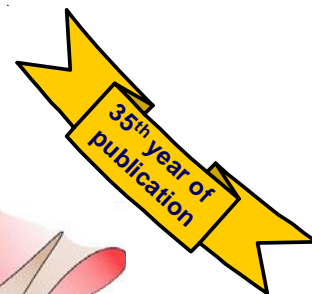


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Fighting a rising tide – update of the HIV/AIDS situation in Singapore 2008

Introduction

Human immunodeficiency virus (HIV)/acquired immunodeficiency syndrome (AIDS) remains an important public health challenge in Singapore. The number of newly diagnosed HIV-infected cases has been steadily increasing over the past decade, mirroring the trend in other Asian countries.

Singapore's multi-pronged National HIV/AIDS Control Programme comprises education of the general public and high-risk groups, legislation, protection of the national blood supply through screening of blood and blood products, management of cases and contact tracing, epidemiological surveillance, and scaling up the prevention and control of conventional sexually-transmitted infections (STIs)¹.

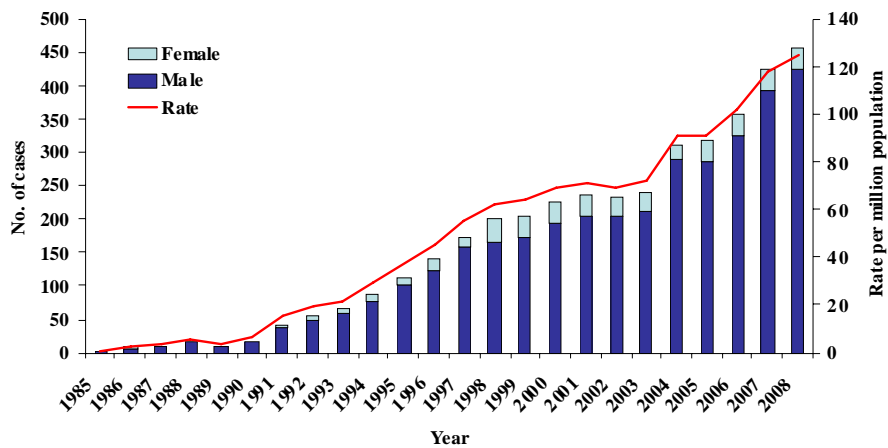
Epidemiology of HIV infection/AIDS

The first case of HIV infection in Singapore was reported in 1985, followed by notification of the first case of AIDS in September 1986. The number of reported cases of HIV infection and AIDS increased rapidly from 42 cases (15.0 per million population) in 1991 before stabilising at 206 cases (63.8 per million population) in 1999. However, the upward trend accelerated in recent years to 311 cases (91.1 per million population) in 2004, and further increased to 456 cases (125.2 per million population) in 2008 (*Fig. 1*). As at end 2008, the total reported number of HIV-infected Singaporeans stood at 3941 cases. Of these, 1799 are asymptomatic carriers, 914 have AIDS-related illnesses and 1228 have died.

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Figure 1
Incidence of new HIV-infected/AIDS cases, 1985 – 2008



Since 1985, the major route of HIV transmission has been sexual. While the mode of HIV transmission at the beginning of the epidemic had been predominantly homosexual or bisexual, heterosexual transmission has become the main mode of HIV transmission in Singapore since the early 1990s.² However, recent trends show that homosexual or bisexual cases now comprise a progressively larger proportion of annual HIV/AIDS notifications; 40.6% were infected via homosexual or bisexual mode of transmission in 2008 compared to 21.1% during 1985-2001 (*Table 1*). At the same time, the proportion of heterosexual cases decreased from 72.5% during 1985-2001 to 54.4% in 2008. HIV infection through intravenous drug use, perinatal transmission and organ transplantation overseas has remained low. Infection via intravenous drug use and perinatal transmission accounted for 2.4% and 0.7%, respectively of the cumulative cases as at end 2008. In 2008, intravenous drug use accounted for 4% of cases (20 cases) - 16 of these cases were detected as a result of screening in prisons

and drug rehabilitation centres, and 4 in the course of medical care.

The HIV infection/AIDS epidemiology in Singapore is characterised by a predominance of male cases (gender ratio 9:1), in sharp contrast to other countries with generalized HIV epidemics in which heterosexual transmission is the predominant mode of transmission. In such countries, almost half of the HIV-infected/AIDS cases are in women.³

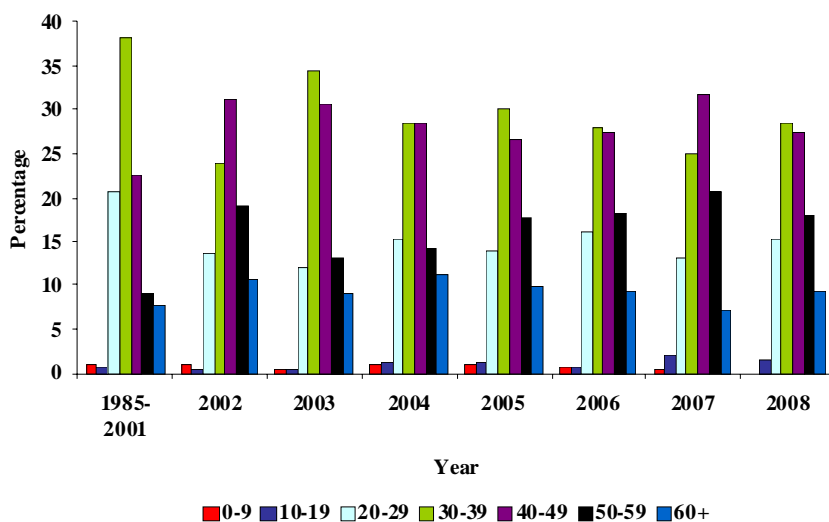
Nearly one-third of newly diagnosed HIV-infected cases in Singapore were in the age group of 30 - 39 years at diagnosis (*Fig. 2*). Amongst males, the highest proportion of cumulative HIV-infected/AIDS cases was in the age group 30 - 39 years (32.8%), followed by those in the age group 40 - 49 years (27.2%). Amongst the females, the age distribution of female HIV-infected/AIDS patients peaked in the age group 20 - 29 years (30.5%) and 30 - 39 years (27.3%).



Table 1
Distribution of HIV-infected cases by mode of transmission, 1985 – 2008

Mode of transmission	1985 – 2001	2002	2003	2004	2005	2006	2007	2008
Sexual transmission								
Heterosexual	1160	181	177	188	186	222	255	248
Homosexual	191	30	40	72	87	95	130	151
Bisexual	146	12	14	22	14	14	15	34
Intravenous drug use	32	6	4	7	4	14	7	20
Blood transfusion	3	0	0	0	0	0	1	0
Renal transplant overseas	5	0	0	0	0	0	0	0
Perinatal (mother to child)	15	2	1	4	3	2	2	0
Uncertain	47	3	6	18	23	12	13	3
Total	1599	234	242	311	317	359	423	456

Figure 2
Distribution (%) of HIV-infected /AIDS cases by age group (years), 1985 – 2008



As at end 2008, over half (60.8%) of the men were single while the majority of women (60.0%) were married at the time of diagnosis (*Table 2*). Among those who acquired the infection through the sexual route, 89% had sexual exposure to commercial sex workers (locally and overseas) and/or casual partners.

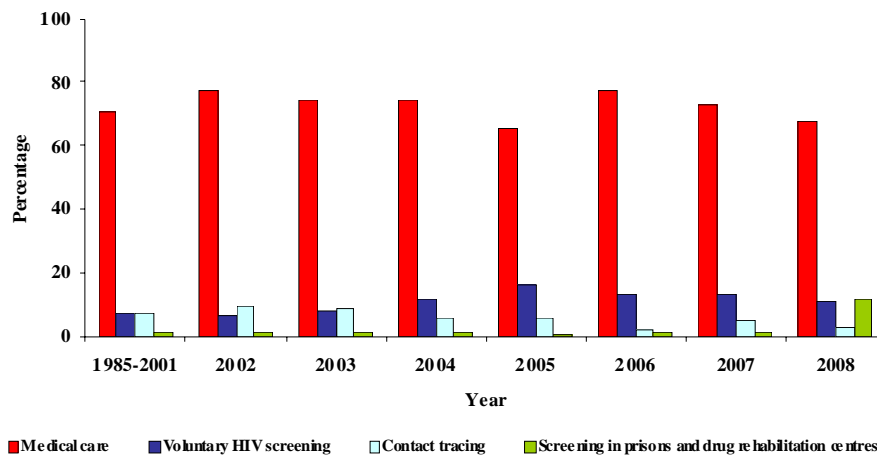
The proportion of HIV-infected/AIDS cases detected as a result of voluntary HIV screening increased from 7% in 1985-2001 to 11% in 2008 (*Fig. 3*). However, the majority of cases are still detected in the

course of medical care. Excluding 51 cases detected as a result of screening in prisons and drug rehabilitation centres, more than three-quarters of the 405 new cases in 2008 (76%) had their HIV infection detected when they had HIV testing in the course of some form of medical care. About 12% were detected as a result of voluntary HIV screening, compared to 13% of 416 cases in 2007. The rest were detected through contact tracing and other screening. When differentiated by sexual orientation, a higher proportion of homosexuals had their HIV infection detected via voluntary

Table 2
Distribution of HIV Cases by marital status and gender, 1985 – 2008

Marital status	1985 – 2001	2002	2003	2004	2005	2006	2007	2008
Male								
Single	868	106	112	180	176	200	230	280
Married	376	71	65	74	82	92	114	105
Divorced/Separated	119	25	28	25	27	30	42	37
Widowed	35	4	7	11	2	5	6	4
Female								
Single	40	6	3	7	7	8	6	1
Married	128	15	21	8	19	17	17	17
Divorced/Separated	19	3	5	2	3	6	7	7
Widowed	14	4	1	4	1	1	1	5

Figure 3
Distribution (%) of HIV-infected /AIDS cases by mode of detection, 1985 – 2008



screening compared to heterosexuals (24% vs 3%), similar to 2007 (29% vs 5%).

In 2008, 50% of the new cases already had late-stage HIV infection when they were diagnosed. Late-stage HIV infection was defined as having a CD4 cell count of less than 200 per mm³ or developing AIDS-defining opportunistic infections at first diagnosis or within one year after HIV diagnosis when the cases were diagnosed. This was similar to the pattern in previous years.

Late-stage HIV infection was mainly detected through diagnostic testing as a result of illnesses. In a retrospective study of HIV-infected/AIDS cases diagnosed between 1985 to 2007 and who were infected via the sexual route, independent factors significantly associated with late-stage HIV infection at diagnosis were being male; aged 30 years and older; being a blue-collar worker, having administrative or service-oriented occupations, or being unemployed; having HIV testing done in the course of some form of medical care; and infection via the heterosexual route.⁴

Comments

The increase in HIV/AIDS notifications in recent years is taking place in a background of an increasing incidence of STIs in Singapore. Unprotected sexual transmission is the major route of HIV transmission in Singapore, and both HIV infection and STIs are indicators of high-risk sexual behaviour with non-monogamous partners. Hence, the trends in the incidence of acute STIs such as gonorrhoea and infectious syphilis serve as early warning signals for potential spread of HIV infection. The incidence of STIs reached a trough in 1996 at 151.7 per 100,000 population from 945.9 per 100,000 population in 1980, and

subsequently resumed an upward trend. The STI incidence increased from 198.6 per 100,000 population in 2003 to 256.7 per 100,000 population in 2004. In 2008, the overall incidence for STIs was 253.8 per 100,000 population.

To address the rising trend of HIV and STI, the Health Promotion Board's educational campaigns have continued to advocate abstinence from casual and commercial sex, as well as being faithful to one's partner. Consistent and correct condom use is strongly advised for those who engage in high-risk sexual behaviour, such as those who have multiple sexual partners or who engage in casual or commercial sex. It is an offence under the Infectious Diseases Act for persons who know that they are infected with HIV not to inform their sex partners of their HIV-infection status before sexual intercourse. The amendment of the Infectious Diseases Act in 2008 now requires that a person who has reason to believe that he has, or has been exposed to a significant risk of contracting, HIV-infection/AIDS must take reasonable precautions to protect his sexual partner, such as by using condoms, even if he is ignorant of his HIV-positive status. Alternatively, he can go for a HIV test to confirm that he is HIV-negative. Otherwise, he must inform his partner of the risk of contracting HIV infection from him, leaving the partner to voluntarily accept the risk, if he or she so wishes.

The Ministry of Health (MOH) has undertaken a series of initiatives in recent years to enhance the prevention and control of HIV infection/AIDS in Singapore.

(1) Enhancing national leadership on HIV infection/AIDS

On 1 December 2006, MOH formed a new National HIV/AIDS Policy Committee, which comprises



representatives from seven ministries (Health; Defence; Home Affairs; Community, Youth and Sports; Manpower; Education; Information, Communication and the Arts), the Communicable Disease Centre, the National Skin Centre, the Health Promotion Board, the AIDS Business Alliance and Action for AIDS. The Committee provides guidance on all policy matters related to HIV infection/AIDS, including public health, legal, ethical, social and economic issues, and coordinates a broad-based multi-sectoral approach to the prevention and control of HIV infection/AIDS in Singapore.

(2) Enhancing education programmes

A cornerstone of the National HIV/AIDS Control Programme in Singapore is education, to equip the population with the necessary information to protect themselves against HIV infection/AIDS, as well as to address stigma and discrimination against those infected and affected by HIV/AIDS. Education programmes for the general population, high-risk groups, schools, and workplaces are constantly reviewed and enhanced to ensure that their educational messages continue to remain relevant.

(3) Encouraging more HIV testing

(a) Implementation of voluntary opt-out HIV testing for hospital inpatients

In September 2006, the US Centers for Disease Control and Prevention (CDC) issued its “Revised recommendations for HIV testing of adults, adolescents, and pregnant women in health-care settings”, in which it recommended that screening for HIV infection should be performed routinely for all patients aged 13-64 years, and that health-care providers should initiate screening unless prevalence of undiagnosed HIV infection in their patients has been documented to be <0.1%.⁵

To determine the HIV seroprevalence among hospital patient population, MOH undertook an unlinked HIV surveillance study of more than 3000 anonymous blood samples collected in hospitals from February to March 2007. It was found that 0.28% of the patients who were not previously known to be HIV-positive were actually infected.

In 2008, MOH worked with acute public sector hospitals to implement voluntary opt-out HIV testing for hospital inpatients aged 21 years and above. The objective of this programme is to give inpatients an opportunity to have HIV screening done as part of the routine medical care they receive during their stay in hospitals. Such screening will facilitate earlier detection of HIV infection, which improves health outcomes. The majority of persons who are aware of their HIV infections also substantially reduce sexual behaviours that might transmit HIV, thus helping to control the spread of HIV.

(b) Increasing access to anonymous HIV testing

On 1 November 2008, MOH gave approval for four additional general practitioner (GP) clinics to offer anonymous HIV testing. There are now a total of seven anonymous HIV test sites in Singapore, comprising six GP clinics and the Action for AIDS anonymous HIV test site. In 2008, a total of 9,916 anonymous HIV tests were carried out, of which 143 (1.4%) were HIV-positive.

(4) Formation of the National Public Health Unit

National HIV surveillance, maintenance of the National HIV Registry, epidemiological analysis, and contact tracing and partner notification are all important public health functions that support the monitor-



ing and control of the HIV infection in Singapore. Historically, these HIV-related public health functions were carried out by several different agencies in Singapore. In September 2008, MOH formed the National Public Health Unit to integrate these different functions under one roof. This will help to bring about greater efficiencies and enhance our effectiveness in carrying out these functions.

Conclusion

HIV infection/AIDS is a multi-faceted problem which requires close collaboration among the public, private and people sectors. The rising trend in HIV infection/AIDS calls for continued concerted efforts on the part of all stakeholders to tackle the problem in a holistic and effective manner.

(Reported by Ang LW and Tay J, Communicable Diseases Division, Ministry of Health)

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An outbreak of norovirus gastroenteritis in a community hospital

Notification

On 17 November 2008, the Ministry of Health (MOH) was notified of an acute gastroenteritis outbreak involving residents and staff at a community hospital.

This was a step-down care institution which accommodated a total of 239 residents and served by 182 medical and nursing staff, and 42 non-nursing staff. It had an in-house kitchen with 11 food handlers who prepared vegetarian meals daily for both residents and

staff. There were 15 workers who were responsible for the cleanliness of the wards and public areas.

The institution comprised five wards located at the second, third and fourth levels of the building. Each ward contained 6-8 beds and was equipped with a shared bathroom. In the layout, the ground level housed facilities for the outpatients, the second level housed a single ward for patients under long-term care, the third level housed two wards for patients undergoing rehabilitation and palliative care, and the fourth



level housed two wards for patients under sub-acute and palliative care.

Epidemiological investigations were conducted to determine the cause and extent of the outbreak, source of infection, and mode of transmission.

Epidemiological findings

A total of 79 cases comprising 54 residents, 17 nursing staff and eight non-nursing staff were notified to MOH. 59 (75%) were Chinese, 9 (11%) Malays, 4 (5%) Indians and 7 (9%) others. There were 30 male residents and 24 female residents, giving a male to female ratio of 1.3. Their ages were between 23 and 100 years. Among the affected staff whose age ranged from 22 to 61 years, there was a female predominance with 22 females and 3 males, giving a female to male ratio of 7.3.

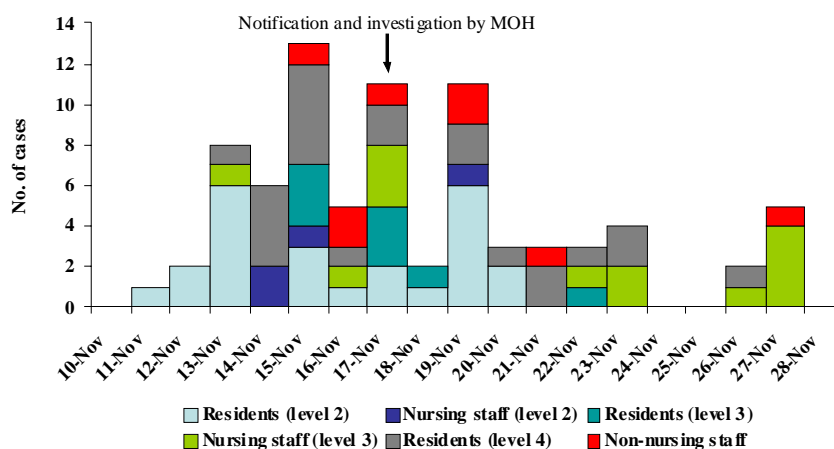
The presenting symptoms of the cases were vomiting (66%), diarrhoea (61%) and fever (3%). Majority (98%) received medical treatment at the hospital or private clinics while the remaining two

self-medicated. One fatality was reported in a 76-year-old male resident with a “recurrent stroke disease”. He developed symptoms in the morning of 13 November 2008 and died later at night from “acute gastroenteritis”.

The attack rates for residents and staff were 23% and 11%, respectively. The ward-specific attack rates among the residents were 36% in the second level ward, 11% in the third level ward and 27% in the fourth level ward. 50% of the affected residents were fed through nasogastric intubation while the rest were on oral diets and consumed food prepared in the in-house kitchen. No cases were identified among visitors to the institution.

The first case was traced to a patient from the level two ward whose onset of diarrhoea occurred on 11 November 2008. He was blind and immobile with no recent travel history, and consumed food prepared by the in-house kitchen. Furthermore, he had no recent visitors besides his wife who was apparently well. The outbreak initially affected residents from the level two ward but soon spread to the other wards (*Fig. 4*).

Figure 4
Time distribution of 79 cases of acute gastroenteritis in a community hospital by residents and staff, 11 – 27 November 2008



Environmental findings

The premises including the in-house kitchen was found to be clean and satisfactorily maintained, with no major environmental or food hygiene irregularities.

Microbiological findings

Of 19 stool samples obtained from the cases, 17 (89.5%) were found to be positive for norovirus genogroup II by PCR at the Department of Pathology, Singapore General Hospital. One sample of vomitus also tested positive. All 11 food handlers referred to the Communicable Disease Centre (CDC), Tan Tock Seng Hospital, for medical screening were tested negative for norovirus.

Prevention and control

At the time of investigations, the hospital had stepped up contact precautions at the level two ward where the first case was identified and cohorted affected residents to another ward at the fourth level on 14 November 2008. In addition, to break the chain of transmission, MOH advised a number of infection control measures:

- Identify and isolate sick residents and staff early;
- 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;
- Observe personal hygiene etiquette, including covering of mouth when coughing or sneezing and washing hands thereafter;
- Carry out regular disinfection of frequently contacted surfaces such as door handles, knobs, staircase railings and lift buttons;

- Ensure that toilets are in a sanitary condition and adequately equipped with soap and toilet papers;
- Ensure adequate ventilation in places of congregation, such as the wards and avoid overcrowding; and
- 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 27 November 2008.

Comments

Noroviruses represent one of four genera of the *Caliciviridae* family and are very common causes of outbreaks in semi-closed or closed communities such as nursing homes, hospitals, hotels and cruise ships¹⁻⁴. For most individuals, norovirus-associated gastroenteritis is self-limiting with symptoms like vomiting and diarrhoea that last for about one or two days. The virus can be transmitted via consumption of contaminated food or water and close contact with an infected person or infectious aerosolized droplets generated by talking, sneezing, coughing or vomiting⁵.

In health-care settings such as hospitals, patients and staff are subjected to prolonged periods of close contact and are therefore likely to be at risk of person-to-person transmission⁶. Unlike residents who were on oral diets and consumed food prepared in the in-house kitchen, liquid feed for residents on nasogastric tubes was prepared directly in the wards by nursing staff. Since residents who did not consume food from the in-house kitchen were similarly affected, contaminated food items from the kitchen were ruled



out as the vehicle of transmission. The ward at level two had the highest attack rate of 36% among residents. As the index case was also residing in the level two ward and was immobile, infection could have spread from the index case to the nursing staff who attended to him and subsequently to other residents in the same ward. Interaction among staff from the various wards probably contributed to the spread of infection from the level two ward to other wards. The female predominance among affected staff was because majority of them were nursing staff. In addition, elderly residents might be less conscientious about personal hygiene due to incontinence or diminished alertness, adding to the spread of infection.

In this outbreak, poor ventilation was observed during the site inspection and this may also contribute to the spread of the virus. Moreover, the hospital had noted a breach in infection control measures involving new and part-time staff at one of the wards. This high-

lights the importance of staff compliance with contact precautions for effective containment of the outbreak⁷. One death was reported in this outbreak. Previous surveillance data on norovirus outbreaks in the United Kingdom revealed that deaths were only reported from outbreaks in health-care institutions and it was postulated that populations in such institutions may be more susceptible by virtue of their greater age or presence of pre-existing or concurrent medical conditions⁶. Although norovirus infection is not likely to be the principal cause of death in most cases, the infection may pose additional burden to vulnerable individuals that are already weakened by other factors such as age, immune status and underlying medical conditions.

The current outbreak illustrates the risk of norovirus transmission in a hospital setting and highlights the importance of staff complying with hospital hygiene protocol and observing good personal hygiene practices at all times.

(Contributed by Tang ZC, Suhana S, Chan PP, Foong BH, Ooi PL and James L, Communicable Diseases Division, Ministry of Health)

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Tuberculosis in HIV-positive persons in Singapore

Human immunodeficiency virus (HIV) is a significant risk factor for progression to active tuberculosis (TB) in people with latent TB infection. The annual risk of developing TB in HIV-infected individuals ranges from 5-10%. Up to 60% of the purified-protein-derivative (PPD)-positive persons infected with HIV develop active TB during their lifetime. This percentage is 6 times greater than that for PPD-positive HIV-negative individuals. HIV increases the rate of recurrent TB, either due to endogenous re-activation or exogenous re-infection. In addition, an increase in TB cases in HIV-infected persons increases the risk of TB transmission to both HIV-positive and HIV-negative persons in the general community.^{1,2}

The incidence of HIV/AIDS in Singapore has been on the rise from 0.6 per 100,000 population in 1990 to 9.1 per 100,000 population in 2005 (*Fig. 5*). The incidence of TB was 49.9 per 100,000 population in 1990 and 37.9 per 100,000 population in 2005. This study describes the demographic and clinical characteris-

tics of HIV-infected patients who developed TB infections, and distribution of the time intervals between HIV infection and TB notifications.

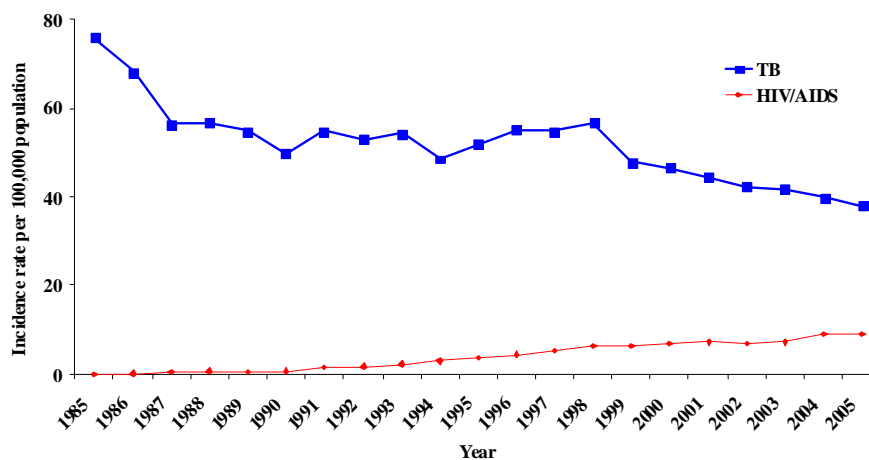
Methods and materials

We carried out a retrospective study matching TB cases that were diagnosed between 1990 and 2005 from the Singapore Tuberculosis Elimination Programme Registry, with the National HIV registry. A total of 210 TB cases among Singapore residents who had prior diagnosis of HIV were analysed in terms of socio-demographic characteristics, baseline CD4 counts, mode of HIV transmission, interval between time of HIV infection and TB diagnosis, as well as site of TB disease.

Results

Of the 210 cases, 96% were males and 88% were Chinese (*Table 3*). About two-thirds were aged 30 to 49 years old at the time of HIV diagnosis, more than

Figure 5
Incidence of HIV/AIDS and TB (per 100,000 population), 1985-2005



50% were blue collar workers and unemployed, 76% were heterosexuals, 74% had a baseline CD4 count of less than 200 per mm³ at first diagnosis of HIV, and 41% were notified to have active TB within one month of HIV diagnosis (Table 4). 43% of the cases presented with pulmonary TB alone and 23% with extrapulmonary TB alone.

Comments

More than half (57%) of the TB patients presented with extrapulmonary TB alone or both extrapulmonary and pulmonary TB, consistent with the findings in other

studies.³ TB cases which were notified within 6 months of HIV notification constituted 56% of the 210 cases. Taking into consideration the time required to confirm the diagnosis of TB, either clinically or based on positive culture result, prior to notification, it is likely that a considerable number of TB cases already had active infection at the time of HIV diagnosis. Further studies should be carried out to identify clinical and demographic determinants of HIV-infected patients who subsequently proceed to develop TB. The findings would guide public health interventions in the control of both TB and HIV infections.

Table 3
Demographic characteristics of 210 TB patients with existing HIV infection

Demographics	No. of patients (%)
Gender	
Male	202 (96.2)
Female	8 (3.8)
Ethnic group	
Chinese	184 (87.6)
Malay	15 (7.1)
Indian	9 (4.3)
Other	2 (1.0)
Age at HIV/AIDS diagnosis (years)	
10 - 19	2 (0.9)
20 - 29	42 (20.0)
30 - 39	89 (42.4)
40 - 49	50 (23.8)
50 - 59	17 (8.1)
60+	10 (4.8)
Occupation	
Services / sales	38 (18.1)
Production craftsman / assembler	41 (19.5)
Cleaner / labourer	35 (16.7)
Managerial / professional	21 (10.0)
Clerical	9 (4.3)
Technical	9 (4.3)
Unemployed	22 (10.5)
Prisoner	21 (10.0)
Others	14 (6.6)



Table 4

Epidemiological and clinical characteristics of 210 TB patients with existing HIV infection

Characteristic	No. of patients (% of total)
Mode of transmission	
Heterosexual	160 (76.2)
Homosexual	15 (7.1)
Bisexual	24 (11.4)
Intravenous drug use	11 (5.2)
Interval (months) between HIV-infection and TB diagnosis	
< 1 month	85 (40.5)
1 - 6 months	33 (15.7)
7 - 12 months	10 (4.8)
13 - 24 months	18 (8.5)
25 - 48 months	30 (14.3)
> 48 months	34 (16.2)
Site of disease	
Pulmonary alone	90 (42.9)
Extrapulmonary alone	49 (23.3)
Both pulmonary and extrapulmonary	71 (33.8)
Stage of HIV diagnosis*	
Not late stage	44 (21.0)
Late stage	166 (79.0)
Baseline CD4 counts (per mm³)	
<200	155 (73.8)
200 - 500	42 (20.0)
> 500	13 (6.2%)

* Late-stage HIV infection was defined as having a CD4 cell count of less than 200 per mm³ or developing AIDS-defining opportunistic infections at first diagnosis or within one year of HIV diagnosis.

(Reported by Tey SH¹, Ang LW¹, Chee CB², Wang YI², Leo YS², Cutter J¹ and James L¹, ¹Communicable Diseases Division, Ministry of Health and ²Tan Tock Seng Hospital)

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Clinical and laboratory findings of the 2008 chikungunya outbreak in Little India, Singapore

Introduction

Chikungunya virus, an arbovirus belonging to the *Alphavirus* genus of the *Togaviridae* family, was first isolated in Tanzania in 1953. The first outbreak in Asia was documented in Bangkok, Thailand, in 1958. Since then, outbreaks have been reported in Cambodia, Vietnam, Laos, Myanmar, Malaysia, Philippines, and Indonesia. In Indonesia, a 1972 serosurvey suggested widespread distribution of chikungunya infection, and numerous outbreaks have re-emerged since 2001. Malaysia reported its first outbreak between December 1998 and February 1999 and a re-emergence in an isolated north-western coastal town in 2006.

In Singapore, although dengue fever has been endemic since the 1960s, the first chikungunya case was only reported in 2006. The following year, 10 imported cases were notified to the Ministry of Health (MOH). Notably, Taiwan reported a case involving a returning student from Singapore in November 2006, suggesting the possibility of autochthonous transmission in Singapore.

Singapore has remained vigilant in the surveillance of chikungunya virus infection. A 2002/2003 serosurvey on 531 healthy young adults revealed only 2 (0.3%) persons with chikungunya antibodies.

Localised outbreak in Little India

On January 14, 2008, a local case of chikungunya infection was detected through the general practition-

ers' laboratory-based surveillance system established by the Environmental Health Institute, National Environment Agency since 2006. The MOH responded with a massive active surveillance exercise. A total of 2,626 people who resided or worked within a 150-m radius from the index case's address, were screened for chikungunya infection. Individuals with an acute febrile illness, signs or symptoms compatible with chikungunya fever or those with positive reverse transcription-polymerase chain reaction (RT-PCR) results or virus isolation were referred to the Communicable Disease Centre at Tan Tock Seng Hospital (CDC/TTSH). During the outbreak period from January 14 to February 21, 2008, 13 patients were confirmed with chikungunya infection. Of these, 10 acutely symptomatic patients (all males; median age 35 years, range 22-69 years) were isolated at CDC/TTSH until fever resolved and a negative chikungunya RT-PCR test was obtained. During hospitalization, patients had four-hourly temperature monitoring and daily chikungunya RT-PCR tests. Viral load profiles were derived from an external standard curve generated by 10-fold serially diluted virus from a concentration of 10^8 pfu/ml, using crossing-point (Cp) values.

Table 5 summarises the presence of viraemia and the patient's febrile status in relation to the day of illness. High viraemic levels were observed during the first 5 days of illness (median 119,126 pfu/ml, range 360-14,605,314 pfu/ml). Fever lasted a median of 5 days (range 3-10 days), with viraemia persisting up to day 9 of illness. The findings concur with those of a European study, suggesting extremely high viraemic



levels at the initial stage of chikungunya disease. Notably, one patient who was screened by MOH, was observed to have a positive chikungunya RT-PCR test result one day prior to symptom onset. Fever resolution did not predict viral clearance. Of note, 30% of

the patients had detectable viraemia (376-8,523 pfu/ml), after fever had settled. The significance of this viraemic level in the transmission of chikungunya remains uncertain; more research is needed to address this pertinent public health question.

Table 5
Daily trend of fever and viremia in 10 hospitalized chikungunya patients, Singapore

Patient no.	Signs and symptoms*	Fever† and chikungunya test results (viral load‡), by day of fever											
		-1	0	1	2	3	4	5	6	7	8	9	10
1	F, A, B, D					NA +	37.7§ +	37.0 -	37.0 -				
2	F, A, H, RE			NA +	39.6§ +	38.4 +	38.0 +	37.6 -	38.5 -	38.0 -	37.4		
3	F, A, R, H			NA +	39.3§ +	37.0 +	37.2 +	37.3 -	37.2 -				
4	F, A	NA +	40.8§ +	39.9 +	38.2 +	37.6 +	37.6 +	37.4 -	37.0				
5	F, A	NA +	37.0§ +	37.8 +	36.8 -	36.6 -							
6	F, D, R, M			NA +	37.6§ +	38.6 +	37.2 -	36.8 -					
7	F, A, H, EP			NA +	38.3§ +	37.0 +	37.0 -						
8	F, A								NA +	37.5§	37.6 +	37.7 -	36.4
9	F, A, N			NA +	38.4§ -	37.8 -	37.1 -	37.1 -					
10	F, A, M						39.2§	36.7 +	36.8 +	37.1 -	37.4 -	36.8	

*At hospitalization. F, fever; A, arthralgia; B, backache; D, diarrhoea; H, headache; RE, red eyes; R, rash; M, myalgia; EP, eye pain; N, nausea.

†Day 0, day of fever onset. Maximum temperature expressed in °C. Light shading indicates self-reported fever; dark shading indicates documented fever (maximum temperature >37.5 °C). NA, not available.

‡Viral load expressed as × 10³ pfu/mL. Reverse transcription-PCR test results for chikungunya: +, positive; -, negative.

§Indicates day patient was hospitalized.



Aedes aegypti mosquitoes were the vectors involved in this outbreak. Viral sequences from the patients revealed a close association to the circulating strains in the 2006 Indian Ocean outbreak (GenBank accession nos. EU441882 and EU441883), without the E1-A226V mutation, which can increase transmission of the virus. Viral phylogenetic studies supported the notion that the East African genotype which emerged in Kenya in 2004 and the Indian Ocean islands in 2005, and closely resembling the 2006 outbreak strain in India, arrived in Singapore in January 2008.

Singapore's outbreak containment strategy focused primarily on intensive vector control, and rapid removal of infectious human reservoirs through active case finding and isolation. The proportion of asymptomatic infections was not determined in this outbreak. Asymptomatic infections could possibly

reduce the effectiveness of control efforts. However, there has been no data thus far, supporting chikungunya transmissibility in asymptomatic persons. Detectable viremia before clinical symptoms and high viraemic levels during early illness, as demonstrated in this study and others, pose logistical challenges in the timeliness of case detection for isolation.

Conclusion

Singapore remains at risk of chikungunya outbreaks. It has a highly susceptible population, a porous border with large travel volumes from epidemic areas, and effective vectors (both *Aedes aegypti* and *Aedes albopictus*). In the absence of a vaccine, high vigilance for autochthonous transmission and stringent vector control would have to be maintained along with a swift public health response.

(Based on Leo YS, Chow ALP, Tan LK et al. Chikungunya outbreak, Singapore, 2008. *Emerging Infect Dis* 2009 [serial on the internet]. 2009 May. Available from <http://www.cdc.gov/EID/content/15/5/836.htm>)

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Any comments or questions should be addressed to:

The Editor
Epidemiological News Bulletin
Communicable Diseases Division, Ministry of Health
College of Medicine Building, 16 College Road,
Singapore 169854
E-mail : Goh_Kee_Tai@moh.gov.sg
Lyn_James@moh.gov.sg