Introduction

Tuberculosis (TB) is a global problem and a major cause of morbidity and mortality \(^1\). The aetiologic agent, *Mycobacterium tuberculosis*, primarily infects the lungs and is spread via airborne droplets produced by coughing or sneezing. Persons who are infected with TB may present with either latent TB infection (LTBI) (which is asymptomatic and non-infectious) or active TB disease. One in 10 individuals with LTBI develops active TB disease in his/her lifetime. The risk of progression to active TB is highest in the first two years after initial infection, especially among those who are immunocompromised \(^2\). We report herein the changing trends in TB disease among Singapore residents in the last 10 years.

Methods and materials

TB is a notifiable disease under the Infectious Diseases Act. All suspected and confirmed TB cases are required to be notified to the Singapore TB Elimination Programme (STEP) registry within 72 hours of starting TB treatment and/or laboratory confirmed results. We extracted data on age and drug-susceptibility results of TB cases notified in Singapore residents from 2002-2011. Age-standardised rates were calculated by the direct method using the World Health Organisation (WHO) standard population as the reference population. For this paper, data on drug-resistant TB was limited to the period 2008-2011 as we have concerns on data completeness and differing case definitions prior to this period.
Results

The TB trend from 1960 to 2010 showed a marked decrease in the incidence rate among Singapore residents. The incidence rate declined from 307.0 per 100,000 population in 1960 to 56.3 per 100,000 population in 1987. From 1987 to 1997, the incidence rate of new TB cases among Singapore citizens and permanent residents stagnated at around 50-55 per 100,000 population. In recent years, the incidence rate has reached a plateau and has been hovering at about 40 cases per 100,000 resident population (Fig. 1). The incidence rate among residents increased for the first time in ten years to 39.8 per 100,000 population in 2008 and since then, it has remained at above 38.0 per 100,000.

We examined the impact of age on TB incidence in Singapore residents by adjusting for the effect of age. Fig. 2 shows that age standardisation had mitigated the TB incidences somewhat, but it still does not fully explain the rising TB incidence in our resident population in recent years.

When we examined the age-specific incidence rates, we noted that there was an overall decreasing trend in the rates of those in the older age groups (i.e. those aged 60 and above). This contrasted with the incidence rates in the younger age groups, which appeared to have increased in the last 5 to 6 years (Fig. 3).

Treatment failure is one of the risk factors for developing drug-resistant TB. We examined the trend in relapsed TB among Singapore residents. The number of relapsed TB cases decreased from 216 cases in 2002 to 139 cases in 2005, plateaued between 125 and 145 cases over the next five years, then moved up to 158 in 2011 (Fig. 4). Majority of relapsed cases occurred in the older age groups, and
Figure 2
Crude and age-standardised TB incidence rates in Singapore residents, 2002-2011

Figure 3
Age-specific TB incidence among Singapore residents, 2002-2011
are predominantly among males. Among the relapsed TB cases with pulmonary disease that had bacterial sensitivity tests done, majority (about 88%) were found to be sensitive to streptomycin, isoniazid and rifampicin (Fig. 5).

Next, we examined drug-resistant TB among Singapore residents in recent years, from 2008 to 2011. In total, there were 21 cases of drug-resistant TB among Singapore residents notified to the STEP registry. Of these, there were 13 multidrug-resistant (MDR) TB cases and eight rifampicin-resistant TB cases (Fig. 6). Two-thirds of the cases were males aged between 20 and 39 years (Fig. 7). Only two cases (both rifampicin-resistant) were reported in individuals aged 60 years and above.

**Comments**

The National TB Control Programme was established in the late 1950s with the setting up of the Tuberculosis Control Unit and a National TB Registry. We have achieved significant reduction in the overall TB incidence among our resident population, and this was largely attributed to substantial improvements in environmental hygiene, housing and nutrition, and the availability of treatment.

Since 1997, the National TB Control Programme was further strengthened with the establishment of the STEP. It comprises two key components - TB surveillance and clinical treatment. TB surveillance consists of case notification, update on treatment progress, and contact investigation. The Tuberculosis Control Unit (TBCU) serves as the national centre for contact investigation and preventive therapy, treatment of TB patients and training and education of health care workers and the public. Directly-observed therapy (DOT) is strongly promoted. The overall proportion of patients on DOT increased from 10% before 1997 to more than 55% currently.
Figure 5
Drug sensitivity of *Mycobacterium tuberculosis* in Singapore residents with relapsed pulmonary TB, 2002-2011

Figure 6
Drug-resistant TB among Singapore residents, 2008-2011

Figure 7
Age distribution of drug-resistant TB cases among Singapore residents, 2008-2011
The early years of STEP brought encouraging results. The TB incidence dropped by 16% from 57 per 100,000 in 1998 to 48 per 100,000 population in 1999. This trend continued in 2001, when the TB incidence was 44 per 100,000. Following enhanced TB control measures implemented by STEP, the incidence rate declined to 35.1 per 100,000 population in 2007. Although STEP was introduced with a view to eliminate TB from the public health landscape in Singapore, we have witnessed a gradual resurgence of TB in our population, which is exacerbated by notable delays in diagnosis and difficulties in enforcing treatment for cases.

Impact of ageing population and trends in age-specific incidence rates

In this paper, we have carried out preliminary analysis of the impact of ageing on TB incidence in Singapore. TB reactivation is recognised to be a significant factor contributing to TB burden especially in countries with growing proportion of the elderly. Geriatric populations represent a large pool of latent TB infection. TB incidence rates increase sharply with age. Age-associated chronic diseases such as diabetes, and weakened immune systems increase the risk of progression from LTBI to active TB in the elderly. Although population ageing is one driver for the increase in crude TB incidence rates, an increasing trend was observed even after age-standardisation, demonstrating that ageing could not wholly explain the recent rise in TB among Singaporeans. Furthermore, in the past 5 to 6 years, age-specific TB incidence rates have increased in residents aged 20 to 59 years, while longer-term declining trends in the above 60 year-age-groups appeared to have plateaued. While active TB in the elderly population is often due to progression of LTBI, younger persons are likely to have acquired the infection recently indicating an ongoing community transmission. The occurrences of active TB among residents aged below 30 years seem to support this. Moreover, community transmission may have increased in recent years as suggested by the increasing age-specific incidence rates in the 20 to 59 year age-groups.

Community transmission is likely to be driven primarily by delayed diagnosis and access to treatment. In 2000, the median cough duration reported at TB notification was 4 weeks. The median cough duration among TB patients with cough for more than 8 weeks rose from 16 weeks in 2004 to 20 weeks in 2008. The number and proportion of smear-positive TB patients presenting with cough for more than 8 weeks rose steadily, from 146 (21.5%) in 2004 to 214 (29%) in 2008. The number and proportion of smear-positive cases with cough for more than 24 weeks similarly increased, from 42 (6.2%) in 2004 to 71 (9.6%) in 2008. The data reinforced the need for the public to come forward to seek medical treatment to exclude TB if they have prolonged cough.

Relapsed TB and drug-resistant TB

Multi-drug resistant TB is an emerging global problem resulting from ineffective treatment and poor patient compliance to anti-TB medications. Treatment for MDR TB lasts much longer than for drug-sensitive TB patients and the success rate is comparatively poorer. Treatment for MDR TB is also very expensive as it relies on second-line anti-TB drugs that are both costly and toxic. Our preliminary analysis of relapsed TB cases over the past 10 years did not find clear evidence of increasing treatment failure, as relapsed cases continue to comprise a small fraction of the total TB burden among Singapore residents.
However, when we examined the trend of drug-resistant TB in recent years, we noticed both an increasing number of cases and differing profile from the overall TB cases. There were more cases of drug-resistant TB detected in younger age groups (aged 49 years and below), and in particular, all cases of MDR TB were detected in younger patients. This contrasted with the general trend of increasing TB with age in the overall TB burden. In addition, anecdotally, younger patients with no prior contact or travel history are being diagnosed with MDR TB.

**Conclusion**

We have shown in this preliminary analysis of TB cases in Singapore residents several interesting trends that warrant further investigation. Firstly, the drivers for community transmission should be studied in greater detail. While the ageing population impacts our TB burden, the reason for the recent TB resurgence is multi-factorial. We can expect the ageing population to remain as an important contributor to TB incidence in the future, but new infections among the younger population must also be addressed in tandem. For example, measures to address TB cases in the younger generations and reduce community transmission should be emphasized in STEP, while ongoing efforts to engage various stakeholders like workplaces and schools, to raise community awareness of TB will be continued.

Next, MDR TB is an emerging problem globally and Singapore is still fortunate to have relatively low drug resistance among our TB patients. However, we cannot afford to be complacent and STEP will actively address this threat moving forward. We observed an increasing trend in MDR TB among younger patients. Further research into our understanding of community transmission is vital to target our control measures effectively and to respond to the threat of MDR TB. Genotype surveillance has been widely used in the US and has proven to be an important tool of the TB control programme to target control measures more effectively. TB genotyping will be an area in which more resources will be allocated, to allow us to better understand the transmission links between cases and to identify novel transmission foci and potential outbreaks. Although STEP has achieved incremental improvements in the overall TB control since it first started, we need to continually evaluate the effectiveness of the programme and to review the changing disease landscape to ensure that our measures remain relevant and appropriate. STEP will continue to be strengthened to align with its original goal of TB elimination.

(Reported by Suhana S, Lim J, Ang LW, Ooi PL, Cutter J, Communicable Diseases Division, Epidemiology & Disease Control Division, Ministry of Health, Singapore)

**References**

Review of dengue serotype surveillance programme in Singapore

Introduction

The incidence of dengue fever has increased significantly in the tropical and sub-tropical regions around the world in the past 30 years.\(^1\)\(^-\)\(^3\) In Singapore, dengue fever is the most prevalent vector-borne disease and poses a major public health threat. As a result of a successful vector control programme, there was a period of low disease incidence in the 1970s and 1980s.\(^4\) However, Singapore has seen a re-emergence of dengue fever since the late 1980s, with 5- to 6-yearly cycles of dengue epidemics of progressively increasing magnitude (Fig. 8).\(^5\)

Factors contributing to the increased local transmission include regional resurgence of dengue, vulnerability to imported infections due to large influx of foreigners and visitors from endemic countries, low herd immunity among the local population, presence of the \textit{Aedes} mosquitoes, and diversity of all four serotypes of dengue virus. A switch in the predominant circulating virus serotype was one of the possible contributing factors of the two dengue epidemics in Singapore in 2005 and 2007.\(^6\)\(^-\)\(^8\) Other studies conducted in Myanmar and Thailand have also shown outbreaks of dengue fever associated with changes in predominant circulating dengue virus serotypes.\(^9\)\(^,\)\(^10\)

Understanding the dengue serotype patterns serves as an important step in the prevention and control of dengue transmission as it can provide early warning of impending dengue epidemics. We
reviewed the trends of dengue incidence in Singapore with particular reference to changing patterns of dengue serotypes.

Materials and methods

Dengue fever surveillance - human, vector and virus

Singapore has a multi-pronged dengue control strategy. The Ministry of Health (MOH) is responsible for the surveillance and epidemiological investigation of dengue fever cases, while the National Environment Agency (NEA) oversees the surveillance and control of the vector population (*Aedes* mosquitoes). Under the Infectious Diseases Act, all medical practitioners are required to notify MOH of all laboratory confirmed dengue cases and deaths, as well as suspected clinical cases, within 24 hours from time of diagnosis.

The main approaches adopted by NEA for dengue are preventive surveillance and control of vectors executed through interagency coordination, risk assessment, community participation and law enforcement. NEA field officers from the Environmental Health Department (EHD) carry out vector surveillance to seek out and destroy potential *Aedes* mosquito breeding sites. In addition to source reduction, indoor misting of insecticides is conducted to remove infected adult mosquitoes, with the aim of eliminating infected mosquitoes to interrupt transmission.

For dengue serotype surveillance, residual blood samples from cases of dengue fever are sent for laboratory diagnosis and tested for viral ribonucleic acid (RNA) or nonstructural protein-1 (NS1) by polymerase chain reaction (PCR) and antigen test, respectively. Samples from hospitals are analysed under the Infectious Diseases Act and samples from a network of general practitioners are analysed under a virus surveillance programme at the Environmental Health Institute (EHI) of NEA. The findings from MOH and EHI are forwarded to NEA to enhance their field vector control operations.
The dengue serotype data from the years 2008 to 2011 were reviewed in conjunction with the epidemiology of dengue cases reported in the corresponding years.

**Statistical analysis**

Difference in proportion between 2 groups was compared using 2-sample independent z-tests, with standard error estimated using pooled value of the independent proportions. A p value less than 0.05 was considered significant.

**Results**

**Dengue serotype surveillance**

Between 2005 and 2011, the annual number of dengue cases which had been serotyped ranged from 208 to 1,111 cases, which constituted 6.7% to 16.3% of all notifications (Table 1). There were higher numbers of serotyped cases in the epidemic years in 2005 and 2007.

The demographic profile of dengue cases notified between 2008 and 2011 is shown in Table 2. Those aged 15-44 years constituted the majority (59.1%-64.2%) of the cases. The male-to-female ratio ranged from 1.5 to 1.6. Among the Singapore residents, Chinese constituted the greatest proportion of the cases, followed by Malays and Indians. About one-third of the cases were foreigners.

Similar to the notified cases, the majority of serotyped cases were aged between 15 and 44 years (64.9-72.7%) (Table 3). Among Singapore residents, the majority of the cases were Chinese, followed by Malays and Indians. The male-to-female ratio among serotyped cases ranged from 1.7 to 1.9, which was slightly higher compared to the notified cases. Among the serotyped cases, the proportions of Singapore residents were higher (ranged from 54.1%-58.7%) compared to foreigners.

A significantly higher proportion of serotyped cases were male and aged 15-44 years, compared to all dengue cases (p<0.005). The proportion of serotyped cases who were Chinese was significantly lower compared to all dengue cases (p<0.005). There was also a significantly lower proportion of serotyped cases who were Singapore residents compared to all dengue cases (p<0.005).

**Trends of circulating dengue serotypes**

Dengue serotype surveillance began in Singapore in May 1992. The surveillance was enhanced

<table>
<thead>
<tr>
<th>Year</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of notified cases</td>
<td>14,209</td>
<td>3,127</td>
<td>8,826</td>
<td>7,031</td>
<td>4,497</td>
<td>5,363</td>
<td>5,330</td>
</tr>
<tr>
<td>No. of serotyped cases</td>
<td>1,111</td>
<td>208</td>
<td>1,062</td>
<td>1,038</td>
<td>710</td>
<td>873</td>
<td>712</td>
</tr>
<tr>
<td>Proportion serotyped</td>
<td>7.8%</td>
<td>6.7%</td>
<td>12.0%</td>
<td>14.8%</td>
<td>15.8%</td>
<td>16.3%</td>
<td>13.4%</td>
</tr>
</tbody>
</table>
Table 2
Demographic characteristics of dengue cases*, 2008 to 2011

<table>
<thead>
<tr>
<th>Year</th>
<th>2008 (n= 6,631)</th>
<th>2009 (n= 4,187)</th>
<th>2010 (n= 4,978)</th>
<th>2011 (n= 5,099)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age group (years)</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Below 15</td>
<td>7.3%</td>
<td>6.4%</td>
<td>7.8%</td>
<td>7.7%</td>
</tr>
<tr>
<td>15-44</td>
<td>62.2%</td>
<td>61.2%</td>
<td>64.2%</td>
<td>59.1%</td>
</tr>
<tr>
<td>45 or older</td>
<td>30.5%</td>
<td>32.4%</td>
<td>28.0%</td>
<td>33.2%</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>61.2%</td>
<td>61.0%</td>
<td>60.8%</td>
<td>59.2%</td>
</tr>
<tr>
<td>Female</td>
<td>38.8%</td>
<td>39.0%</td>
<td>39.2%</td>
<td>40.8%</td>
</tr>
<tr>
<td>Ethnic group</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Singapore resident*</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chinese</td>
<td>50.3%</td>
<td>52.5%</td>
<td>49.3%</td>
<td>55.0%</td>
</tr>
<tr>
<td>Malay</td>
<td>6.2%</td>
<td>6.8%</td>
<td>6.2%</td>
<td>8.0%</td>
</tr>
<tr>
<td>Indian</td>
<td>3.5%</td>
<td>4.6%</td>
<td>3.8%</td>
<td>3.8%</td>
</tr>
<tr>
<td>Others</td>
<td>3.0%</td>
<td>3.7%</td>
<td>4.1%</td>
<td>3.3%</td>
</tr>
<tr>
<td>Foreigner</td>
<td>37.0%</td>
<td>32.4%</td>
<td>36.6%</td>
<td>29.9%</td>
</tr>
</tbody>
</table>

* Foreigners seeking medical treatment were excluded.
* Refers to Singapore citizens and permanent residents.

Table 3
Demographic characteristics of serotyped dengue cases, 2008 to 2011

<table>
<thead>
<tr>
<th>Year</th>
<th>2008 (n=1012)</th>
<th>2009 (n=710)</th>
<th>2010 (n=873)</th>
<th>2011 (n=712)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age-group (years)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-14</td>
<td>5.1%</td>
<td>4.4%</td>
<td>5.6%</td>
<td>7.4%</td>
</tr>
<tr>
<td>15-44</td>
<td>68.5%</td>
<td>71.1%</td>
<td>72.7%</td>
<td>64.9%</td>
</tr>
<tr>
<td>45+</td>
<td>26.4%</td>
<td>24.5%</td>
<td>21.7%</td>
<td>27.7%</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>62.4%</td>
<td>63.9%</td>
<td>64.1%</td>
<td>65.9%</td>
</tr>
<tr>
<td>Female</td>
<td>37.6%</td>
<td>36.1%</td>
<td>35.9%</td>
<td>34.1%</td>
</tr>
<tr>
<td>Ethnicity</td>
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<td></td>
</tr>
<tr>
<td>Singapore resident*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chinese</td>
<td>46.7%</td>
<td>45.4%</td>
<td>41.6%</td>
<td>47.8%</td>
</tr>
<tr>
<td>Malay</td>
<td>5.7%</td>
<td>4.9%</td>
<td>5.4%</td>
<td>5.8%</td>
</tr>
<tr>
<td>Indian</td>
<td>3.8%</td>
<td>3.9%</td>
<td>3.2%</td>
<td>3.2%</td>
</tr>
<tr>
<td>Others</td>
<td>2.5%</td>
<td>3.5%</td>
<td>3.9%</td>
<td>1.8%</td>
</tr>
<tr>
<td>Foreigner</td>
<td>41.3%</td>
<td>42.3%</td>
<td>45.9%</td>
<td>41.4%</td>
</tr>
</tbody>
</table>

* Refers to Singapore citizens and permanent residents.
in 2005 to include more samples from hospitals and GP clinics. Past dengue serotype surveillance data had shown switches in the predominant circulating dengue virus serotype which coincided with the dengue epidemic periods. There was an increase in the proportion of the dengue virus serotype 1 (DEN-1) from 1993 to 1997 (Fig. 9). This switch in the predominant circulating dengue serotype coincided with the epidemics in 1997 and 1998.

In 2001, the predominant serotype was DEN-2, followed by a switch to DEN-1 in 2004. The number of dengue notifications increased in 2004 and culminated in Singapore’s largest-ever reported dengue epidemic in 2005. In 2007, the predominant circulating serotype switched back from DEN-1 to DEN-2, and the number of dengue notifications in that year was almost three-fold that of 2006. Between 2007 and 2011, DEN-2 was the predominant circulating serotype.

**Spatial distribution**

The spatial distributions of the notified cases and serotyped dengue cases were plotted using the Geographical Information System (GIS). Fig. 10 and Fig. 11 showed that the serotyped cases were widely distributed throughout Singapore and their distribution followed closely that of all dengue cases notified in 2010 and 2011.

**Comments**

The representativeness of the dengue serotype surveillance programme is affected by the number of cases with serotyping done. The monthly sample size required for dengue virus serotype surveillance was estimated to range from 70 to 100, with the upper limit of 100 as the minimum sample size during the period of dengue epidemics. This was based on the premise of an anticipated proportion of at least 50%
Figure 10
Geographical distribution of dengue cases and serotype cases, 2010

a. All dengue cases

b. Serotyped cases
Figure 11
Geographical distribution of dengue cases and serotype cases, 2011

a. All dengue cases

b. Serotyped cases
of the dominant serotype with confidence level 95% and absolute precision of 10% points. Finite population correction was factored in for the lower limit of 70. The monthly number of serotyped cases ranged from 25 to 144 (Fig. 12).

Following the largest dengue epidemic in 2005, the dengue virus serotype surveillance programme was enhanced as part of an integrated programme to strengthen vector control operations. Besides allowing NEA to enhance efforts in areas where uncommon serotypes such as DEN-3 and DEN-4 were circulating, information from the dengue serotype surveillance was used by NEA to identify priority areas for carrying out vector surveillance and control operations. Several threats of switches in serotype have triggered enhanced response to mitigate the impact. NEA hypothesised that the integrated programme could have moderated the dengue transmission from 2008 to 2012 resulting in lower incidence of dengue cases. Although it would be difficult to evaluate the effectiveness of such an intervention, it may nevertheless be a contributory factor to explain why there has been no change in the circulating predominant serotype in recent years.

The clinical manifestation of dengue can range from asymptomatic infection to dengue shock syndrome. Singapore’s dengue serotype surveillance programme is mainly based on febrile patients who seek medical treatment and have their blood samples taken for laboratory analysis. There is thus no information on the dengue serotype of asymptomatic or mild cases who do not seek medical attention.

There are many factors which affect dengue transmission, including environmental and biological factors. Vector control is the key strategy to control dengue transmission, especially when an effective dengue vaccine or antiviral drug is not available. The dengue serotype surveillance programme plays an important role in vector control as it can provide early indication of a potential switch in the predominant circulating serotype, which may signal an impending dengue epidemic. Data from the dengue serotype surveillance programme also allows effective vector control operations to be targeted in priority areas, thus maximizing the use of limited resources. However, the monthly sample size for the surveillance programme needs to be sufficiently large in order to ensure better representation of the predominant circulating serotype.

Figure 12
Monthly number of serotyped dengue cases, 2008 to 2011

![Graph showing monthly number of serotyped dengue cases, 2008 to 2011]
Acknowledgements

We thank our colleagues in the Communicable Diseases Division of the Ministry of Health, the Environmental Health Institute and the Environmental Health Department of the National Environment Agency and Dr Ng Lee Ching for contributing to this paper.

(Reported by Han HK, Ang LW, Tay J, Public Health Group, Ministry of Health)

References


Epidemiology and control of food poisoning outbreaks in Singapore, 2009-2011

Introduction

Food poisoning is a food-borne illness or disease of public health importance. The World Health Organization (WHO) defines it as a food-borne illness or disease, either infectious or toxic in nature, caused by agents that enter the body through the ingestion of food1. Food poisoning can be caused by bacteria,
viruses or chemicals (for example from the accidental ingestion of naturally occurring compounds such as wild mushrooms and puffer fish)\textsuperscript{2}. However, bacterial infections are the most common causes of food poisoning. Although any person can get food poisoning, those whose immune systems are either not fully developed or weakened with age such as young children and the elderly, are most susceptible. The predominant clinical symptoms of food poisoning are diarrhoea, vomiting and crampy abdominal pain, with or without fever.

The US Centers for Disease Control and Prevention (CDC) estimated that roughly 1 in 6 Americans or 48 million people fell ill, 128,000 were hospitalised and 3,000 died of food-borne diseases each year\textsuperscript{3}. WHO also estimated that the diseases caused by major food-borne pathogens alone cost up to US $35 billion annually in medical expenses and lost productivity\textsuperscript{4}. The top five food-borne pathogens found in the US are norovirus, non-typhoidal Salmonella, Clostridium perfringens, Campylobacter species and Staphylococcus aureus.

In Singapore, the number of food poisoning notifications and cases involved have increased significantly (by 14 and 17 times, respectively) from 1965 to 2011 (Fig. 13). This increasing trend is an important public health concern as more people tend to consume meals outside of their homes. According to the Health Promotion Board (HPB), Singapore residents usually eat out at least four times a week at hawker centres, food courts and coffee shop stalls. The proportion has increased from 49\% in 2004 to 60\% in 2010\textsuperscript{5}. Owing to the frequency of dining out, the number of licensed food establishments has increased from 25,162 in 2001 to 30,291 in 2011\textsuperscript{6}. There were 91,264 workers employed in the food and beverage (F&B) industry in 2010, which averages to about 15 workers per establishment\textsuperscript{7}. Poor hygiene practices in these establishments will increase the risk of food poisoning outbreaks.

![Figure 13](image_url)

**Figure 13**

Food poisoning notifications in Singapore, 1965-2011

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**Epidemiological News Bulletin**
The globalisation of the food supply is another means by which pathogens can spread rapidly and widely from one locality to another. In Singapore, more than 90% of all food consumed locally is imported, which means that the contamination of food anywhere along the global supply chain will have the potential to cause an outbreak.

**Surveillance and management of food poisoning outbreaks in Singapore**

The functions of surveillance, prevention and management of food poisoning incidents in Singapore are carried out by various government agencies and statutory boards. The Ministry of Health (MOH) monitors all reported incidents of food poisoning and notifications of food-borne diseases. The National Environment Agency (NEA) monitors the hygiene standards of food establishments to ensure that food sold is prepared hygienically and safe for consumption. The Agri-food and Veterinary Authority (AVA) enforces stringent regulations on the importation of food products and monitors the hygiene standards of food factories, while the Public Utilities Board (PUB) ensures that the drinking water supply is clean and safe.

Food poisoning is not a legally notifiable disease in Singapore. However, members of the public can inform MOH and NEA of food poisoning incidents through various channels such as the NEA or MOH hotlines, emails, normal mails, or smartphone applications. Doctors and laboratory personnel can notify MOH of food poisoning incidents or food-borne diseases through the Notification of Infectious Diseases form (MD131), the handphones of MOH duty officers or fax.

When MOH is notified of a food poisoning incident, telephone interviews will be conducted to verify the occurrence and obtain more details from the affected cases. Based on the information given, the notification will be classified either as a substantiated or an unsubstantiated incident. The criteria for a substantiated notification depends on various components such as availability of the informant’s contact details for verification, the number of cases affected, signs and symptoms experienced, type of treatment, severity of cases and availability of laboratory results. Reported incidents where the complainant was uncontacetable or did not seek medical treatment will be classified as an unsubstantiated incident and referred to NEA for a hygiene inspection at the food establishment. Substantiated notifications will be further categorised into established outbreaks or isolated cases. An outbreak is defined as the occurrence of two or more food poisoning cases who had consumed food from the same source on the same day and/or with similar epidemiological details. In addition, a case of food poisoning is defined as an individual who, after consumption of a specific meal, develops either (1) two or more of the following symptoms: diarrhoea, vomiting, nausea, abdominal pain, fever; or (2) several bouts of vomiting or diarrhoea alone.

MOH will conduct field investigations for a proportion of the established outbreaks. Incidents which do not undergo MOH field investigation will be referred to NEA for hygiene inspections at the implicated food establishment (Fig. 14).

The primary aim of epidemiological investigations into food poisoning outbreaks is to identify the source of the outbreak and to implement measures to control the spread of disease and prevent its future occurrence, so as to safeguard public health. Since January 2005, MOH has implemented a set of triggers for field investigation of food poisoning outbreaks. Field investigations are carried out jointly with NEA,
AVA and PUB, wherever relevant. The components of field investigation include inspections of the food establishment, the collection of food samples and environmental swabs, the referral of food handlers for stool screening, and the collection of stool samples from cases. During the inspection of food establishments, the goal is to identify any contributing factors in the occurrence of outbreak. The laboratory results of samples collected will help to identify the potential pathogen carriers, sources of contamination and causative agents of the outbreak.

Study objective

The analysis of data obtained during the course of investigation can provide information on the epidemiology of food-borne diseases and highlight any changing trends in such diseases. Prevention and control strategies can be developed based on this information.

The objectives of this study are:

- Firstly, to determine the common food-borne pathogens found in food samples, environmental swabs and stool samples collected from cases and food handlers during epidemiological investigations of food poisoning outbreaks.
- Secondly, to identify the risk factors associated with food poisoning outbreaks based on the information collected during field investigations.

Methods

A retrospective study was conducted to analyse the data obtained during epidemiological investigations of food poisoning outbreaks that were reported to MOH between January 2009 and December 2011. All food poisoning notifications and established outbreaks for which field investigation was carried out were included in the study.
Results

MOH received a total of 1,469 food poisoning notifications between January 2009 and December 2011. 746 notifications (50.8%) were classified as substantiated and the remaining notifications were unsubstantiated. Among the substantiated notifications, there were 702 (94.1%) established outbreaks involving 5,251 cases of food poisoning. Field investigation was conducted for 193 (27.5%) established outbreaks (Table 4).

The monthly distribution of all food poisoning notifications from January 2009 to December 2011 showed that there was no seasonal trend. The notifications were noted to peak in April 2009, August 2010 and October 2011, respectively (Table 5).

A wide variety of food establishments were involved in food poisoning outbreaks. The majority of these establishments were restaurants (37.3%), followed by eating houses (16.8%), licensed caterers (8.7%) and hawker centres (8.1%) (Table 6).

A total of 250 stool samples were collected from reported cases, of which 128 (51.2%) were tested positive. The predominant pathogen detected was *Salmonella* species and it has shown a significant increase in the pick-up rate over the years (Table 7).

Of the 925 food samples and environmental swabs collected during field investigations, 60 (6.5%) were tested positive (Table 8). *Escherichia coli* was the most frequent pathogen detected, followed by *Staphylococcus aureus*. The pick-up rate for *Escherichia coli* has been increasing over the past three years.

There were a total of 1,484 implicated food handlers who were referred for stool screening. Of these, 122 (8.2%) were tested positive for food-borne

### Table 4

<table>
<thead>
<tr>
<th>Year</th>
<th>All notifications</th>
<th>Substantiated notifications</th>
<th>Established outbreaks</th>
<th>No. of cases involved</th>
<th>Outbreaks with field investigation</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>379</td>
<td>211</td>
<td>201</td>
<td>1,539</td>
<td>40</td>
</tr>
<tr>
<td>2010</td>
<td>463</td>
<td>273</td>
<td>255</td>
<td>1,596</td>
<td>91</td>
</tr>
<tr>
<td>2011</td>
<td>627</td>
<td>262</td>
<td>246</td>
<td>2,116</td>
<td>62</td>
</tr>
<tr>
<td>Total</td>
<td>1,469</td>
<td>746</td>
<td>702</td>
<td>5,251</td>
<td>193</td>
</tr>
</tbody>
</table>

### Table 5

<table>
<thead>
<tr>
<th>Year</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>29</td>
<td>16</td>
<td>16</td>
<td>78</td>
<td>22</td>
<td>27</td>
<td>26</td>
<td>38</td>
<td>39</td>
<td>27</td>
<td>21</td>
<td>40</td>
<td>379</td>
</tr>
<tr>
<td>2010</td>
<td>18</td>
<td>29</td>
<td>28</td>
<td>43</td>
<td>30</td>
<td>37</td>
<td>33</td>
<td>67</td>
<td>39</td>
<td>55</td>
<td>40</td>
<td>44</td>
<td>463</td>
</tr>
<tr>
<td>2011</td>
<td>43</td>
<td>40</td>
<td>43</td>
<td>45</td>
<td>32</td>
<td>40</td>
<td>33</td>
<td>44</td>
<td>68</td>
<td>102</td>
<td>72</td>
<td>65</td>
<td>627</td>
</tr>
</tbody>
</table>
Table 6
Distribution of food establishments implicated in outbreaks, Jan 09 - Dec 11

<table>
<thead>
<tr>
<th>Type of establishment</th>
<th>2009 No.</th>
<th>2009 %</th>
<th>2010 No.</th>
<th>2010 %</th>
<th>2011 No.</th>
<th>2011 %</th>
<th>Total No.</th>
<th>Total %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Restaurant</td>
<td>74</td>
<td>36.8</td>
<td>89</td>
<td>34.9</td>
<td>99</td>
<td>40.2</td>
<td>262</td>
<td>37.3</td>
</tr>
<tr>
<td>Eating House</td>
<td>31</td>
<td>15.4</td>
<td>53</td>
<td>20.8</td>
<td>34</td>
<td>13.8</td>
<td>118</td>
<td>16.8</td>
</tr>
<tr>
<td>Licensed caterer</td>
<td>12</td>
<td>6.0</td>
<td>25</td>
<td>9.8</td>
<td>24</td>
<td>9.8</td>
<td>61</td>
<td>8.7</td>
</tr>
<tr>
<td>Hawker centre</td>
<td>23</td>
<td>11.4</td>
<td>16</td>
<td>6.3</td>
<td>18</td>
<td>7.3</td>
<td>57</td>
<td>8.1</td>
</tr>
<tr>
<td>Food court</td>
<td>11</td>
<td>5.5</td>
<td>18</td>
<td>7.1</td>
<td>14</td>
<td>5.7</td>
<td>43</td>
<td>6.1</td>
</tr>
<tr>
<td>Fast food outlet</td>
<td>9</td>
<td>4.5</td>
<td>9</td>
<td>3.5</td>
<td>10</td>
<td>4.1</td>
<td>28</td>
<td>4.0</td>
</tr>
<tr>
<td>Canteen</td>
<td>5</td>
<td>2.5</td>
<td>10</td>
<td>3.9</td>
<td>10</td>
<td>4.1</td>
<td>25</td>
<td>3.6</td>
</tr>
<tr>
<td>In-house (eg dormitory)</td>
<td>6</td>
<td>3.0</td>
<td>1</td>
<td>0.4</td>
<td>8</td>
<td>3.3</td>
<td>15</td>
<td>2.1</td>
</tr>
<tr>
<td>Unlicensed caterer</td>
<td>4</td>
<td>2.0</td>
<td>5</td>
<td>2.0</td>
<td>0</td>
<td>0</td>
<td>9</td>
<td>1.3</td>
</tr>
<tr>
<td>Supermarket</td>
<td>3</td>
<td>1.5</td>
<td>2</td>
<td>0.8</td>
<td>2</td>
<td>0.8</td>
<td>7</td>
<td>1.0</td>
</tr>
<tr>
<td>Fun/food fairs</td>
<td>3</td>
<td>1.5</td>
<td>1</td>
<td>0.4</td>
<td>1</td>
<td>0.4</td>
<td>5</td>
<td>0.7</td>
</tr>
<tr>
<td>Food factory</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0.8</td>
<td>2</td>
<td>0.3</td>
</tr>
<tr>
<td>Others</td>
<td>20</td>
<td>10.0</td>
<td>26</td>
<td>10.2</td>
<td>24</td>
<td>9.8</td>
<td>70</td>
<td>10.0</td>
</tr>
<tr>
<td>Total</td>
<td>201</td>
<td>100</td>
<td>255</td>
<td>100</td>
<td>246</td>
<td>100</td>
<td>702</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 7
Percentage of stool samples from reported cases tested positive for various pathogens, Jan 09 – Dec 11

<table>
<thead>
<tr>
<th>Pathogens</th>
<th>2009 % (no. positive/no. tested)</th>
<th>2010 % (no. positive/no. tested)</th>
<th>2011 % (no. positive/no. tested)</th>
<th>Total % (no. positive/no. tested)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salmonella species</td>
<td>45.7% (35/77)</td>
<td>76.7% (30/39)</td>
<td>90.5% (63/69)</td>
<td>75.0% (128/175)</td>
</tr>
<tr>
<td>Vibrio species</td>
<td>42.9% (30/71)</td>
<td>20.0% (10/50)</td>
<td>1.6% (1/63)</td>
<td>16.4% (42/250)</td>
</tr>
<tr>
<td>Norovirus</td>
<td>2.8% (1/47)</td>
<td>3.3% (1/31)</td>
<td>6.3% (1/16)</td>
<td>4.7% (3/64)</td>
</tr>
<tr>
<td>Rotavirus</td>
<td>5.7% (1/18)</td>
<td>0.0% (0/30)</td>
<td>0.0% (0/51)</td>
<td>1.6% (1/90)</td>
</tr>
<tr>
<td>Aeromonas species</td>
<td>2.9% (1/34)</td>
<td>0.0% (0/31)</td>
<td>1.6% (1/61)</td>
<td>1.6% (2/96)</td>
</tr>
</tbody>
</table>
Table 8
Percentage of food and environmental swabs tested positive for various pathogens, Jan 09 – Dec 11

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Escherichia coli</td>
<td>16.7%</td>
<td>35.7%</td>
<td>38.5%</td>
<td>35.0%</td>
</tr>
<tr>
<td>Staphylococcus aureus</td>
<td>49.9%</td>
<td>32.2%</td>
<td>15.4%</td>
<td>26.7%</td>
</tr>
<tr>
<td>Bacillus cereus</td>
<td>16.7%</td>
<td>10.7%</td>
<td>19.2%</td>
<td>15.0%</td>
</tr>
<tr>
<td>Vibrio parahaemolyticus</td>
<td>16.7%</td>
<td>10.7%</td>
<td>7.7%</td>
<td>10.0%</td>
</tr>
<tr>
<td>Salmonella species</td>
<td>0</td>
<td>3.6%</td>
<td>15.4%</td>
<td>8.3%</td>
</tr>
<tr>
<td>Norovirus</td>
<td>0</td>
<td>7.1%</td>
<td>3.8%</td>
<td>5.0%</td>
</tr>
</tbody>
</table>

The predominant pathogens detected among the food handlers were *Salmonella* species, *Aeromonas* species and norovirus.

During field investigation, NEA will verify if the food handlers had attended and passed the Basic Food Hygiene Course, which is a mandatory requirement. Those who failed to attend and pass the course will be considered as unregistered food handlers. A small proportion (3%) of the 1,484 food handlers screened was found to be unregistered which ranged from 0.9% to 4.2% (Table 10).

51.6% of the food handlers with positive stool samples were foreigners. Of the remaining food handlers who were Singapore residents, the majority were Chinese (67.8%) and Indian (23.7%). The rate of foreigners screened positive (42 per 1,000 screened) was slightly higher than that of Singapore residents (40 per 1,000 screened) (Table 11).

Food handlers who had positive stool samples were interviewed by MOH officers to determine their health status prior to the collection of the stool sample. They were also banned from work until certified fit by a medical practitioner (i.e. when repeat stool samples became negative). Based on the information provided by the food handlers during the interview, a minority of them (8.2%) reported being symptomatic with gastroenteritis symptoms prior to the food poisoning outbreak (Table 12).

**Discussion**

Food poisoning outbreaks occurred throughout the year in Singapore with no distinct pattern observed. There are several factors which may contribute to this observation, such as under-reporting of cases as well as cases who did not seek medical attention even if they had food poisoning symptoms. In a study done in the UK, food-borne outbreaks mostly occurred in summer (37.4%) and spring (15.5%). As Singapore experiences a tropical climate throughout the year, this could explain why there was no specific seasonality pattern. Nevertheless, we have observed that the number of food poisoning notifications has continued to increase over the years, with a greater number of people reported to be affected. This increase could be due to either a true increase in the number of food-borne illnesses, and/or an increase in awareness in the population, leading to increased reporting.

Singapore is a multi-cultural food paradise and well-known for the wide variety of food available.
Table 9
Percentage of food handlers tested positive for various pathogens, Jan 09 – Dec 11

<table>
<thead>
<tr>
<th>% (no. positive/no tested) with pathogens</th>
<th>2009</th>
<th>2010*</th>
<th>2011*</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>8.7% (37/427)</td>
<td>7.7% (46/601)</td>
<td>8.6% (39/456)</td>
<td>8.2% (122/1,484)</td>
</tr>
<tr>
<td>Salmonella species</td>
<td>37.8%</td>
<td>54.2%</td>
<td>38.5%</td>
<td>44.3%</td>
</tr>
<tr>
<td>Aeromonas species</td>
<td>16.2%</td>
<td>28.2%</td>
<td>20.5%</td>
<td>22.1%</td>
</tr>
<tr>
<td>Norovirus</td>
<td>10.8%</td>
<td>2.2%</td>
<td>23.1%</td>
<td>11.5%</td>
</tr>
<tr>
<td>Rotavirus</td>
<td>10.8%</td>
<td>4.3%</td>
<td>7.6%</td>
<td>7.4%</td>
</tr>
<tr>
<td>Plesiomonas shigelloides</td>
<td>10.8%</td>
<td>2.2%</td>
<td>7.6%</td>
<td>6.5%</td>
</tr>
<tr>
<td>Campylobacter species</td>
<td>8.2%</td>
<td>8.7%</td>
<td>5.1%</td>
<td>7.4%</td>
</tr>
<tr>
<td>Vibrio parahaemolyticus</td>
<td>2.7%</td>
<td>2.2%</td>
<td>2.6%</td>
<td>2.5%</td>
</tr>
<tr>
<td>Salmonella typhi</td>
<td>2.7%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.8%</td>
</tr>
</tbody>
</table>

* In 2010, one sample was tested positive for Aeromonas and Campylobacter species
* In 2011, one sample was tested positive for Salmonella species and Plesiomonas shigelloides and another sample was tested positive for Salmonella species and Vibrio parahaemolyticus

Table 10
Breakdown of food handlers screened by registration status, Jan 09 – Dec 11

<table>
<thead>
<tr>
<th></th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
<td>%</td>
<td>No.</td>
<td>%</td>
</tr>
<tr>
<td>No. of registered</td>
<td>423</td>
<td>99.1</td>
<td>579</td>
<td>96.3</td>
</tr>
<tr>
<td>food handlers</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of unregistered</td>
<td>4</td>
<td>0.9</td>
<td>22</td>
<td>3.7</td>
</tr>
<tr>
<td>food handlers</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>427</td>
<td>100</td>
<td>601</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 11
Food handlers tested positive for pathogens by ethnic group and rate per 1,000 screened, Jan 09 – Dec 11

<table>
<thead>
<tr>
<th>Singapore Citizen / PR</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
<td>%</td>
<td>No.</td>
<td>%</td>
</tr>
<tr>
<td>Chinese</td>
<td>15</td>
<td>83.3</td>
<td>11</td>
<td>57.9</td>
</tr>
<tr>
<td>Malay</td>
<td>0</td>
<td>0.0</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>Indian</td>
<td>3</td>
<td>16.7</td>
<td>6</td>
<td>42.1</td>
</tr>
<tr>
<td>Others</td>
<td>0</td>
<td>0.0</td>
<td>2</td>
<td>10.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rate per 1,000 screened</td>
<td>42</td>
<td></td>
<td>32</td>
<td></td>
</tr>
<tr>
<td>Foreigners</td>
<td>19</td>
<td>51.4</td>
<td>27</td>
<td>58.7</td>
</tr>
<tr>
<td>Rate per 1,000 screened</td>
<td>44</td>
<td></td>
<td>45</td>
<td></td>
</tr>
</tbody>
</table>
In addition, compared to the past, a larger number of people are eating meals prepared at restaurants, eating houses, hawker centres and food courts. The highest proportion of reported food poisoning outbreaks in Singapore was linked to restaurants. A study done in the US showed a similar trend, with 52% of the food-borne disease outbreaks associated with restaurants.

In recent years, the number of catering services has surged to cope with demands from consumers. At the same time, there has been an increase in the number of unlicensed catering businesses. According to the Singapore Department of Statistics, food caterers recorded the highest profitability ratio of 19.2% among all the F&B services groups in 2010. Factors such as preparation of large quantities of catered food within short timeframes, long duration from food preparation till consumption and sub-optimal temperature control at the site where the food is consumed create ample opportunities for contamination and multiplication of pathogens. There has been an increase in the number of food poisoning outbreaks linked to catering services, highlighting a need to implement more stringent control measures for caterers, who typically cater to large numbers of people at the same time. Since February 2012, NEA has implemented a time-stamping regulation, in which caterers have to specify the time ready-to-eat food has to be consumed. The interval cannot be longer than 4 hours in total from the time the food is first prepared for consumption.

Stool samples from affected cases are important in helping to determine the causative agent of an outbreak. *Salmonella* species was the most common pathogen isolated from cases and food handlers in food poisoning outbreaks investigated between January 2009 and December 2011. Studies conducted in UK and Saudi Arabia also revealed that *Salmonella* species accounted for most outbreaks and were responsible for 81% of the cases detected. In the US, *Salmonella* species was the second most common food-borne pathogen identified, and the leading cause of death for food-borne illnesses.

The pick-up rate for pathogens in food samples and environmental swabs collected was extremely low at 2.5% - 9.0% in Singapore. This result is not surprising as food poisoning incidents are usually reported a few days after consumption of the implicated meal. As such, by the time field investigations are carried out, the implicated food item is often no longer available for testing. In such instances, samples will be randomly collected from a different batch of food samples which are available at the time of inspection. In particular, high-risk and ready-to-eat foods are chosen for sampling.

### Table 12

<table>
<thead>
<tr>
<th></th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
<td>%</td>
<td>No.</td>
<td>%</td>
</tr>
<tr>
<td>Symptomatic</td>
<td>3</td>
<td>8.1</td>
<td>2</td>
<td>4.3</td>
</tr>
<tr>
<td>Asymptomatic</td>
<td>34</td>
<td>91.9</td>
<td>44</td>
<td>95.7</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>37</strong></td>
<td><strong>100</strong></td>
<td><strong>46</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>
Food handlers play an important part in ensuring that the food prepared is safe for consumption. However, due to the high turnover rate, licensees may deploy food handlers even if they have not yet attended the Basic Food Hygiene Course. This accounted for the discovery of unregistered food handlers during field investigations.

In addition, the proportion of food handlers who had positive stool samples showed an increase from 3.1% in 2001-2005 to 8.2% in 2009-2011. There were more food handlers screened positive for norovirus since the laboratory testing was established in 2004. Inadequate knowledge on food hygiene practices may increase the risk of food-borne illnesses through inadvertent cross-contamination of food or lack of attention to proper food preparation practices. In addition, food handlers may continue to work even if they are ill, as they may not feel that their symptoms are serious enough to prevent them from working. This practice, coupled with poor personal hygiene practices, could increase the risk of food-borne outbreaks.

Food poisoning remains an important public health concern in Singapore. Food poisoning outbreaks can be prevented through better public education on safe food preparation and consumption practices, adequate training of food handlers and constant vigilance by government agencies on food hygiene standards.

(Reported by Toh HY, Fong NP and Tay J, Communicable Diseases Division, Ministry of Health and Saw Swee Hock School of Public Health, National University of Singapore)

References


Epidemiological News Bulletin
Norovirus outbreak at a nursing home in Singapore

Introduction

On 28 Nov 2011, the Ministry of Health (MOH) was notified of a possible gastroenteritis outbreak at a nursing home, involving 51 residents (including 12 hospitalised cases) who had developed fever, diarrhoea and vomiting between 20 and 28 Nov 2011.

The 4-storey nursing home, which is licensed by MOH, has a total of 135 residents and 95 staff (10 administrative and 78 nursing staff, 2 house keepers and 5 food handlers). An epidemiological investigation on this outbreak, including an inspection at the implicated nursing home, was carried out immediately. This report summarizes the findings of the outbreak investigation.

Methods

A case was defined as a resident or staff of the nursing home who developed one or more symptoms of gastroenteritis (vomiting, watery diarrhea, abdominal pain, fever and nausea) between 18 Nov and 5 Dec 2011.

Cases from the nursing home were identified and their personal particulars such as age, gender and ethnicity were recorded with the help of the nursing manager. Signs and symptoms of those who were ill and the types of medical treatment sought were also obtained. Active case detection was carried out by interviewing staff, nurses and food handlers from the home.

Findings

Through active case detection, additional four more cases were detected using the case definition above. A total of 55 cases, which consisted of 53 residents and 2 staff, were identified, giving an overall attack rate of 23.9%. The attack rate was 39% for residents compared to 2.1% for staff only. The mean age of the 53 affected residents was 78 years. The two affected staff were aged 27 and 41 years, respectively. Their clinical features comprised watery diarrhoea (83.2%), vomiting (79.2%), fever (20.8%) and abdominal cramp (1.8%). A total of 16 cases (29%) were hospitalized for observation while the rest were treated by the nursing home’s medical team. All recovered uneventfully. The epidemic curve is shown in Fig. 15.

In this institution, the majority of the residents were nursed in rooms on the second and third floors. Most of the cases of the outbreak were also from residents of these two floors, with only one case from the first and two cases from the fourth floors. The attacked rates per floor were 8.3% in level 1, 54.5% in level 2, 37.7% in level 4 and 13.3% in level 4. All the cases had moderate to severe functional and cognitive disabilities, including 17 who were completely dependent for all aspects of care and required tube-feeding.

All four stool samples obtained from the cases were tested positive for norovirus. Further genetic analyses of the viruses carried out by the National Public Health Laboratory, showed that all were of the same genotype GII.

Five food handlers were referred to the Communicable Disease Centre, Tan Tock Seng hospital, for stool screening for common enteropathogens in Singapore (Shigella, Campylobacter, Vibrio, Sal-
monella, rotavirus and norovirus). One was tested positive for rotavirus and he was one of the three staff members involved in daily food preparation for residents. Another food handler was tested positive for Aeromonas veronii. This food handler was the supervisor of the kitchen and he worked only part-time (i.e. 3 days a week) there.

Meals were prepared and cooked at an in-house kitchen and were consumed by all staff and residents. All food handlers and staff were well prior to the incident. The kitchen was found clean and satisfactorily maintained during the site inspection. No major hygiene lapses were observed.

In the 2-week period prior to this incident, the nursing home had not organized any social functions involving visitors and guests. However, the nursing manager confirmed that when relatives and families visited the home, it was a common practice for them to bring food for the residents.

**Prevention and control**

At the time of investigating this outbreak, the home had already stepped up infection control procedures to prevent further ongoing transmission especially at the second and third levels where the attack rate was higher. In addition, to break the chain of transmission, MOH advised a number of infection control measures:

1. Identify and isolate sick residents and staff early;
2. Set up isolation rooms for cases.
3. Promote frequent hand washing with proper techniques among healthcare workers and other
staff, especially after attending to patients, toilet visits and before eating or preparing food;

4. Put on hold the daily morning physical activity session for the residents from 25 Nov.

5. Prohibit visitors to the home.

6. Promote frequent hand washing with proper techniques among healthcare workers and other staff, especially after attending to patients, toilet visits and before eating or preparing food;

7. Carry out regular disinfection of frequently contacted surfaces such as door handles, knobs, staircase railings and lift buttons;

8. Ensure that toilets are in a sanitary condition and adequately equipped with soap and toilet papers;

9. Ensure adequate ventilation in places of congregation, such as the wards and avoid overcrowding; and

10. Remind food handlers to observe good food and personal hygiene, and to refrain from handling food if they are unwell.

Following strict observation of prevention and control measures, the outbreak subsided with the onset of illness of the last reported case occurring on 1 Dec 2011.

Discussion

The epidemiological and clinical features of this outbreak, with watery diarrhoea and vomiting as the predominant symptom suggest that this was probably an outbreak of viral gastroenteritis transmitted from person to person. The isolation of norovirus genogroup GII from the stools of 4 cases pointed to this viral pathogen as the aetiology of the outbreak. The findings of rotavirus and Aeromonas veronii were likely to be incidental, as both food handlers were asymptomatic prior to this incident, and these pathogens were not isolated from the cases.

Noroviruses are highly contagious and are usually transmitted directly from person to person by faecal-oral spread, and indirectly through contaminated food and water, or environmental contact1. Good evidence exists for transmission due to aerosolisation of vomitus that presumably results in droplets contaminating surfaces or entering the oral mucosa and being swallowed. There is no evidence to suggest that infection occurs through the respiratory system2.

Seroprevalence studies in the Amazon, southern Africa, Mexico, Chile, and Canada have shown that norovirus infections are common throughout the world, and most children will have experienced at least 1 infection by the age of 5 years. In both developing and developed countries, noroviruses are estimated to cause 12% of all severe diarrhoeal disease3. Norovirus is the leading cause in the United States constituting over 50% of all foodborne-disease outbreaks due to a known cause that were reported to the US Centers for Disease Control and Prevention from 2006 to 20084. In Germany, according to the Robert-Koch-Institute in Berlin, the number of norovirus outbreaks has increased by 20% between 2009 and 2010 and become the top among reportable diseases5. In Singapore, a recent study carried out by the Communicable Diseases Division highlighted an increasing trend of detection of norovirus in reported gastroenteritis outbreaks (2.8% to 6.3%) as well as in implicated food handlers (10.8% to 23.1%) between 2009 and 20116.

The incubation period for norovirus is 12-48 hours and symptoms may last 24-72 hours. The virus
is usually present in very high amounts in the stool and vomitus of those who are unwell, and the infection can be transmitted rapidly in crowded, closed settings. Healthcare facilities, including nursing homes and hospitals, are the most commonly reported settings for norovirus outbreaks in the United States and other industrialized countries. Nearly two-thirds of all norovirus outbreaks reported in the United States occur in long-term care facilities.

Noroviruses in humans belong to one of three norovirus genogroups (GI, GII, or GIV), which are further divided into >25 genetic clusters. Over 75% of confirmed human norovirus infections are associated with genotype GII.

The index case, a 91 year-old female resident, presented with symptoms on 20 Nov 2011. The infection may have been subsequently transmitted to other cases through contact in the wards or during the physical activity sessions in the morning. She could have been infected by an asymptomatic relative or through consumption of contaminated food brought in by a visitor. However, as the history could only be obtained from the nurses and not from the case, this hypothesis could not be confirmed.

It is unlikely that this outbreak was due to contaminated food prepared at the in-house kitchen, as the meals prepared by the kitchen were consumed by all the staff and residents, and out of 95 staff, only two were affected. A much higher attack rate among the staff would have been expected if the in-house meals were the cause of this outbreak.

The following factors could have also contributed to the explosive nature of the outbreak:

There were a high proportion of cases (80%) with vomiting. The nursing manager of the home confirmed that some of the cases had vomited during their physical activity and TV watching sessions. Vomiting can give rise to infectious droplet aerosols and widespread contamination of the environment.

The densely populated floors and the sharing of facilities such as toilets and common TV areas could facilitate transmission of the infection to other susceptible residents in the same ward. The first and fourth floors of the home had proportionately fewer residents than that of the second and third floors. The majority of the cases from the second and third floors (55% and 36%, respectively of all cases) corroborating the hypothesis that the infection could have been transmitted rapidly in crowded and closed settings.

Since nurses were not assigned to a specific floor for their duties, affected nurses could also have spread the virus to susceptible resident in the different floors.

There were substantial limitations to the investigation. No case-control study was conducted due to a potential recall bias as more than 80% of the affected cases were frail and elderly. Furthermore, no food samples and environmental swabs could be collected during the field investigation because the kitchen was in the midst of cleaning and no cooked food sample was available for microbial analysis.

To prevent the recurrence of similar outbreaks, MOH has directed the nursing home on measures to improve environmental, food and personal hygiene and in-house infection control procedures.
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