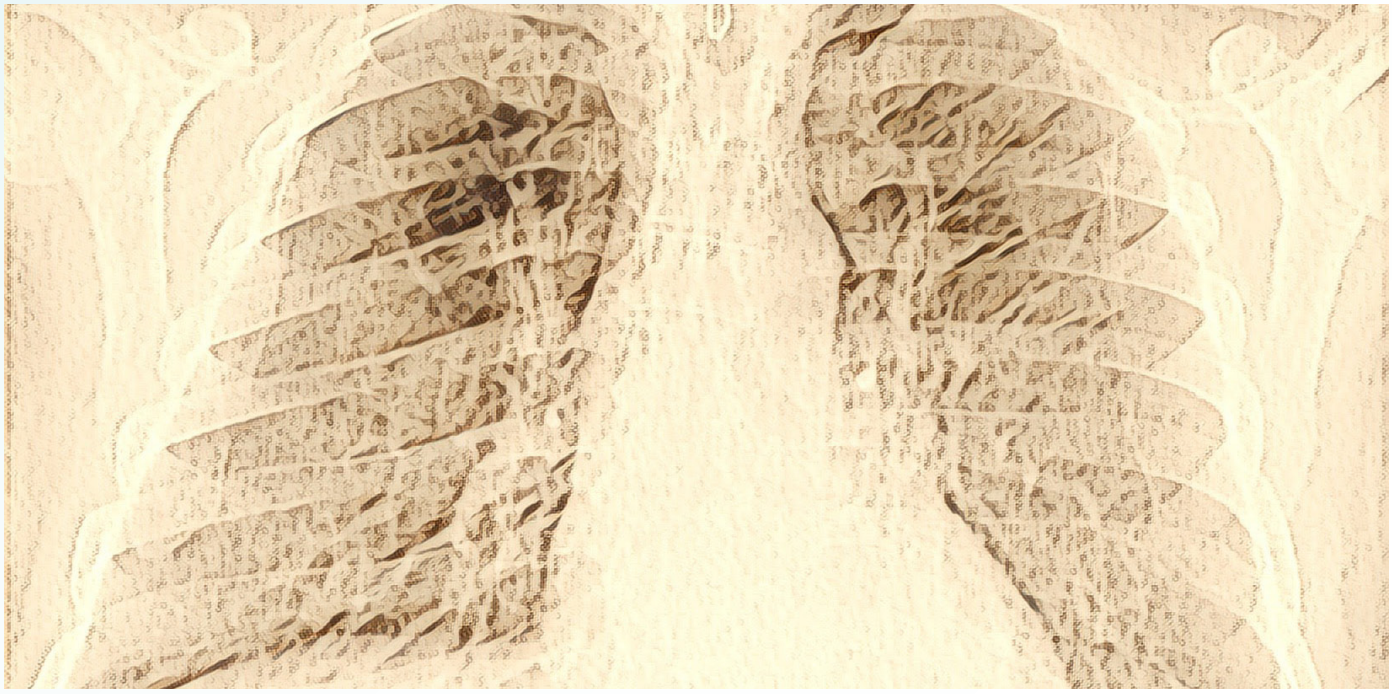
CHAPTER 6

OTHER DISEASES



Tuberculosis is one of the top ten causes of death worlwide, and most often affects the lungs. Leprosy is a chronic infection caused by bacteria in the same bacterium family. Both diseases are treatable. Besides people and animals, sources of infection are present in the environment, and promotion of better environmental management or infection control practices in healthcare settings can prevent the spread of diseases. Singapore also keeps a lookout for novel, emerging diseases through the Severe Illness and Death from Possibly Infectious Causes (SIDPIC) programme.

LEGIONELLOSIS

Legionellosis is an acute bacterial disease caused by the bacterium *Legionella pneumophila*. It has two recognised distinct clinical and epidemiological manifestations: Legionnaires' disease and Pontiac fever. Both conditions are characterised by fever, chills, anorexia, malaise, myalgia and headache, but only Legionniares' disease is associated with pneumonia. The chest X-ray for a patient with Legionnaires' disease may reveal patchy or focal areas of consolidation. The mode of transmission is airborne and includes aspiration of aerosolised water containing the bacteria.

A total of 12 cases of laboratory-confirmed legionellosis were reported in 2016, compared with 17 cases in 2015 (Figure 6.1). Nine of these 12 cases were local residents, while the remaining three included one tourist and two foreigners seeking medical treatment in Singapore. 11 cases had confirmed Legionnaires' disease and one case had presumptive Legionnaires' disease (Table 6.1). One of the nine cases had acquired the infections overseas (Table 6.3).

Figure 6.1
Weekly distribution of reported legionellosis cases, 2015-2016

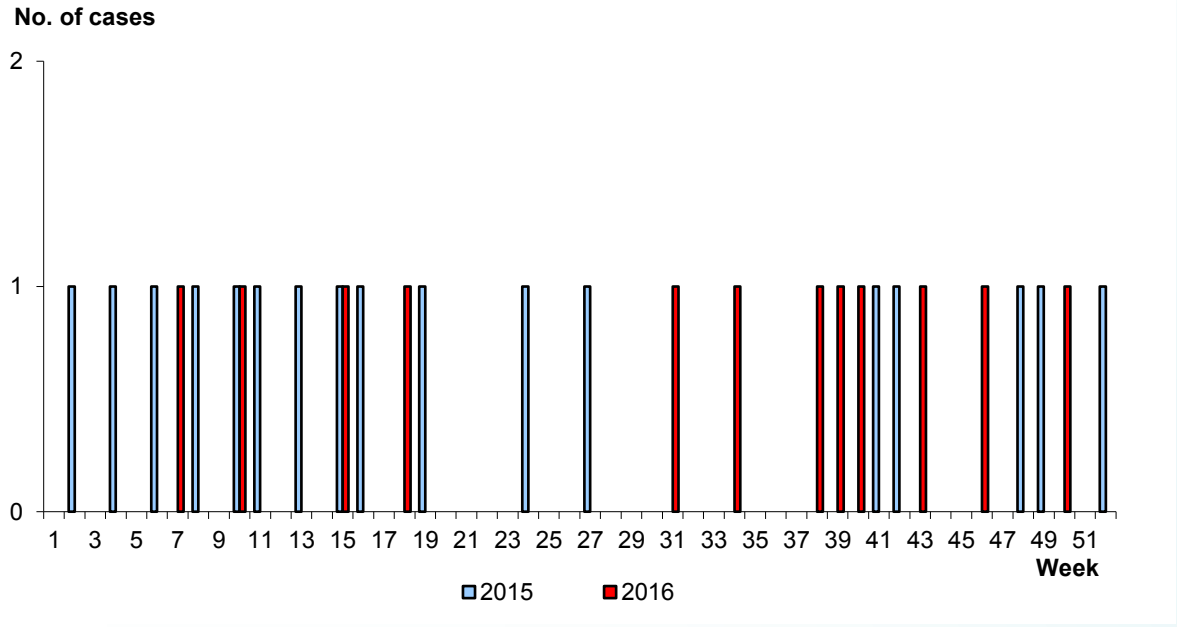


Table 6.1
Classification of reported legionellosis cases, 2016

	Pontiac fever	Legionnaires' disease	Total
Confirmed cases	0	11	11
Presumptive cases	0	1	1
Total	**0**	**12**	**12**

The overall incidence rate for local residents was 0.2 per 100,000 population, with the highest incidence rate in the 65+ years age group (Table 6.2).

Table 6.2
Age-gender distribution and age-specific incidence rate of reported legionellosis cases^, 2016

Age group	Male	Female	Total	%	Incidence rate per 100,000 population*
0-4	0	0	0	0	0
5-14	0	0	0	0	0
15-24	0	0	0	0	0
25-34	0	0	0	0	0
35-44	1	0	1	11.1	0.1
45-54	1	0	1	11.1	0.1
55-64	2	1	3	33.3	0.5
65+	3	1	4	44.5	0.7
Total	**7**	**2**	**9**	**100**	**0.2**

^Excluded two foreigners seeking medical treatment in Singapore and one tourist.
*Rates are based on 2016 estimated mid-year population.
(Source: Singapore Department of Statistics)

Table 6.3
Total number of notifications* received for legionellosis cases, 2012-2016

Age group	2012		2013		2014		2015		2016	
	Local	Imported	Local	Imported	Local	Imported	Local	Imported	Local	Imported
0-4	0	0	0	0	0	0	0	0	0	0
5-9	0	0	0	0	0	0	0	0	0	0
10-14	0	0	0	0	0	0	0	0	0	0
15-24	0	0	0	0	0	0	0	0	0	0
25-34	1	0	1	0	1	0	0	0	0	0
35-44	2	0	1	0	2	1	0	0	1	0
45-54	4	0	3	0	1	1	2	0	1	0
55-64	2	3	6	2	4	0	3	0	2	1
65+	10	0	4	2	19	2	11	1	4	0
Total	**19**	**3**	**15**	**4**	**27**	**4**	**16**	**1**	**8**	**1**

*Excluded tourists and foreigners seeking medical treatment in Singapore.

Among the three major ethnic groups, Malays had the highest incidence rate of 0.6 per 100,000 population (Table 6.4). Various occupational groups were also affected (Table 6.5).

Table 6.4
Ethnic-gender distribution and ethnic-specific incidence rate of legionellosis cases^, 2016

	Male	Female	Total	%	Incidence rate per 100,000 population*
Singapore residents					
Chinese	4	2	6	66.7	0.2
Malay	3	0	3	33.3	0.6
Indian	0	0	0	0	0
Others	0	0	0	0	0
Foreigners	0	0	0	0	0
Total	**7**	**2**	**9**	**100**	**0.2**

^Excluded one tourist and two foreigners seeking medical treatment in Singapore.
*Rates are based on 2016 estimated mid-year population.
(Source: Singapore Department of Statistics)

Table 6.5
Occupations of reported legionellosis cases, 2016*

Occupation	No. of cases (n=9)
Cleaners, labourers & related workers	0
Clerical workers	0
Service & shop/market sales workers	1
Professionals, Self-employed & Managers	0
Drivers	0
Production craftsmen & technicians	2
Others	0
Retiree	6

*According to Singapore Standard Occupational Classification 2000 (Department of Statistics).

Key presenting symptoms of the nine legionellosis cases included fever, cough and shortness of breath (Table 6.6).

Table 6.6
Clinical presentation of reported legionellosis cases^, 2016*

Clinical presentation	No. of cases (n=9)
Fever (with/without chills and rigors)	7
Respiratory symptoms	
Cough (productive and non-productive)	5
Shortness of breath	5
Chest pain and discomfort	2
Other signs and symptoms	
Chills	1
Myalgia	1
Loss of Appetite	1
Giddiness	1
Abdominal pain	1
Generalised weakness	1
Vomiting	2

* Cases might have one or more clinical presentations.
^ Excluded one tourist and two foreigners seeking medical treatment in Singapore.

Seven (77.8%) of the cases had known risk factors for legionellosis (Table 6.7). No legionellosis deaths were reported.

Table 6.7
Number of cases with known risk factors for legionellosis^, 2016*

Risk Factors	No of Cases
Diabetes mellitus	3
Chronic lung disease (e.g. asthma, chronic obstructive pulmonary disease)	4
Immunosupression (e.g. corticosteroid therapy, organ transplantation)	0
Smoking	0

*Cases might have one or more concurrent medical conditions.
^Excluded one tourist and two foreigners seeking medical treatment in Singapore.

LEPROSY

Leprosy is a chronic bacterial disease of the skin, peripheral nerves and the upper airway (in lepromatous patients) by *Mycobacterium leprae*. The manifestations of the disease vary in a continuous spectrum between the two polar forms, lepromatous and tuberculoid leprosy. It can present as hypopigmented patches with diminished sensation, multiple raised plaques, thickened nerves or neuritis. Diagnosis can be made through clinical features, a slit skin smear or skin biopsy for histological examination.

In the past, leprosy was regarded as a highly contagious, mutilating and incurable disease leading to social stigma associated with the disease and the people afflicted with it. Before effective treatment for leprosy was available, patients were segregated in leprosariums to prevent the spread of leprosy to the community. Modern treatment for leprosy was introduced in 1941 when dapsone and its derivatives were used. With effective chemotherapy, leprosy is curable today and patients are now treated in the general health services alongside other diseases. Currently, the Cutaneous Infections Unit of the National Skin Centre undertakes the treatment of leprosy based on the WHO guidelines for therapy.

The distribution of leprosy notifications among Singapore residents and non-residents from 2010 to 2016 is shown in Table 6.8.

Table 6.8
Leprosy notifications among Singapore residents and non-residents, 2010-2016

Year	No. of cases (%)		
	Resident	Non-resident	Total
2010	4 (30.8%)	9 (69.2%)	13
2011	5 (31.3%)	11 (68.8%)	16
2012	5 (33.3%)	10 (66.7%)	15
2013	3 (25.0%)	9 (75.0%)	12
2014	1 (16.7%)	5 (83.3%)	6
2015	1 (33.3%)	2 (66.7%)	3
2016	2 (28.6%)	5 (71.4%)	7

Leprosy in Singapore residents

The incidence rate of leprosy among Singapore residents has declined over the past five decades, from 21.3 per 100,000 population in 1960 to 0.05 per 100,000 population in 2016. In 2016, two male Singapore residents with leprosy were notified (Table 6.9).

Table 6.9
Distribution of leprosy notifications among Singapore residents by gender, 2010-2016

Year	No. of cases		
	Male	Female	Total
2010	3	1	4
2011	2	3	5
2012	4	1	5
2013	1	2	3
2014	1	0	1
2015	0	1	1
2016	2	0	2

Leprosy patients are classified into multibacilliary and paucibacilliary types. One Singapore resident in 2016 had multibacilliary leprosy (Table 6.10).

Table 6.10
Distribution of leprosy notifications among Singapore residents by type of infection, 2010-2016

Year	No. of cases		
	Multibacilliary	Paucibacilliary	Total
2010	2	2	4
2011	3	2	5
2012	5	0	5
2013	2	1	3
2014	1	0	1
2015	1	0	1
2016	1	1	2

Leprosy in non-residents

The contribution of non-residents to the total number of cases has fluctuated over the years. In 2016, there were five non-residents (four males and one female) notified with leprosy (Table 6.11).

Table 6.11
Distribution of leprosy notifications among non-residents by gender, 2010-2016

Year	Male	Female	Total
2010	5	4	9
2011	7	4	11
2012	7	3	10
2013	6	3	9
2014	2	3	5
2015	1	1	2
2016	4	1	5

In 2016, there were three cases of paucibacilliary leprosy among non-residents (Table 6.12).

Table 6.12
Distribution of leprosy notifications among non-residents by type of infection, 2010-2016

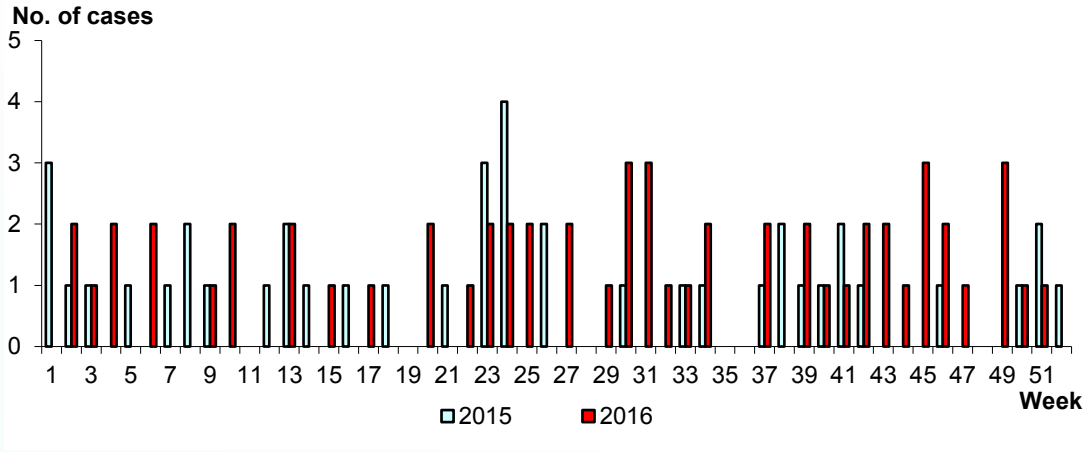
Year	Multibacilliary	Paucibacilliary	Unknown	Total
2010	4	5	0	9
2011	9	2	0	11
2012	6	4	0	10
2013	6	2	1	9
2014	2	2	1	5
2015	0	2	0	2
2016	2	3	0	5

MELIOIDOSIS

Melioidosis is a bacterial infection with a wide spectrum of clinical manifestations, ranging from pulmonary consolidation to localised cutaneous or visceral abscesses, and necrotising pneumonia with or without fulminant septicaemia. The infectious agent is *Burkholderia pseudomallei*. The mode of transmission is by contact with contaminated soil or water through overt or inapparent skin lesions. It can also be transmitted by aspiration or ingestion of contaminated water or inhalation of dust from contaminated soil.

There were 58 cases of laboratory confirmed melioidosis in 2016, compared with 42 cases in 2015 (Figure 6.2). 53 of these were classified as indigenous cases and five were imported cases. The latter involved two Singapore residents, and three foreigners (one tourist, one foreigner seeking treatment and one work permit holder) (Table 6.14).

Figure 6.2
Weekly distribution of reported melioidosis cases, 2015-2016



The mean age of the reported cases was 56 years. The overall incidence rate for local residents was 1.0 per 100,000 population, with highest incidence recorded in the 55-64 years age group (Table 6.13).

Table 6.13
Age-gender distribution and age-specific incidence rates of melioidosis cases^, 2016

Age group	Male	Female	Total	%	Incidence rate per 100,000 population*
0-4	0	0	0	0	0
5-14	1	0	1	1.8	0.2
15-24	1	1	2	3.6	0.3
25-34	1	0	1	1.8	0.1
35-44	5	2	7	12.5	0.7
45-54	9	0	9	16.1	1.2
55-64	15	5	20	35.6	3.3
65+	13	3	16	28.6	3.0
Total	**45**	**11**	**56**	**100**	**1.0**

^Excluded one foreigner seeking medical treatment in Singapore and one tourist.
*Rates are based on 2016 estimated mid-year population.
(Source: Singapore Department of Statistics)

Among the three major ethnic groups, Malays had the highest incidence, followed by Indians and Chinese (Table 6.14).

Table 6.14
Ethnic distribution and ethnic-specific incidence rates of melioidosis cases^, 2016

	Male	Female	Total	%	Incidence rate per 100,000 population*
Singapore residents					
Chinese	16	5	21	37.5	0.7
Malay	14	3	17	30.4	3.2
Indian	6	1	7	12.5	2.0
Others	1	0	1	1.8	0.8
Foreigners	8	2	10	17.8	0.6
Total	**45**	**11**	**56**	**100**	**1.0**

^Excluded one tourist and one foreigner seeking medical treatment in Singapore.
*Rates are based on 2016 estimated mid-year population.
(Source: Singapore Department of Statistics)

Table 6.15
Total number of notifications* received for melioidosis cases, 2012-2016

Age group	2012		2013		2014		2015		2016	
	Local	Imported	Local	Imported	Local	Imported	Local	Imported	Local	Imported
0-4	0	0	0	0	0	0	0	0	0	0
5-9	0	0	1	0	0	0	0	0	0	0
10-14	2	0	1	2	2	0	1	0	1	0
15-24	2	0	1	0	2	0	3	0	2	0
25-34	2	0	1	1	2	0	1	0	1	0
35-44	8	1	4	0	8	1	3	1	7	0
45-54	8	0	7	0	8	0	9	2	9	0
55-64	2	0	8	2	2	0	11	1	18	2
65+	8	0	5	0	8	0	9	0	15	1
Total	**32**	**1**	**28**	**5**	**32**	**1**	**37**	**4**	**53**	**3**

*Excluded tourists and foreigners seeking medical treatment in Singapore.

Burkholderia pseudomallei were isolated from blood cultures in 39 cases (Table 6.16).

Table 6.16
Types of laboratory sample of melioidosis cases^, 2016

Types of laboratory sample	No. of cases	%
Blood	39	69.6
Bronchial alveolar lavage	3	5.4
Pus	6	10.7
Endotracheal tube aspirate	1	1.8
Swabs	4	7.1
Sputum	3	5.4
Total	**56**	**100**

^Excluded one tourist and one foreigner seeking medical treatment in Singapore.

The predominant signs and symptoms of melioidosis were fever, and cough (Table 6.17). 33.9% of the cases presented with localised or multiple abscesses. Those who presented with bacteraemia comprised 66.1% of the cases in 2016 (Table 6.18).

Table 6.17
Clinical presentation of reported melioidosis cases^, 2016*

Clinical presentation	No. of cases (n=56)
Fever (with/without chills and rigors)	44
Respiratory symptoms	
Cough (productive and non-productive)	19
Runny nose	2
Chest pain	4
Other signs and symptoms	
Abdominal pain/discomfort/epigastric pain	5
Vomiting	4
Diarrhoea	1
Abscesses (localised, systemic)	19

^Excluded one tourist and one foreigner seeking medical treatment in Singapore.
*Cases may have one or more clinical presentations.

Table 6.18
Cases of melioidosis presenting with bacteraemia and abscesses, 2012 – 2016

Year	Cases	Bacteraemia		Abscesses			
		No.	%	All Abscesses		Cutaneous	
				No.	%	No.	%
2012	31	19	61.3	13	41.9	6	19.4
2013	34	14	41.2	20	58.8	6	17.6
2014	32	15	46.9	11	34.4	2	6.3
2015	41	22	53.7	19	46.3	9	22.0
2016^	56	37	66.1	19	33.9	12	21.4

^Excluded one tourist and one foreigner seeking medical treatment in Singapore.

36 (64.2%) of the cases had known risk factors for melioidosis (Table 6.19). Three melioidosis and six melioidosis-related deaths were reported, giving a case-fatality rate of 16.1%.

Table 6.19
Number of cases with known risk factors for melioidosis^, 2016*

Risk factors	No of cases
Diabetes mellitus	33
Chronic lung disease (e.g. asthma, chronic obstructive pulmonary disease)	5
Chronic renal disease (e.g. chronic renal failure, kidney disease)	6

*Cases may have one or more concurrent medical conditions.
^Excluded one tourist and one foreigner seeking medical treatment in Singapore.

TUBERCULOSIS

Tuberculosis (TB) is a mycobacterial disease that is a major cause of death and disability in many parts of the world especially in developing countries. Initial tuberculous infection is typically asymptomatic and is known as latent TB infection (LTBI). About 10% of immunocompetent adults with LTBI will eventually progress to active disease, and half of them will do so in the first two years following infection. The risk of progression to active disease is increased in immunosuppressed persons and in children under five years of age.

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. The programme was enhanced with the launch of the Singapore Tuberculosis Elimination Programme (STEP) in 1997. The main aim of STEP is to eliminate TB in Singapore by detecting, diagnosing and treating all infectious TB cases, identifying and treating infected tuberculosis contacts, and preventing the emergence of multidrug-resistant tuberculosis.

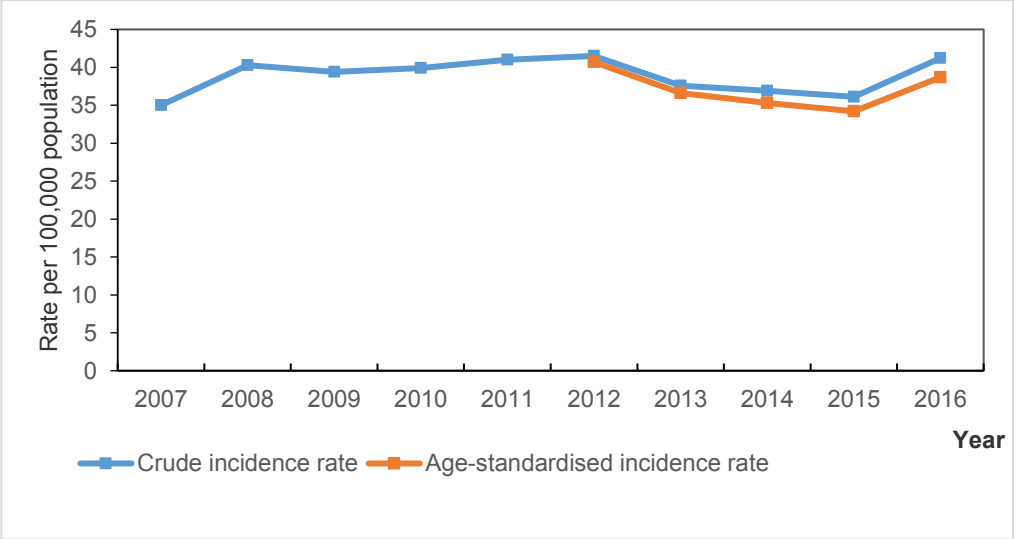
Incidence and site of disease in total population (Singapore residents, long-staying foreigners)

A total of 3,294 cases of TB were notified in 2016. This comprised 1,617 new and 142 relapsed cases among Singapore residents (citizens and PRs) and 1,483 new and 52 relapsed cases among non-residents (long-and short-staying foreigners).

A total of 2,310 new cases of TB were notified among Singapore residents and long-staying foreigners in 2016. The crude incidence rate of TB was 41.2 per 100,000 population in 2016. (Figure 6.3). To better reflect changes in the incidence rate of TB, after accounting for changes in population demographics, age-standardised rates for the incidence of TB have been reported from 2012 and onwards, using 2010 as the reference year. The age-standardised incidence rate of TB was 38.7 per 100,000 population in 2016.

The majority (83.5%) of cases had pulmonary TB with or without extra-pulmonary involvement, while the remainder (16.5%) had exclusively extra-pulmonary TB (Table 6.20).

Figure 6.3
TB incidence rates in Singapore residents and long-staying foreigners,* 2007-2016



*Age-standardised rate using 2010 mid-year Singapore resident population.
(Source: Singapore Department of Statistics)

Table 6.20
New TB cases by site of disease in Singapore residents and long-staying foreigners, 2007-2016

Year	New cases			Incidence rate per 100,000 population		
	Pulmonary[1]	Extra pulmonary	Total	Pulmonary[1]	Extra pulmonary	Total
2007	1,349	259	1,608	29.4	5.6	35.0
2008	1,611	340	1,951	33.3	7.0	40.3
2009	1,624	342	1,966	32.6	6.9	39.4
2010	1,727	301	2,028	34.0	5.9	39.9
2011	1,811	315	2,126	34.9	6.1	41.0
2012	1,897	306	2,203	35.7	5.8	41.5
2013	1,750	278	2,028	32.4	5.1	37.6
2014	1,705	313	2,018	31.2	5.7	36.9
2015	1,691	309	2,000	30.6	5.6	36.1
2016	1,930	380	2,310	34.4	6.8	41.2

[1] Pulmonary TB referred to TB of the lung parenchyma and included cases that had both pulmonary and extrapulmonary tuberculosis.

Distribution by age and gender

Of the 2,310 new cases notified in 2016, 1,156 (50.0%) were 50 years old and above, and 1,365 (59.1%) were males. TB continued to be a disease among older males, as shown in the age and gender-specific incidence rates (Table 6.21).

Table 6.21
Age-gender distribution and incidence rate of TB in Singapore residents and long-staying foreigners, 2016

Age group	Male	Female	Total	%	Incidence rate per 100,000 population*		
					Male	Female	Total
0-4	3	7	10	0.4	2.5	6.2	4.3
5-9	0	5	5	0.2	0.0	4.4	2.1
10-14	1	3	4	0.2	0.8	2.7	1.7
15-19	19	11	30	1.3	13.0	8.1	10.6
20-29	171	224	395	17.1	28.0	45.8	35.9
30-39	174	255	429	18.6	28.0	47.4	37.0
40-49	165	116	281	12.2	35.7	28.6	32.4
50-59	283	107	390	16.9	81.2	31.6	56.8
60-69	286	101	387	16.8	119.8	39.3	78.0
70-79	161	67	228	9.9	166.3	57.2	106.5
80+	102	49	151	6.5	261.3	76.1	146.0
Total	**1,365**	**945**	**2,310**	**100**	**46.7**	**35.2**	**41.2**

*Rates are based on 2016 estimated mid-year population.
(Source: Singapore Department of Statistics).

In 2016, among the 1,930 new pulmonary TB cases in Singapore residents and long-staying foreigners, 1,831 (94.9%) had bacteriological tests done. The proportion found to have demonstrable bacillary disease was 64.8% (Table 6.22).

Table 6.22
Bacillary status of new pulmonary TB cases in Singapore residents and long-staying foreigners, 2007-2016

Year	No. tested for bacillary disease	% of notified pulmonary cases tested	No. of pulmonary cases with bacillary disease	% of pulmonary cases tested positive	Incidence rate per 100,000 population
2007	1,291	95.7	1,007	78.0	21.9
2008	1,544	95.8	1,177	76.2	24.3
2009	1,548	95.3	1,147	74.1	23.0
2010	1,652	95.7	1,169	70.8	23.0
2011	1,770	97.7	1,259	71.1	24.3
2012	1,816	95.7	1,213	66.8	22.8
2013	1,669	95.4	1,084	64.9	20.1
2014	1,621	95.1	1,033	63.7	18.9
2015	1,646	97.3	1,060	64.4	19.2
2016	1,831	94.9	1,187	64.8	21.1

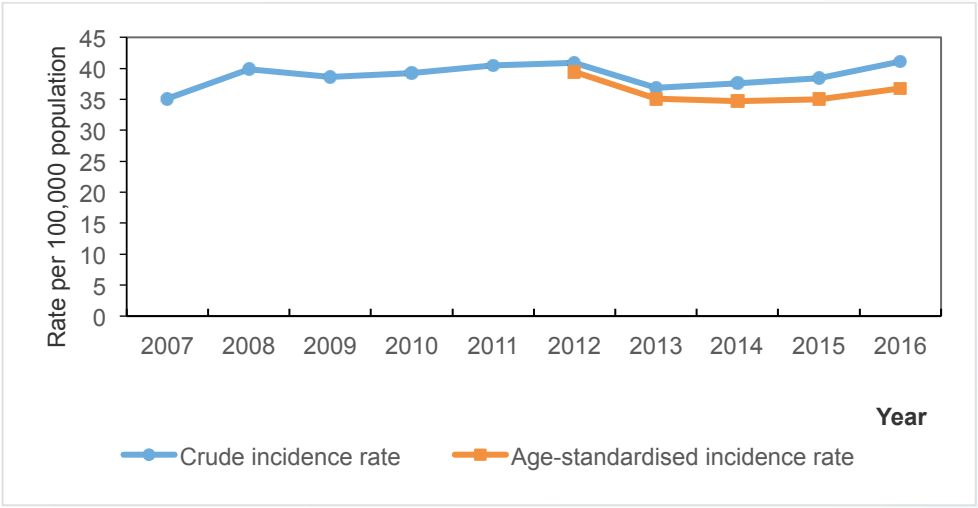
The table included only bacteriological investigations (smear and/or cultures) done from three months before to two weeks after the date of notification or date of starting treatment, whichever earlier.

Incidence and site of disease in Singapore residents

From a historical perspective, the crude incidence rate of TB declined from 307 per 100,000 population in 1960 to 56.3 per 100,000 population in 1987. From 1987 to 1997, the crude incidence rate of new TB cases among Singapore residents stagnated around 50-55 per 100,000 population. Following enhanced TB control measures implemented by STEP, the crude incidence rate declined from 56.9 per 100,000 population in 1998 to a historical low of 35.1 per 100,000 population in 2007. However, in 2008, the crude incidence rate increased for the first time in ten years to 39.8 per 100,000 population. Between 2009 and 2015, the crude incidence rate stagnated at 38.6 to 40.9 per 100,000 population, before decreasing to 36.9 per 100,000 in 2013. Since then, the crude incidence rate has risen slightly up to 41.1 per 100,000 population in 2016 (Figure 6.4). In contrast, the age-standardised incidence rate of TB was 36.7 per 100,000 population in 2016 (Figure 6.4).

Of the 1,617 new TB cases among Singapore residents notified in 2016, 83.7% (1,353) of cases had pulmonary TB while 16.3% (264) had exclusively extra-pulmonary TB. Of those with pulmonary TB, 13.3% (180) had extra-pulmonary involvement while 86.7% (1,173) did not have extra-pulmonary involvement. (Table 6.23). Among cases with extra pulmonary TB disease (444), the most common site of extra-pulmonary TB was the pleura (144), followed by the lymphatic system (139) in 2016.

Figure 6.4
TB incidence rates in Singapore residents, 2007-2016



Age-standardised rate using 2010 mid-year Singapore resident population.
(Source: Singapore Department of Statistics).

Table 6.23
Distribution of new TB cases by site of disease in Singapore residents, 2007-2016

Year	New Cases			Incidence rates per 100,000 population		
	Pulmonary[1]	Extra pulmonary	Total	Pulmonary[1]	Extra pulmonary	Total
2007	1,074	182	1,256	30.0	5.1	35.1
2008	1,208	243	1,451	33.2	6.7	39.8
2009	1,205	237	1,442	32.3	6.3	38.6
2010	1,265	213	1,478	33.5	5.6	39.2
2011	1,309	224	1533	34.5	5.9	40.5
2012	1,359	201	1,560	35.6	5.3	40.9
2013	1,249	171	1,420	32.5	4.4	36.9
2014	1,220	234	1,454	31.5	6.0	37.6
2015	1,271	227	1,498	32.6	5.8	38.4
2016	1,353	264	1,617	34.4	6.7	41.1

[1] Pulmonary TB referred to TB of the lung parenchyma and included cases that had both pulmonary and extra-pulmonary tuberculosis.

Distribution by age and gender

As in previous years, TB in Singapore residents (citizens and PRs) continued to be a disease of older males (Table 6.24). Of the 1,617 new cases notified in 2016, 1,114 (68.8%) were 50 years old and above, and 1,006 (65.9%) were males. The TB incidence rate among males increased from 52.6 per 100,000 population in 2015 to 55.2 per 100,000 population in 2016, while that among females increased from 24.6 per 100,000 population in 2015 to 27.5 per 100,000 population in 2016.

Table 6.24
Age-gender distribution and incidence rate of TB in Singapore residents, 2016

Age group	Male	Female	Total	%	Incidence rate per 100,000 population*		
					Male	Female	Total
0-4	3	5	8	0.5	3.1	5.5	4.3
5-9	0	4	4	0.2	0.0	4.0	2.0
10-14	1	3	4	0.2	0.9	2.9	1.9
15-19	14	10	24	1.5	11.4	8.6	10.0
20-29	58	69	127	7.9	21.5	25.4	23.5
30-39	61	74	135	8.3	21.9	24.0	23.0
40-49	121	80	201	12.4	40.3	25.4	32.7
50-59	270	96	366	22.6	87.5	31.3	59.5
60-69	277	97	374	23.1	125.1	42.5	83.1
70-79	159	66	225	13.9	181.4	63.4	117.3
80+	102	47	149	9.2	276.9	77.1	152.4
Total	**1,066**	**551**	**1,617**	**100**	**55.2**	**27.5**	**41.1**

* Rates are based on 2016 estimated mid-year population.
(Source: Singapore Department of Statistics)

Ethnic distribution

Malays had the highest TB incidence among the three main ethnic groups, although the incidence rate in Malays decreased from 60.1 per 100,000 population in 2015 to 57.6 per 100,000 population in 2016 The incidence rates among Chinese and Indians increased from 35.7 and 25.9 per 100,000 population in 2015, to 39.2 and 31.9 per 100,000 population respectively in 2016 (Table 6.25).

Table 6.25
Ethnic-gender distribution and ethnic-specific incidence rate of TB in Singapore residents, 2016

Ethnic group	Male	Female	Total	%	Incidence rate per 100,000 population*
Chinese	764	381	1,145	70.8	39.2
Malay	215	88	303	18.7	57.6
Indian	70	44	114	7.1	31.9
Others	17	38	55	3.4	43.1
Total	**1,066**	**551**	**1,617**	**100**	**41.1**

* Rates are based on 2016 estimated mid-year population.
(Source: Singapore Department of Statistics).

Clinical presentation and bacteriological status

In 2016, 1,304 (96.3%) of the 1,353 new pulmonary TB cases in Singapore residents had bacteriological tests done. The proportion found to have demonstrable bacillary disease was 71.3% (Table 6.26).

Table 6.26
Bacillary status of new pulmonary TB cases in Singapore residents, 2007-2016

Year	No. tested for bacillary disease	% of notified pulmonary cases tested	No. of pulmonary cases with bacillary disease	% of pulmonary cases tested positive	Incidence rates per 100,000 population
2007	1,036	96.5	844	81.5	23.6
2008	1,177	97.4	952	80.9	26.1
2009	1,164	96.6	937	80.5	25.1
2010	1,236	97.7	951	76.9	25.2
2011	1,276	97.5	977	76.6	25.8
2012	1,321	97.2	981	74.3	25.7
2013	1,207	96.6	879	72.8	22.9
2014	1,183	97.0	858	72.5	22.2
2015	1,249	98.3	887	71.0	22.7
2016	1,304	96.3	931	71.3	23.7

Relapsed TB cases

In 2016, there were 142 relapsed TB cases notified among Singapore residents. This accounted for 8.1% of all cases (new and relapsed) among Singapore residents (Table 6.27).

Table 6.27
Age-gender distribution of relapsed TB cases in Singapore residents, 2012-2016

Age group	2012		2013		2014		2015		2016	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
0-9	0	0	0	0	0	0	0	0	0	0
10-19	2	0	0	3	1	0	0	0	0	0
20-29	1	3	0	2	3	0	0	3	0	3
30-39	4	5	5	3	5	7	3	2	3	5
40-49	11	2	12	3	10	3	7	6	8	3
50-59	22	4	20	2	22	5	30	9	16	8
60- 69	34	3	20	5	29	7	18	7	38	8
70+	42	3	37	7	35	10	53	6	42	8
Sub Total	**116**	**20**	**94**	**25**	**105**	**32**	**111**	**33**	**107**	**35**
Total	**136**		**119**		**137**		**144**		**142**	

TB cases in Singapore residents by country of birth

Of the 1,617 new cases notified among residents in 2016, 1,315 (81.3%) were Singapore-born and 302 (18.7%) were foreign-born. Of the 142 relapsed TB cases notified among residents, 123 (86.6%) were Singapore-born and 19 (13.4%) were foreign-born (Table 6.28).

Table 6.28
Distribution of TB cases by age group and country of birth in Singapore residents, 2015-2016

Age group	New cases						Relapsed cases					
	2015			2016			2015			2016		
	S'pore born	Foreign born	Unk#	S'pore born	Foreign born	Unk#	S'pore born	Foreign born	Unk #	S'pore born	Foreign born	Unk#
0-9	3	0	0	10	2	0	0	0	0	0	0	0
10-19	37	4	0	24	4	0	0	0	0	0	0	0
20-29	74	15	0	107	20	0	2	1	0	1	2	0
30-39	80	55	0	88	47	0	5	0	0	3	5	0
40-49	164	47	1	145	56	0	9	4	0	8	3	0
50-59	317	35	0	325	41	0	36	3	0	23	1	0
60- 69	277	29	0	329	45	0	24	1	0	43	3	0
70+	285	75	0	287	87	0	54	5	0	45	5	0
Total	**1,237**	**260**	**1**	**1,315**	**302**	**0**	**130**	**14**	**0**	**123**	**19**	**0**

Unknown country of birth

TB-HIV co-infection in residents

People living with HIV (PLWHIV) are known to be particularly susceptible to TB, both from the reactivation of latent infection and from new infection with rapid progression to active disease. PLWHIV are about 26 to 31 times more likely to develop TB disease than those who are HIV-negative worldwide. According to the 2016 WHO Global Tuberculosis Report, people living with HIV accounted for 1.2 million (11%) of all new TB cases worldwide.

In 2016, there were a total of 1,759 notified cases of TB among Singapore residents. Of the 84.5% (1,487 cases) who had a documented HIV status[1], 1,366 were new TB infections while 121 were relapsed cases.

The prevalence of TB-HIV co-infection among TB cases with a documented HIV status was 2.3% (34 cases) of which 23 were diagnosed to be HIV positive within three months of TB diagnosis. The prevalence of TB-HIV co-infection among the new and relapsed TB cases were 2.2% (30 cases) and 3.3% (4 cases) respectively.

The highest TB-HIV co-infection rates among new TB cases were observed among males 50-59 years of age (Table 6.29). By ethnic group, Indians had the highest TB-HIV co-infection rates (Table 6.30).

Table 6.29
Age-gender distribution of new cases with TB-HIV co-infection in Singapore residents, 2016

Age group	New cases				Incidence rate per million population*		
	Male	Female	Total	%	Male	Female	Total
0-14	0	0	0	0	0	0	0
15-19	0	0	0	0	0	0	0
20-29	1	0	1	3.3	3.7	0	1.8
30-39	3	0	3	10.0	10.7	0	5.1
40-49	6	1	7	23.3	20.0	3.2	11.4
50-59	11	1	12	40.0	35.7	3.3	19.5
60+	7	0	7	23.3	20.2	0	9.5
Total	**28**	**2**	**30**	**100**			
Age-standardised rate					13.6	1.0	7.2
Crude Rate					14.5	1.0	7.6

*Rates are based on 2016 estimated mid-year Singapore resident population and standardized population for Age-standardised rate using 2010 mid-year Singapore resident population.
(Source: Singapore Department of Statistics).

[1] This refers to the proportion of notified TB cases who were previously documented to be HIV-positive before TB diagnosis or tested for HIV in the three months after TB diagnosis.

Table 6.30
Ethnic-gender distribution of new cases with TB-HIV co-infection in Singapore residents, 2016

Ethnic group	New cases				Incidence rate per million population*		
	Male	Female	Total	%	Male	Female	Total
Chinese	14	1	15	50	9.8	0.7	5.1
Malay	5	1	6	20	19.1	3.8	11.4
Indian	7	0	7	23	38.3	0.0	19.6
Others	2	0	2	7	33.5	0.0	15.7
Total	**28**	**2**	**30**	**100**	**14.5**	**1.0**	**7.6**

*Rates are based on 2016 estimated mid-year Singapore resident population.
(Source: Singapore Department of Statistics).

TB cases in non-residents

In 2016, there were 1,483 new TB cases notified among non-residents (long-and short-staying foreigners) in Singapore. The number of new TB cases among long-and short-staying foreigners gradually decreased from 2012 to 2015, but increased again in 2016 (Table 6.33). As in previous years, the number of new TB cases notified among short-staying foreigners outnumbered that among long-staying foreigners, contributing 25.5% (Table 6.32) and 22.4% of total notified new cases respectively (Table 6.31).

Table 6.31
New TB cases by site of disease in long-staying foreigners, 2007-2016

Year	Pulmonary		Extrapulmonary		Total	
	No.	% of total new cases notified	No.	% of total new cases notified	No.	% of total new cases notified
2007	275	13.6	77	3.8	352	17.5
2008	403	16.5	97	4.0	500	20.5
2009	419	16.6	105	4.2	524	20.8
2010	462	16.6	88	3.2	550	19.7
2011	502	16.5	91	3.0	593	19.6
2012	538	17.2	105	3.4	643	20.6
2013	501	17.9	107	3.8	608	21.7
2014	485	17.7	79	2.9	564	20.6
2015	420	15.5	82	3.0	502	18.6
2016	577	18.6	116	3.7	693	22.4

Table 6.32
New TB cases by site of disease in short- staying foreigners, 2007-2016

Year	Pulmonary		Extrapulmonary		Total	
	No.	% of total new cases notified	No.	% of total new cases notified	No.	% of total new cases notified
2007	340	16.9	66	3.3	406	20.2
2008	412	16.8	81	3.3	493	20.2
2009	482	19.1	69	2.7	551	21.9
2010	672	24.1	91	3.3	763	27.3
2011	833	27.4	73	2.4	906	29.9
2012	832	26.7	85	2.7	917	29.4
2013	678	24.2	95	3.4	773	27.6
2014	641	23.4	82	3.0	723	26.3
2015	620	22.9	84	3.1	704	26.0
2016	690	22.3	100	3.2	790	25.5

Table 6.33
New TB cases by pass category/status in non-residents, 2012-2016

	2012	2013	2014	2015	2016
Long-staying foreigners					
Work Permit Holders	458	434	409	353	473
Employment Pass Holder	53	52	27	36	44
Other Pass Holders*	132	122	128	113	176
Sub-total	643	608	564	502	693
Short-staying foreigners					
Work Permit Applicants	528	389	391	351	370
Visitors**	238	216	215	204	233
Others***	151	168	117	149	187
Sub-total	917	773	723	704	790
Total	**1,560**	**1,381**	**1,287**	**1,206**	**1,483**

* Professional pass holder, dependent pass holder, long-term social visit pass holder, student pass holder and S pass holder.
** Short term social visitor.
*** Professional visit pass applicant, dependent pass applicant, long-term social visit pass applicant, student pass applicant, employment pass applicant, S pass applicant, illegal immigrant and other pass applicants.

TB drug resistance

In the following, analyses related to TB drug resistance for Singapore residents would be presented separately amongst those who are Singapore-born and foreign-born. Cases with unknown countries of birth were excluded from the analysis. The data presented was based on the drug susceptibility testing result of mycobacterial cultures taken at baseline (from three months before to two weeks after the date of notification or date of starting treatment, whichever earlier).

Singapore-born residents

In 2016, drug resistance was detected in 41 (5.3%) of the 774 new pulmonary TB cases in whom drug-susceptibility testing was performed, 34 (4.4%) were resistant to one drug and 7 (0.9%) were resistant to more than one drug (Table 6.34). Multi-drug-resistant TB (MDR-TB), i.e. resistance to both rifampicin and isoniazid, was detected in three (0.4%) cases, while resistance to isoniazid but not rifampicin was detected in 19 (2.4%) cases.

Drug resistance was detected in 11.1% (eight cases) of the 72 relapsed pulmonary TB cases with drug susceptibility testing performed, 9.7% (seven cases) were resistant to one drug and 1.4% (one case) was resistant to more than one drug. There were no MDR-TB cases detected. Resistance to isoniazid but not rifampicin was 8.3% (six cases). No Singapore-born resident with initially pan-sensitive or isoniazid mono-resistant TB developed MDR-TB during treatment in 2016. There was no case of extensively-drug-resistant TB (XDR-TB), i.e. MDR-TB with resistance to any fluoroquinolone and second-line injectable agent, among Singapore-born TB cases in 2016.

Table 6.34
***Mycobacterium tuberculosis* drug susceptibility in Singapore-born residents with pulmonary TB, 2013-2016**

Sensitivity result of sputum examination*	2013		2014		2015		2016	
	No.	%	No.	%	No.	%	No.	%
New cases								
**Sensitive to:								
Streptomycin, Isoniazid, Rifampicin	666	93.4	661	92.7	680	93.1	733	94.7
Resistant to:								
Single drug	38	5.3	38	5.3	43	5.9	34	4.4
More than 1 drug	9	1.3	14	2.0	7	1.0	7	0.9
Total	**713**	**100**	**713**	**100**	**730**	**100**	**774**	**100**
***Resistant to Isoniazid	**21**	**2.9**	**24**	**3.4**	**24**	**3.3**	**19**	**2.4**
Resistant to Rifampicin & Isoniazid	**2**	**0.3**	**[#]6**	**0.8**	**5**	**0.7**	**3**	**0.4**
Relapsed cases								
Sensitive to:								
Streptomycin, Isoniazid, Rifampicin	57	93.4	54	88.5	61	89.7	64	88.9
Resistant to:								
Single drug	3	5.0	5	8.2	6	8.8	7	9.7
More than 1 drug	1	1.6	2	3.3	1	1.5	1	1.4
Total	**61**	**100**	**61**	**100**	**68**	**100**	**72**	**100**
Resistant to Isoniazid	**1**	**1.6**	**6**	**9.8**	**5**	**7.4**	**6**	**8.3**
Resistant to Rifampicin & Isoniazid	[¥]1	**1.6**	**0**	**0**	**0**	**0**	**0**	**0**

* In the case of dual lesions, the sensitivity result recorded was that of organisms cultured from sputum.
** Sensitive to isoniazid, rifampicin, streptomycin and ethambutol.
*** Any of isoniazid resistance, exclusive of MDR.
[¥] MDR case was notified as both pulmonary and extra-pulmonary TB, but MDR result was from an extra-pulmonary specimen only.
[#] One MDR case was notified as both pulmonary and extra-pulmonary TB, but MDR result was from an extra-pulmonary specimen only.

Foreign-born residents

In 2016, drug resistance was detected in 7.4% (11 cases) of the 149 new pulmonary TB cases in whom drug-susceptibility testing was performed. All of them were resistant to isoniazid only (Table 6.35). There was no MDR-TB case detected. Among the nine relapsed pulmonary TB cases in foreign-born residents with drug susceptibility testing performed, resistance to more than one drug was detected in one case (11.1%). There were no cases of MDR-TB or XDR-TB detected.

Table 6.35
***Mycobacterium tuberculosis* drug susceptibility in foreign-born residents with pulmonary TB, 2013-2016**

Sensitivity result of sputum examination *	2013		2014		2015		2016	
	No.	%	No.	%	No.	%	No.	%
New cases								
**Sensitive to:								
Streptomycin, Isoniazid, Rifampicin	126	88.1	116	91.3	125	89.3	138	92.6
Resistant to:								
Single drug	12	8.4	8	6.3	12	8.6	11	7.4
More than 1 drug	5	3.5	3	2.4	3	2.1	0	0.0
Total	**143**	**100**	**127**	**100**	**140**	**100**	**149**	**100**
***Resistant to Isoniazid	**10**	**7.0**	**2**	**1.5**	**9**	**6.4**	**7**	**4.7**
Resistant to Rifampicin & Isoniazid	**0**	**0**	**1**	**0.8**	**0**	**0**	**0**	**0**
Relapsed cases								
Sensitive to:								
Streptomycin, Isoniazid, Rifampicin	6	100	8	88.9	6	85.7	8	88.9
Resistant to:								
Single drug	0	0	1	11.1	1	14.3	0	0
More than 1 drug	0	0	0	0	0	0	1	11.1
Total	**6**	**100**	**9**	**100**	**7**	**100**	**9**	**100**
Resistant to Isoniazid	**0**	**0.0**	**0**	**0.0**	**1**	**14.3**	**1**	**11.1**
Resistant to Rifampicin & Isoniazid	**0**	**0.0**	**0**	**0**	**0**	**0**	**0**	**0**

* In the case of dual lesions, the sensitivity result recorded was that of organisms cultured from sputum.
** Sensitive to isoniazid, rifampicin, streptomycin and ethambutol.
*** Any of isoniazid resistance, exclusive of MDR

Non-residents

In 2016, drug resistance was detected in 16.2% (74 cases) of the 457 cases of new pulmonary TB cases among non-residents with drug-susceptibility testing performed. 10.7% (49 cases) of cases were resistant to one drug and 5.5% (25 cases) were resistant to more than one drug (Table 6.36). MDR-TB was detected in 18 cases (3.9%), and resistance to isoniazid but not rifampicin was detected in 33 cases (7.2%).

Among the eight relapsed pulmonary TB cases with drug susceptibility testing performed, 12.5% (one case) was resistant to one drug and 37.5% (three cases) to more than one drug. MDR-TB was detected in two cases (25.0%), and resistance to isoniazid but not rifampicin was detected in one case (12.5%).

Table 6.36
***Mycobacterium tuberculosis* drug susceptibility in non-residents with pulmonary TB, 2013-2016**

Sensitivity result of sputum examination*	2013		2014		2015		2016	
	No.	%	No.	%	No.	%	No.	%
New cases								
**Sensitive to:								
Streptomycin, Isoniazid, Rifampicin	341	87.0	294	86.7	287	86.5	383	83.8
Resistant to:								
Single drug	32	8.2	23	6.8	32	9.6	49	10.7
More than 1 drug	19	4.8	22	6.5	13	3.9	25	5.5
Total	**392**	**100**	**339**	**100**	**332**	**100**	**457**	**100**
***Resistant to Isoniazid	**27**	**6.9**	**24**	**7.1**	**27**	**8.1**	**33**	**7.2**
Resistant to Rifampicin & Isoniazid	**#12**	**3.1**	**10**	**2.9**	**6**	**1.8**	**18**	**3.9**
Relapsed cases								
Sensitive to:								
Streptomycin, Isoniazid, Rifampicin	15	75.0	11	64.7	11	68.8	4	50.0
Resistant to:								
Single drug	1	5.0	4	23.5	1	6.2	1	12.5
More than 1 drug	4	20.0	2	11.8	4	25.0	3	37.5
Total	**20**	**100**	**17**	**100**	**16**	**100**	**8**	**100**
Resistant to Isoniazid	**1**	**5.0**	**3**	**17.6**	**3**	**18.8**	**1**	**12.5**
Resistant to Rifampicin & Isoniazid	**4**	**20.0**	**1¶**	**5.9**	**2**	**12.5**	**2**	**25.0**

* In the case of dual lesions, the sensitivity result recorded was that of organisms cultured from sputum.
** Sensitive to isoniazid, rifampicin, streptomycin and ethambutol.
***Any of isoniazid resistance, exclusive of MDR.
One MDR case was notified as both pulmonary and extra-pulmonary TB, but MDR result was from an extra-pulmonary specimen only.
¶ MDR-TB resistant to both fluoroquinolone and second-line injectable.
Note: Extra-pulmonary MDR-TB was detected in 3 new cases among non- residents in 2016.

TB mortality

In 2016, there were 39 deaths from TB among Singapore residents, giving a mortality rate of 1.0 cases per 100,000 population (Table 6.37). The majority were males (82.1%) and those aged 70 years and above (66.7%).

Table 6.37
Age-gender distribution and age-specific mortality rates of TB, 2016

Age group	Male	Female	Total	%	Mortality rates per 100,000 population*
0–9	0	0	0	0	0
10–19	0	0	0	0	0
20-29	0	0	0	0	0
30–39	0	0	0	0	0
40–49	0	1	1	2.6	0.2
50–59	3	1	4	10.2	0.7
60–69	6	2	8	20.5	1.8
70+	23	3	26	66.7	9.0
Total	**32**	**7**	**39**	**100**	**1.0**

* Rates are based on 2016 estimated mid-year resident population.
(Source: Singapore Department of Statistics, Registry of Births & Deaths)

HEALTHCARE-ASSOCIATED OUTBREAKS

Healthcare-associated outbreaks are defined as clusters of infections in healthcare settings related in time and place, and occurring above a baseline or threshold level for a facility, specific unit, or ward. Healthcare settings include public and private hospitals, nursing homes, welfare homes and day-care centres.

The Healthcare Epidemiology (HCE) team is a newly formed team on 1 April 2016 within the Surveillance and Response Branch of Communicable Diseases Division in MOH, to assist in the investigation of healthcare institutions associated outbreaks. The team comprised several field epidemiologists, and a public health practitioner. In some outbreaks, member(s) of the National Outbreak Response Team are called upon by DMS to augment the outbreak investigation. The National Outbreak Response Team was set up in March 2016 to draw on national resources and expertise to augment efforts in dealing with infectious diseases.

Suspected clusters of hospital acquired infections (HAIs) are reported to HCE early so that MOH can detect trends at the national level, monitor the situation and advise on perspectives that extend beyond individual hospitals. Table 6.38 list the triggers and guiding criteria for reporting clusters of HAIs to the Ministry.

In year 2016, a total of 43 healthcare-associated outbreaks were reported by the hospitals and institution-based care facilities (Table 6.39). Of these outbreaks, respiratory outbreaks accounted for the most cases of illness, with 494 cases (Table 6.40).

Table 6.38
Guiding criteria for reporting of outbreaks/ clusters of infectious diseases to MOH

Institution Type	Guiding Criteria
Hospital/ Community Hospital	When assessing whether to report an incident, the hospital should report the incident (which may involve Multidrug Resistant Organisms) to MOH as soon as possible, if any of the following guiding criteria are met: 1. Organism e.g. if it involves a pathogen or gene novel to the institution or country. 2. Potential impact beyond the institution e.g. if there is a: a. Risk of community transmission. b. Common product used beyond institution. c. Critical facility that relied upon nationally that is significantly affected especially if closure is being considered e.g. burns units and cardiothoracic intensive care unit (ICU). d. Population of patient with significant healthcare contact outside the facility is affected e.g. renal dialysis. 3. Institutional capability e.g. if the increase in the cluster size does not slow despite control measures, or if assistance/resources are required to control outbreak. 4. Media sensitivity e.g. any incident which potentially may be media sensitive.
	Hospitals should also specifically report the following: 5. Cluster (2 or more cases) of a highly infectious agent (e.g. measles, chickenpox) with suspected transmission to staff or patient in a vulnerable population e.g. neonates, transplant and other immunocompromised patients, or critical facility e.g. ICUs, oncology, and operating rooms.
Institution-based care facilities	1. 10% of the total population (residents and staff) within 14 days are affected with the same illness. 2. 10 cases within 3 consecutive days. 3. Case(s) in the cluster that are severely ill [Dangerously Ill List (DIL) or in ICU] or died. [where this information is available].
Timeline for notification	All clusters/outbreaks of infectious diseases that are identified to have met MOH's reporting criteria, should be notified within 24 hours. After initial notification, the reporting institution will be required to provide daily situational updates to MOH. MOH will adjust the periodicity of the updates, when necessary.
Mode of notification	1. Email: reportidcluster@moh.gov.sg For hospitals/community hospitals – to submit Annex C (Reporting form for incident/cluster of healthcare-associated infections). Request for individual case details will be requested separately, if necessary. For Institution-based care facilities – refer to email reporting template below: • Name of Institution: e.g. ABC Nursing Home (COO Office) • Address of Institution • Point-of-contact: e.g. Ms Lucy Goh (Manager) • Number of cases • Signs & symptoms

Table 6.39
Number of reported outbreaks in hospitals and institution-based care facilities, 2016

Type of institution	No. of outbreaks
Hospitals (private and public)	12
Community Hospitals	1
Institution-based care facilities	30
Total	43

Table 6.40
Healthcare associated outbreaks by disease condition, 2016

Institution type/ Disease Condition	No. of incidents	Total No. of cases (range)
Hospital (12)		
Respiratory	1	9
Gastrointestinal	0	
Skin	2 (Group A *Streptococcus*)	27 (10-17)
Multi-drug resistant organisms (MDRO)	3	20 (3-12)
Others	6 (*Burkholderia cepacia,* chickenpox, conjunctivitis, Hepatitis B, measles, *Stenotrophomonas maltophilia*)	21 (1-7)
Community Hospitals (1)		
Respiratory	1	14
Gastrointestinal	0	
Skin	0	
MDRO	0	
Others	0	
Institution-based care facilities (30)		
Respiratory	14	494 (6-91)
Gastrointestinal	10	206 (6-34)
Skin	2	29 (1-28)
MDRO	0	
Others	4 (3-chickenpox, 1-dengue/ HFMD)	21 (1-10)

Outbreak of *Pseudomonas aeruginosa* conjunctivitis at a Neonatal Intensive Care Unit

Newborns in neonatal intensive care unit (NICU) are highly susceptible to nosocomial infections due to their immature immune system, underdeveloped protective barriers, as well as the exposure to various invasive procedures. On 29 April 2016, the Ministry of Health (MOH) was notified of four cases of bacterial conjunctivitis among neonates in the NICU of a private Hospital, who developed symptoms of eye discharges between 20 and 29 April. Laboratory tests showed *P. aeruginosa* and the isolates from two cases showed the same antibiotic sensitivity profile.

Epidemiological investigations were immediately conducted by the HCE Team to determine the extent of the outbreak, source of infection, and mode of transmission. A case was defined as a neonate with culture-confirmed *P. aeruginosa* conjunctivitis, and had stayed in the NICU from 13 April onwards (one week before the onset of the first case). Samples were collected from the affected neonates and environment for bacterial culture and antibiotic sensitivity profiling. Further analysis was conducted on the positive isolates via Pulsed Field Gel Electrophoresis (PFGE) at the hospital's contracted laboratory.

A total of seven affected neonates were identified in this outbreak. Median days from NICU admission to onset of illness was 14 (range, 6–28 days), while median number of days hospitalized was 27.5 (range, 22-41 days). Environmental sampling found five positive *P. aeruginosa* isolates from the affected NICU's drain outlets of the sinks. Two control

isolates from non-affected areas were also found to be positive for *P. aeruginosa*. Multipronged infection control approach was adopted by the hospital to stop the transmission of this outbreak. No further new cases identified after 1 May. The PFGE results showed that six isolates from five affected neonates and one environmental sample in NICU (i.e. sink drain) had the same PFGE clone. The remaining positive isolates including those from the control group had different PFGE clones.

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

SEVERE ILLNESS AND DEATH FROM POSSIBLY INFECTIOUS CAUSES

The SIDPIC (Severe Illness and Death from Possibly Infectious Causes) programme is a hospital-based sentinel surveillance programme which reviews cases of unexplained deaths and critical illness to identify possible emerging infections caused by novel pathogens. It aims to reduce delays in recognising emerging infections of public health importance. The project is presently operational in six public hospitals, including the existing programmes in TTSH, NUH, SGH and KKH and recent extensions to CGH (since 1 April 2016) and NTFGH (since 1 October 2016).

In 2016, a total of 13,820 hospital patients were screened by SIDPIC project coordinators in participating hospitals (Table 6.41). Of these, 339 SIDPIC cases that fulfilled the inclusion criteria[2] were identified. The majority of SIDPIC cases (35.7%) had illnesses with respiratory syndromes (Table 6.42). Of the 339 cases identified in 2016, 201 were found to have alternate aetiologies, including 101 with causative pathogens detected.

The top two causative pathogens amongst all pathogens identified were respiratory viruses (46.6%), and *Streptococcus pneumoniae* (8.6%). The remaining 100 cases had clinical presentations that were consistent with the clinical diagnosis, e.g. auto-immune disorders. Despite extensive laboratory testing, the aetiology in 138 (40.7%) cases remained unknown. Table 6.43 lists the pathogens which may be tested for under the SIDPIC programme.

Table 6.41
SIDPIC performance indicators, 2016

Surveillance Indicators	NUH	TTSH	SGH	KKH	CGH	NTFGH	TOTAL
No. of cases screened*	3,861	5,947	852	817	2,212	131	**13,820**
Death	1,329	2,985	153	111	545	3	**5,126**
Non-death	2,532	2,962	699	706	1,667	128	**8,694**
No. of SIDPIC cases	111	145	8	64	13	1	**342^**
Aetiology Found	46	75	0	45	10	1	**177**
Unknown Aetiology	65	68	8	18	3	0	**162**
Co-morbidity found	0	2	0	0	4	0	**6**
No. of missed cases#	-	-	-	-	-	-	**0**

* The total number of cases screened refers to the sum of ICU admissions and death certificates screened.
^ Included 3 duplicate cases.
# Based on surrogate indicator (viral encephalitis between January and September 2016, and invasive pneumococcal disease [IPD] between October and December 2016) notified to MOH that are not identified as SIDPIC cases.
There were a total of 17 viral encephalitis between January and September 2016, and 21 IPD between October and December 2016 notified to MOH. All 38 cases did not fulfil SDIPIC recruitment criteria and they were not identified as SIDPIC cases.

[2] Inclusion criteria of SIDPIC programme:
- Age 1 to 49 years.
- Previously healthy. Exclusion criteria:
  - Immunosuppression (e.g. HIV/ AIDS, cancers, and immune disorders)
  - Chronic diseases (e.g. cardiac, lung, renal and hepatic)
- Clinical presentation suggestive of infection.
- Death or critically ill cases.
- Routine testing has not identified a known cause.

Cases with suspected infectious disease, who do not fit the above criteria but are deemed by SIDPIC physicians to be of possible public health importance are also included in the programme.

Table 6.42
Distribution of SIDPIC cases based on syndrome* classification, 2016

Syndrome	Aetiology Found	Unknown Aetiology	Total	%
Neurological	47	32	79	23.3
Cardiac	43	13	56	16.5
Respiratory	67	54	121	35.7
Gastrointestinal	6	8	14	4.1
Multisystem	38	31	69	20.4
Total	**201**	**138**	**339**	**100**

* Syndrome Classification:
i. Neurological – meningitis or encephalitis
ii. Cardiac – myocarditis, pericarditis, endocarditis
iii. Respiratory – pneumonia, acute respiratory distress syndrome (ARDS), respiratory failure
iv. Gastrointestinal – hepatitis, hepatic failure, severe diarrhoea
v. Multisystem – sepsis, haemorrhagic fever, rash, shock

Table 6.43
SIDPIC Lab Test Panels

	Pneumonia		Encephalitis		Viral Haemorrhagic Fever
First line panel*	**Respiratory Samples** Multiplex PCR Influenza PCR H5N1 PCR SARS CoV-PCR MERS-CoV PCR TB PCR **Blood** Bacterial culture *Mycoplasma* serology *Legionella* serology *Chlamydia* serology H5N1 PCR SARS CoV-PCR	**Urine** Urine culture Pneumococcal Ag *Legionella* Ag **Other samples (e.g. lung tissue)** PCP stain Fungal stain	**Cerebrospinal Fluid** Bacterial culture AFB PCR, culture Fungal culture Enterovirus PCR HSV/ CMV/ VZV/ EBV PCR Dengue PCR JE IgM, PCR WNV PCR Nipah PCR **Respiratory Samples** EV PCR Nipah PCR	**Stool** Enterovirus PCR Poliovirus PCR **Other samples (e.g. Brain tissue)** Histopathology	**Blood & Respiratory Samples** Dengue PCR, serology Chikungunya PCR, serology Yellow fever PCR, serology Lassa, Ebola, Marburg fever
Second line panel#	**Blood** *Brucella* serology **Respiratory Samples** Viral isolation Hantaan virus PCR Nipah PCR Zikavirus (Micronesia area)		**Cerebrospinal Fluid** Viral isolation, also consider lymphocytic choriomeningitis virus Rickettsial isolation Kunjin Chandipura Measles Polio Rabies, and other viral encephalitides dependent on travel history, e.g. WEE, SLE, VEE, Kyasanur forest disease (India)	Toscana (from Europe/ Spain) Sindbis virus (Europe/ Australia/ Asia) **Stool** Viral isolation **Other samples (e.g. Brain tissue)** EM	**Blood & Respiratory Samples** VEE, CCHF, RVF and other South American arenaviruses, e.g. Junin, Machupo, Guanarito and Sabia viruses, depending on travel history HFRS Virus isolation EM

Table 6.43
SIDPIC Lab Test Panels (*cont'd)*

	Myocarditis		Gastrointestinal		
First line panel*	**Blood** EV71 PCR **Stool** Enterovirus PCR	**Other samples (e.g. Cardiac tissue)** Histopathology	**Stool** Vibrio Cholera E. coli O157:H7	**Other samples (e.g. Liver/ intestinal tissue)** Histopathology Special stains	**Blood** Bacterial culture Yellow fever PCR, serology
Second line panel#	**Blood** Virus isolation	**Other samples (e.g. Cardiac tissue)** EM, special stains	**Stool** Rotavirus, astrovirus, sapovirus, adenovirus 40.41, Norovirus PCR Viral isolation	**Other samples (e.g. Liver/ intestinal tissue)** EM, special stains	

* **First line panel**: These are the first-line tests which may be conducted after a check has been made to ensure that these pathogens have not already been tested for, as part of the patient's clinical management.

\# **Second line panel**: These tests may be conducted after the SIDPIC physician and the laboratory have evaluated the epidemiological and clinical features of the case.

Abbreviations:			
AFB	= Acid-fast bacillus	**SLE**	= St Louis encephalitis
Ag	= Antigen	**TB**	= Tuberculosis
CCHF	= Crimean-Congo haemorrhagic fever	**VEE**	= Venezuelan equine encephalitis
CMV	= Cytomegalovirus	**VZV**	= Varicella zoster virus
E. coli O157:H7	= Escherichia coli serotype O157:H7	**WEE**	= Western equine encephalitis
EBV	= Epstein-Barr virus	**WNV**	= West Nile Virus
EM	= Electron microscopy		
EV	= Enterovirus		
EV71	= Enterovirus Type 71		
H5N1	= Influenza A virus subtype H5N1		
HFRS	= Haemorrhagic fever with renal syndrome		
HSV	= Herpes simplex virus		
JE IgM	= Japanese encephalitis immunoglobulin M		
MERS-CoV	= Middle East respiratory syndrome coronavirus		
PCP	= Pneumocystis carinii pneumonia		
PCR	= Polymerase chain reaction		
RVF	= Rift Valley fever		
SARS-CoV	= Severe acute respiratory syndrome coronavirus		

Contributed by
Alvin Gay, Chan Pei Pei, Constance Low, Cynthia Chee, Flora Huang, Heather Tan, Imran Muhammad, Kelly Foo, Khin Mar Kyi Win, Khine Nandar, Koh Han Fang, Leo Lim, Ng Yixiang, Pan Jiun Yit, Phoebe Lee, Steven Ooi, Zhang Yiwen, Zubaidah Said