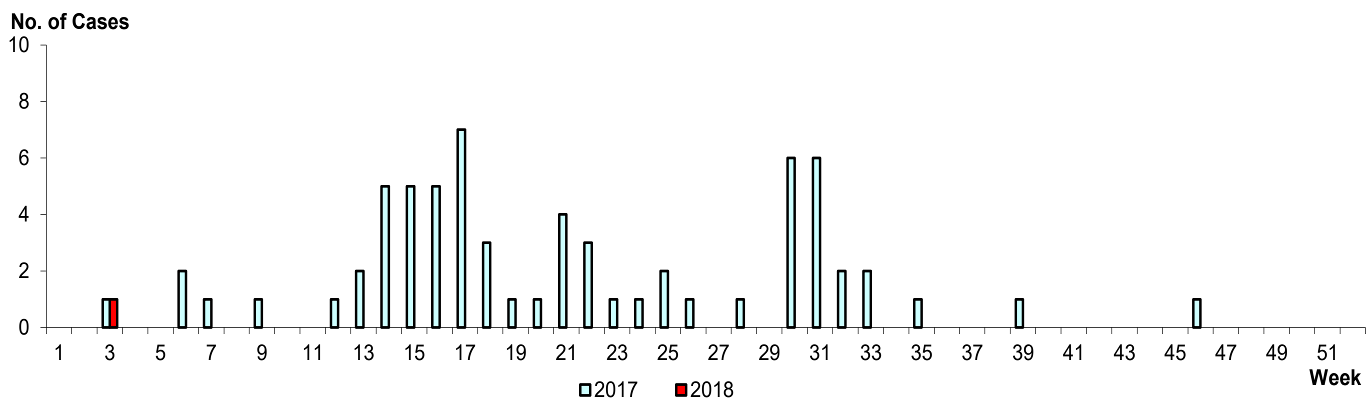
Dengue Surveillance

The number of dengue notifications remained low, well below the mean + 1 standard deviation (SD) level, from January to March. Preliminary results of all positive dengue samples serotyped in March 2018 showed DEN-1, DEN-2, DEN-3 and DEN-4 at 0%, 64.3%, 21.4% and 14.3% respectively.

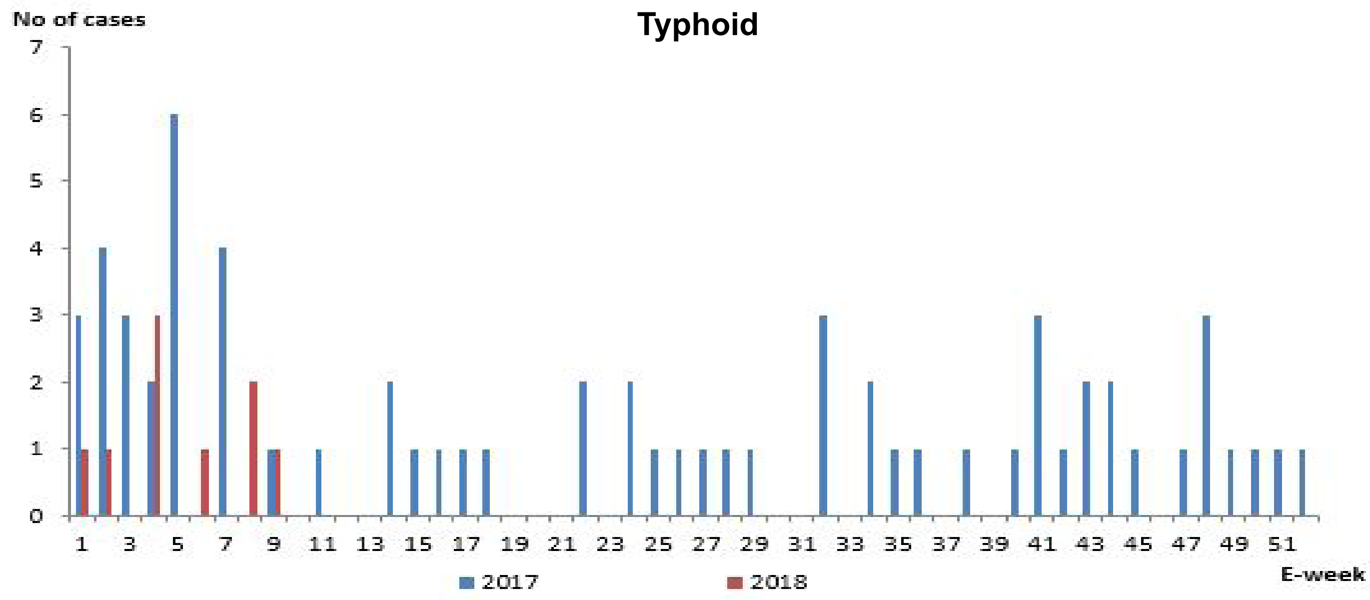


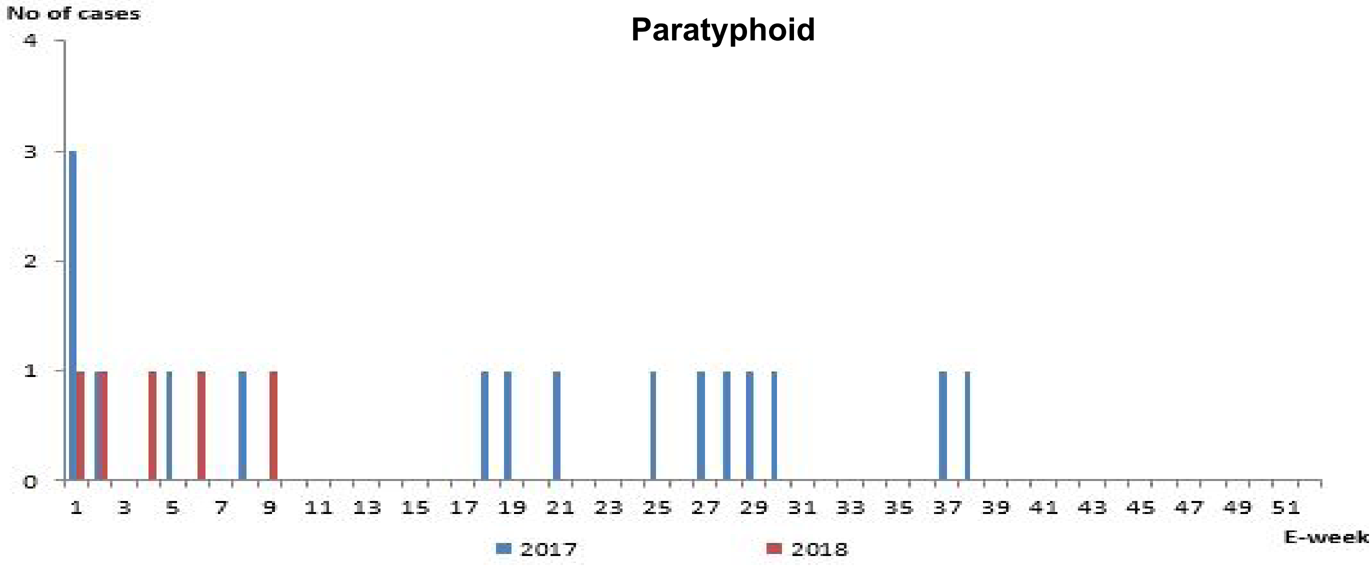
Zika Surveillance

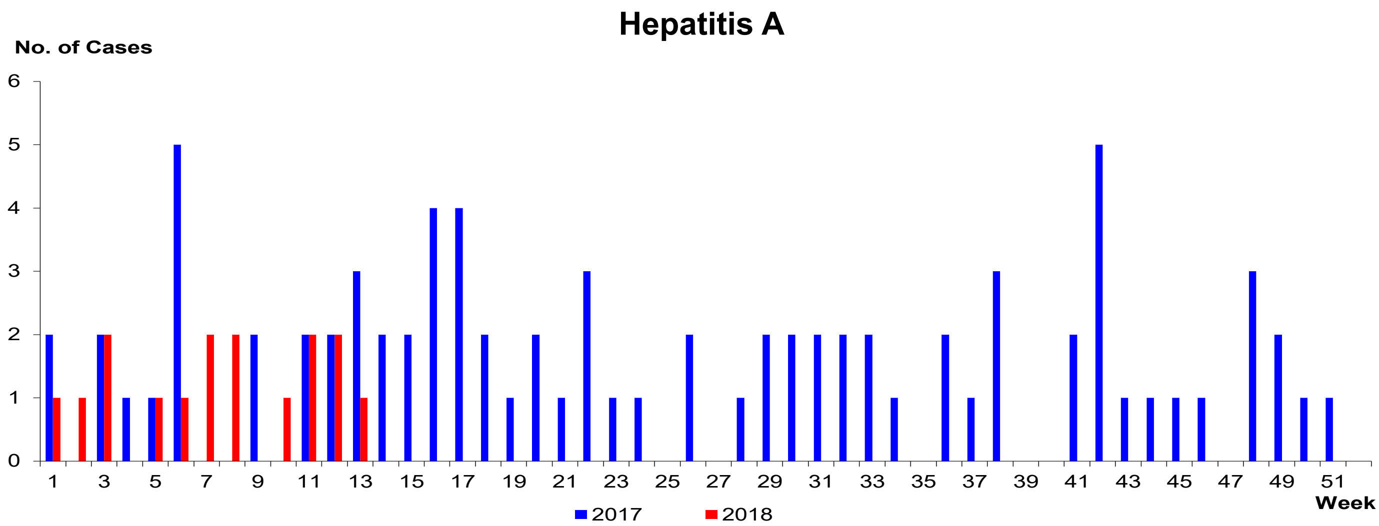
As of 1 March 2018, there was 1 case of Zika reported. There were 67 cases reported in 2017



Surveillance of Other Selected Diseases







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Do you have any ideas or suggestions?
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