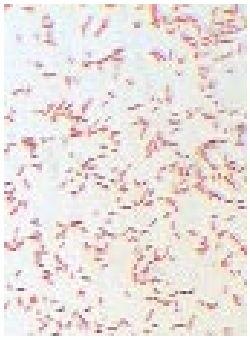
Environment-related Diseases



VI

ENVIRONMENT-RELATED DISEASES

LEGIONELLOSIS

A total of 65 cases of legionellosis comprising 58 cases of legionnaires' disease and 7 cases of Pontiac fever were reported in 2000 *(Fig. 6.1).* The diagnosis was mainly based on an indirect fluorescent antibody titre of ≥1:1024 in a single blood specimen in the presence of characteristic clinical findings. Seven cases of legionnaires' disease were confirmed by the urinary *Legionella* antigen test *(Table 6.1).* Three deaths were reported giving a case-fatality rate of 4.6%.

There were ten imported cases. Eight were foreigners who came to Singapore to seek medical treatment and two were local residents who contracted the disease while staying overseas *(Table 6.2)*. The rest occurred singly and sporadically throughout the island (*Fig.2*). The ages of the reported cases ranged from 30 years to 89 years. The overall incidence rate was 2.0 per 100,000 with the highest age-specific rate among persons aged 65 years and above *(Table 6.3).* The male to female ratio was 1.5:1. Among the three major ethnic groups, Indians had the highest incidence rate (2.7 per 100,000), followed by Chinese (1.4 per 100,000) and Malays (1.1 per 100,000) *(Table 6.4).* The majority of the cases were retirees (22 cases, 33.8%) and housewives (18 cases, 27.7%) *(Table 6.5).* Although cases occurred throughout the year, there were more cases reported during the months of January and December *(Fig. 6.3).* There was a correlation between disease incidence and rainfall in 2000 (r = 0.68) *(Fig. 6.4).*

Figure 6.1
Reported incidence of legionellosis in Singapore, 1986 - 2000

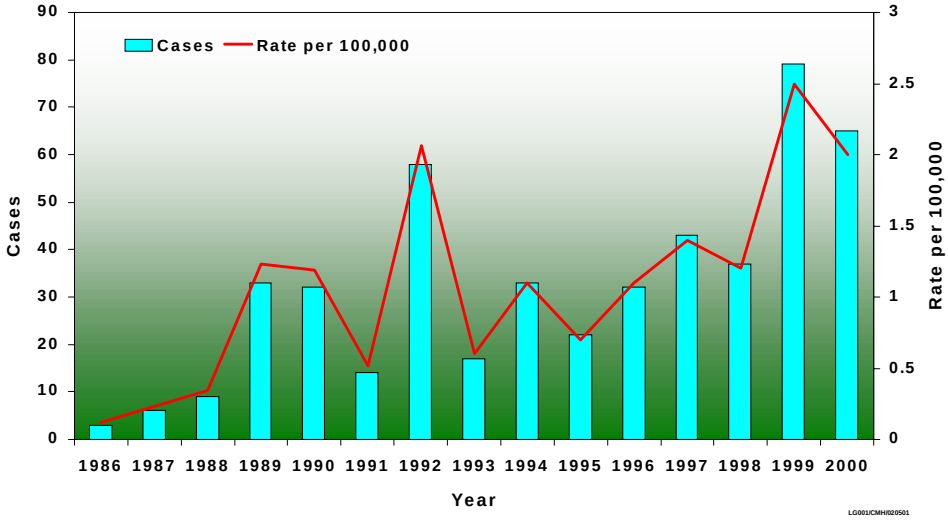


Table 6.1

Reported cases of legionellosis, 2000

	Legionnaires' disease	Pontiac fever	Total
Confirmed case+	7	0	7
Presumptive case*	51	7	58
Total	58	7	65

+ Urinary antigen test positive

* Indirect immunofluorescence antibody titre $\geq$ 1024 in a single blood specimen

Table 6.2

Details of two local residents who contacted legionnaires' diseases overseas, 2000

Age	Gender	Ethnic group	Country visited	Duration of stay overseas	Date of onset of illness
80	Male	Chinese	Australia	18 Jul - 18 Oct	12 Oct 00
40	Male	Indian	India	26 May - 26 Jun	23 Jun 00

Figure 6.2

Geographical distribution of 55 local sporadic cases of legionellosis, 2000

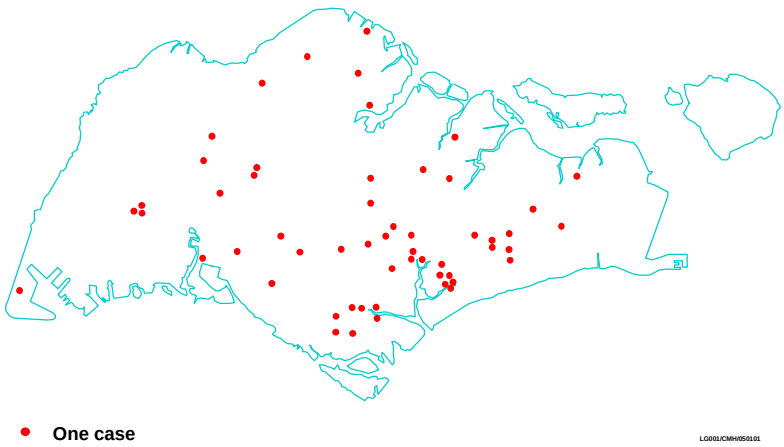


Table 6.3

Age-gender distribution, age-specific incidence rates and case-fatality rates of reported legionellosis in Singapore, 2000

Age group	Male	Female	Total	Incidence rate per 100,000*	No. of deaths	Case-fatality rate (%)
0-4	0	0	0	0	0	0
5-14	0	0	0	0	0	0
15-24	0	0	0	0	0	0
25-34	4	2	6	1.1	0	0
35-44	6	2	8	1.3	1	12.5
45-54	5	3	8	1.7	0	0
55-64	7	2	9	3.8	0	0
65+	17	17	34	14.3	2	5.9
Total	39	26	65	2.0	3	4.6

*Rates are based on 2000 census population.
(Source: Department of Statistics, Singapore)

Table 6.4

Ethnic-gender distribution, ethnic-specific incidence rates and case-fatality rates of reported legionellosis in Singapore, 2000

Age group	Male	Female	Total	Incidence rate per 100,000*	No. of Deaths	Case-fatality rate (%)
Chinese	20	16	36	1.4	2	5.6
Malays	1	4	5	1.1	0	0.0
Indians	4	3	7	2.7	1	14.3
Others	1	1	2	4.3	0	0.0
Foreigners	13	2	15	-	0	0.0
Total	39	26	65	2.0	3	4.6

* Rates are based on 2000 census population.
(Source: Department of Statistics, Singapore)

Table 6.5

Distribution of 465 reported cases of legionellosis by occupation, 1989-2000

	1989-99 n=400 (48)	2000 n=65 (3)	Total n=465 (51)
Cleaners, labourers & related workers			
Construction labourer	49 (5)	2	51 (5)
Office/school/hospital attendant	7 (1)	1	8 (1)
Factory/production operator	3	0	3
Domestic maid	2	0	2
Gardener	2	0	2
Kitchen assistant	2 (1)	0	2 (1)
Packer/component assembler	2	0	2
Armed Forces personnel	23	0	23
Clerical workers	13	0	13
Service & shop/market sales workers			
Security guard	4 (2)	1 (1)	5 (3)
Hawker	3 (2)	0	3 (2)
Policeman	1	1	2
Barber	1	0	1
Chef	1	0	1
Housekeeper	1	0	1
Shop assistant	2	0	2
Tourist guide	1	0	1
Sales supervisor	1	0	1
Professionals			
Optometrist	0	1	1
Manager	2 (1)	4 (1)	6 (2)
Dental surgeon	1	0	1
Engineer	3 (1)	1	4(1)
Doctor	1	0	1
Teacher	2	0	2
Religious worker	2	1	3
Accountant	1	2	3
Information technology researcher	1	0	1
Surveyor	0	2	2
Drivers	7	0	7
Production craftsmen & related workers			
Welder	3	0	3
Baker	1	0	1
Electrician	2	0	2
Supervisor	1 (1)	1	2 (1)
Machine operator	2	0	2
Carpenter	1	1	2
Mechanic	1	0	1
Technicians & associate professionals			
Nurse	6	0	6
Technician	4	2	6
Stockbroker	1	0	1
Senior officials & managers			
Working proprietor	5 (1)	0	5 (1)
Company director	1 (1)	0	1 (1)
Translators and Interpreters			
Translator	1	0	1
Others			
Retiree	127 (21)	22 (1)	149 (22)
Housewife	77 (10)	18	95 (10)
Unemployed	12	0	12
Student	3	0	3
Seaman	0	5	5
No record	14 (1)	0	14 (1)

( ) = death

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

Figure 6.3
Monthly distribution of reported local cases* of legionellosis, 1990 - 2000

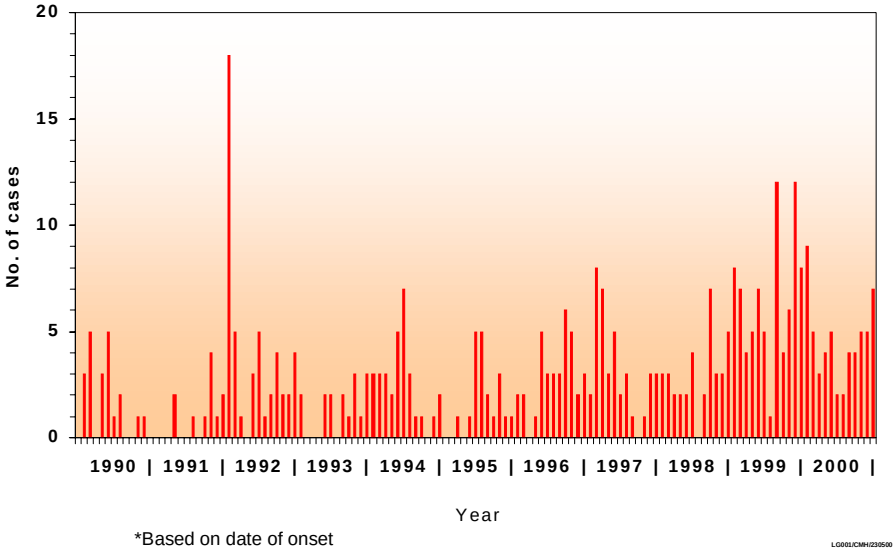
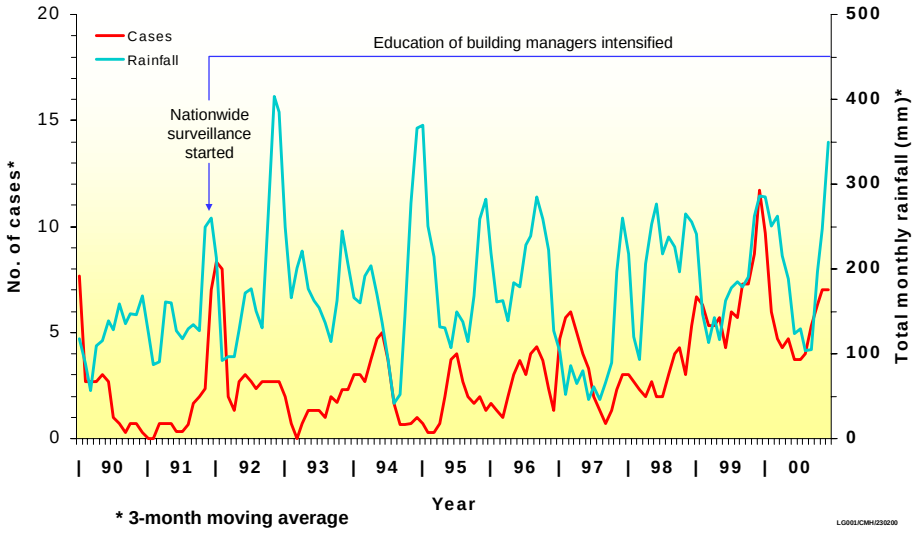


Figure 6.4
Monthly distribution of reported local cases of legionellosis and rainfall, 1990 - 2000



Fifty-nine of the 65 reported cases presented with cough (90.8%), 50 with fever (76.9%), 22 with breathlessness (33.8%), 10 with chest pain (15.4%), 9 with nausea/vomiting (13.8%), and the rest with malaise (7.7%), drowsiness/giddiness (7.7%), loss of appetite (7.7%) and loss of weight (7.7%) *(Table 6.6).*

Of the reported cases, 45 (69.2%) had concurrent medical illness such as hypertensive disease, ischaemic heart disease, cerebrovascular disease, diabetes mellitus, asthma, pulmonary tuberculosis and renal failure *(Table 6.7).* The particulars of the three local fatal cases are summarised

Table 6.6

Clinical presentation* of 65 cases of legionellosis, 2000

Clinical presentation	No. of cases	%
Fever (with/without chills and rigors)	50	76.9
Respiratory symptoms		
Cough	59	90.8
Breathlessness	22	33.8
Chest pain	10	15.4
Gastrointestinal symptoms		
Nausea/vomiting	9	13.8
Diarrhoea	4	6.2
Abdominal pain/discomfort/epigastric pain	4	6.2
Neuromuscular symptoms		
Headache	4	6.2
Drowsiness/giddiness	5	7.7
Myalgia	1	1.5
Cardiovascular symptoms		
Palpitation	1	1.5
Urinary symptoms		
Dysuria	1	1.5
General symptoms		
Malaise	5	7.7
Loss of weight	5	7.7
Unconsciousness	1	1.5
Body pain	4	6.2
Loss of appetite	5	7.7

* Cases may have one or more clinical presentations.

Table 6.7

Concurrent medical conditions* of 465 reported cases of legionellosis, 1989-2000

Concurrent medical condition	1989-99 n = 400 (48)		2000 n = 65 (3)		Total n = 465 (51)	
Disorders of the circulatory system						
Cardiomegaly	0		1		1	
Hypertension	79	(15)	21	(1)	100	(16)
Ischaemic heart disease	61	(16)	15	(2)	76	(18)
Heart failure	20	(3)	1		21	(3)
Cerebrovascular disease	27	(11)	5		32	(11)
Peripheral vascular disease	1		0		1	
Moyamoya disease	1	(1)	0		1	(1)
Atrial fibrillation	0		1		1	
Metabolic disorders						
Diabetes mellitus	65	(16)	21	(1)	86	(17)
Gout	2		0		2	
Thyrotoxicosis	2		0		2	
Disorders of the respiratory system						
Chronic obstructive pulmonary disease	46	(10)	1		47	(10)
Asthma	40	(2)	7		47	(2)
Bronchiectasis	17	(4)	2		19	(4)
Fibrosing alveolitis	1		0		1	
Interstitial lung disease	1		0		1	
Infectious diseases						
Pulmonary tuberculosis	33	(2)	3		36	(2)
Septicaemia	4	(4)	0		4	(4)
Melioidosis	2		0		2	
Hepatitis	1		0		1	
Dengue fever	1		0		1	
Leprosy	1		0		1	
Neoplasms	16	(4)	4	(2)	20	(6)
Disorders of the digestive system						
Cholecystitis, cholangitis, cholelithiasis	7		0		7	
Peptic ulcer	9	(1)	0		9	(1)
Alcoholic liver disease	3	(1)	0		3	(1)
Liver cirrhosis	2	(1)	1		3	(1)
Duodenitis	1		0		1	
Blood disorders						
Anaemia	13	(2)	0		13	(2)
Thalasseamia minor	1		1		2	
Mental disorders						
Schizophrenia	6	(2)	0		6	(2)
Dementia	1		0		1	
Disorders of the musculoskeletal system and connective tissue						
Arthritis	1		1		2	
Systemic lupus erythematosus	2	(2)	0		2	(2)
Disorders of the genitourinary system						
Renal failure	21	(4)	6		27	(4)
Pyelonephritis	1		0		1	
Urinary tract infection	2	(1)	1		3	(1)
Disorders of the nervous system						
Parkinson's disease	5	(1)	1		6	(1)

( ) = death

*Patients may have one or more concurrent medical conditions

in *Table 6.8*. Significantly higher case-fatality rates were noted among those with concurrent medical conditions compared with those without (p<0.0001) *(Table 6.9).* The case-fatality rate was also higher among smokers/ex-smokers compared with non-smokers *(Table 6.10).*

Surveillance of *Legionella* bacteria in the environment

A total of 107 buildings with 190 cooling towers were surveyed. Of these, 101 water samples were collected during epidemiological investigation of reported cases. The positivity rate for *Legionella*

Table 6.8

Details of three local fatal cases of legionnaires' disease, 2000

Gender	Age (yrs)	Ethnic group	Concurrent medical conditions
Male	74	Chinese	Lung carcinoma, colorectal carcinoma, ischaemic heart disease, diabetes mellitus, hypertension
Male	43	Indian	Cardiomyopathy
Male	68	Chinese	Ischaemic heart disease

Table 6.9

Case-fatality rate of reported legionellosis by history of medical conditions, 1989-2000

Year	Concurrent medical conditions					
	Present		Absent		Total	
	Cases	Deaths	Cases	Deaths	Cases	Deaths (%)
1989	16	4	17	0	33	4 (12.1)
1990	18	3	14	0	32	3 (9.4)
1991	11	2	3	0	14	2 (14.3)
1992	37	5	21	1	58	6 (10.4)
1993	15	4	2	0	17	4 (23.5)
1994	19	8	14	1	33	9 (27.3)
1995	11	2	11	0	22	2 (9.1)
1996	23	4	9	0	32	4 (12.5)
1997	40	4	3	0	43	4 (9.3)
1998	28	5	9	0	37	5 (13.5)
1999	60	5	19	0	79	5 (6.3)
2000	45	2	20	1	65	3 (4.6)
Total	323	48	142	3	465	51
Overall case-fatality rate (%)	14.9[a]		2.1[b]		11.0	

a vs b: p < 0.0001

Odds ratio = 8.1

95% confidence interval = 2.4 – 23.2

Table 6.10

Case-fatality rate of reported legionellosis by history of smoking, 1989-2000

Year	Smoking history					
	Yes#		No		Total	
	Cases	Deaths	Cases	Deaths	Cases	Deaths (%)
1989	10	2	23	2	33	4 (12.1)
1990	13	2	19	1	32	3 (9.4)
1991	9	1	5	1	14	2 (14.3)
1992	19	4	39	2	58	6 (10.4)
1993	7	2	10	2	17	4 (23.5)
1994	16	5	17	4	33	9 (27.3)
1995	15	1	7	1	22	2 (9.1)
1996	18	3	14	1	32	4 (12.5)
1997	20	3	23	1	43	4 (9.3)
1998	24	1	13	4	37	5 (13.5)
1999	14	2	65	3	79	5 (6.3)
2000	14	3	51	0	65	3 (4.6)
Total	179	29	286	22	465	51
Overall case-fatality rate (%)	16.2[a]		7.7[b]		11.0	

#Includes smokers and ex-smokers
a vs b: p = 0.007
Odds ratio = 2.3
95% confidence interval = 1.2- 4.4

bacteria was 59.5%. One of three outdoor water fountains and 2 of six swabs collected from shower heads/taps were also tested positive. The isolation rates for the various types of buildings are shown in *Table 6.11.* The distribution of *Legionella* count in cooling towers tested is shown in *Table 6.12.* Eight (4.2%) of the cooling towers were found to have *Legionella* count of Of ≥100,000 cfu/l.

Of the 190 cooling towers surveyed, 188 were maintained by water treatment contractors and two had in-house maintenance. During the period 1996-2000, the isolation rate of *Legionella* bacteria in cooling towers with cleaning/treatment maintenance programme (58.2%) was lower than that in those without (71.4%), but the difference was not statistically significant. There was also no significant difference in isolation rate of *Legionella* bacteria in cooling towers with in-house treatment (50.0%) compared with those maintained by CIDB-registered/non-CIDB registered contractors (58.3%). Moreover, the isolation rate of legionella bacteria in cooling towers maintained by CIDB-registered contractors (58.9%) was not significantly different from those maintained by non-CIDB-registered contractors (50.8%) *(Table 6.13).*

Table 6.11

Isolation rate of *Legionella* bacteria in the environment by type of premises, 2000

Type of premises	No. positive/No. tested (%)			
	Cooling tower	Fountain (outdoor)	Shower head/tap swab	Total
Office	22/ 47 (46.8)	-	-	22/ 47 (46.8)
Office/shopping complex	12/ 28 (42.9)	-	-	12/ 28 (42.9)
Shopping complex	30/ 41 (73.2)	0/1 (0)	-	30/ 42 (71.4)
Hotel	21/ 36 (58.3)	1/1 (100.0)	0/2 (0)	22/ 39 (56.4)
Library	8/ 12 (66.7)	-	-	8/ 12 (66.7)
Polytechnic	2/ 2 (100.0)	-	-	2/ 2 (100.0)
Factory	5/ 8 (62.5)	-	-	5/ 8 (62.5)
Food outlet/supermarket	12/ 15 (80.0)	-	-	12/ 15 (80.0)
Construction site	1/ 1 (100.0)	-	-	1/ 1 (100.0)
Residence	-	0/1 (0)	2/4 (50.0)	2/ 5 (40.0)
Government	10/ 17 (58.8)	-	-	10/ 17 (58.8)
Government restructured	4/ 5 (80.0)	-	-	4/ 5 (80.0)
Private	99/168 (60.0)	1/3 (33.3)	2/6 (33.3)	102/177 (57.6)
Total	113/190 (59.5)	1/3 (33.3)	2/6 (33.3)	116/199 (58.3)

Table 6.12

Results of tests for *Legionella* in cooling towers following investigations into legionellosis cases and building-related complaints in Singapore, 2000

Estimated legionella count (cfu/l)	No. of samples (% positive) collected in relation to		
	Case investigation	Building-related complaints and random sampling	Total
Negative:			
<100	44 (43.6)	33 (37.1)	77 (40.5)
Positive:	57 (56.4)	56 (62.9)	113 (59.5)
100-	8 (7.9)	14 (15.7)	22 (11.6)
1,000-	26 (25.7)	18 (20.2)	44 (23.2)
10,000-	20 (19.8)	19 (21.3)	39 (20.5)
100,000-	3 (3.0)	5 (5.6)	8 (4.2)
≥100,000	0	0	0
Total	101 (100.0)	89 (100.0)	190 (100.0)

Table 6.13

Isolation rate of legionella bacteria in cooling towers by type of water treatment contractor, 1996-2000

	No. positive /No. tested (%)					
	1996	1997	1998	1999	2000	Total
Water treatment contractor						
CIDB#-registered	157/262 (59.9)	105/167 (62.9)	31/61 (50.8)	74/134 (55.2)	111/188 (58.9)	478/812 (58.9)[a]
Non-CIDB#-registered	26/ 47 (55.3)	0/ 7 (0)	6/10 (60.0)	1/1 (100.0)	0/ 0 (0)	33/ 65 (50.8)[b]
In-house treatment	0/ 0 (0)	0/ 0 (0)	0/ 0 (0)	0/2 (0)	2/ 2 (100.0)	2/ 4 (50.0)[c]
No contractor/treatment	8/ 12 (66.7)	0/ 0 (0)	0/ 0 (0)	2/2 (100.0)	0/ 0 (0)	10/ 14 (71.4)[d]
Total	191/321 (59.5)	105/174 (60.3)	37/71 (52.1)	77/139 (55.4)	113/190 (60.1)	523/895 (58.4)

#Construction Industry Development Board.

c vs a + b: p = 0.862 (ns)

d vs a + b + c: p = 0.471 (ns)

a vs b: p = 0.253 (ns)

It was also noted that of 190 water samples tested for total colony count (TCC), 50.6% had counts ≥10,000,000 cfu/l and 19% had counts ≥100,000,000 cfu/l. The rate of isolation of *Legionella pneumophila* peaked (57.9%) at TCC of 1,000,000 to <10,000,000 cfu/l, thereafter the rate of isolation decreased progressively at higher TCCs *(Table 6.14)*. However, the total colony count was not correlated with the concentration of *Legionella* bacteria *(Table 6.15)*.

Table 6.14

Relationship between total colony count and rate of isolation of legionella bacteria from cooling towers, 2000

Total colony count (37°C/24 hrs) (cfu/l)	No. of samples	%	Rate of isolation			
			Legionella bacteria		*Legionella pneumophila*	
			No.	%	No.	%
10^4 - <10^5	13	6.8	8	61.5	7	53.8
10^5 - <10^6	24	12.6	20	83.3	12	50.0
10^6 - <10^7	57	30.0	37	64.9	33	57.9
10^7 - <10^8	60	31.6	30	50.0	24	40.0
10^8 - <10^9	22	11.6	11	50.0	3	13.6
10^9 - <10^{10}	14	7.4	7	50.0	1	7.1
Total	190	100.0	113	59.5	80	42.1

Table 6.15

Relationship between total colony count and concentration of legionella bacteria in cooling towers, 2000

Total colony count (37°C/24 hrs) (cfu/l)	Estimated legionella count (cfu/l)					
	<10^2	10^2	10^3	10^4	10^5	Total
<10^5	5	4	1	3	0	13
10^5 - <10^6	4	4	9	7	0	24
10^6 - <10^7	22	5	17	14	3	61
10^7 - <10^8	28	5	7	12	4	56
10^8 - <10^9	11	2	7	2	0	22
10^9 - <10^{10}	7	2	3	1	1	14
Total	77	22	44	39	8	190

Of 116 *Legionella* bacteria isolated, 85 (73.3%) were classified as *L. pneumophila*, and 29 (25.0%) as *Legionella*-like organisms. *L. dumoffii* and *L. bozemanii* were not common *(Table 6.16)*.

Whenever *Legionella* bacteria were isolated, building managers were immediately informed and advised to review the maintenance schedules. They were also asked to adhere to the Code of Practice on the Control of *Legionella* Bacteria in Cooling Towers and to take preventive measures to minimise the risk of disease transmission.

Table 6.16

Classification of legionella species isolated from the environment, 2000

Legionella species	No. of positive isolates			
	Cooling towers	Outdoor fountain	Shower head	Total
Legionella pneumophila				
Serotype 1	23			23
3	4			4
6	2			2
7	20			20
8	5	1		6
10	2			2
13	3			3
1 & 5	4		1	5
1 & 7	10			10
1 & 13	2			2
7 & 10	1			1
1, 5 & 7	1			1
1, 8 & 13	1			1
1, 5, 7 & 8	1			1
7 & *Legionella bozemanii*	1			1
1, 5 & *Legionella bozemanii*	1			1
5, 8 & *Legionella bozemanii*	1			1
1 & strain cross reaction with polyvalent antisera to groups 5 & 8	1			1
Legionella bozemanii	1			1
Legionella dumoffii	1			1
Legionella-like organisms	28		1	29
Total	113	1	2	116

Legionnaires' disease in a foreigner associated with travel to Singapore

The Communicable Disease Control Branch, Department of Human Services, Australia, notified ENV of a case of legionnaires' disease in a 73-year-old male Australian who had a travel history to Singapore. He arrived from UK en-route to Australia and stayed in a hotel in Singapore on 2 Sep 2000. He fell ill on 8 Sep 2000. He was serologically confirmed to have legionnaires' disease (*Legionella pneumophila* SG1) when he returned to Australia. Water samples from the cooling towers and swabs from the shower heads of the hotel rooms were negative for *Legionella*. A water sample collected from the water fountain was positive for *Legionella pneumophila,* but the serogroup (SG2-14) was different from that found in the infected traveller.

MELIOIDOSIS

A total of 77 cases of melioidosis were reported in 2000 as compared with 81 cases in 1999 (*Fig. 6.5*). The cases were notified by the Department of Pathology, Singapore General Hospital; Changi General Hospital; Department of Microbiology, National University Hospital; Department of Microbiology, Tan Tock Seng Hospital; Department of Microbiology, National University of Singapore; and Microbiology Department, Mount Elizabeth Hospital. Sixty-five (84.4%) cases were diagnosed by culture of *Burkholderia pseudomallei* from clinical specimens (blood, pus, sputum, lower respiratory aspirate, tissue, wound, fluid and urine). Another twelve (15.6%) cases were diagnosed serologically based on an indirect haemagglutination antibody titre of ≥1:16 *(Table 6.17)* in the presence of clinical findings.

Figure 6.5
Reported incidence of melioidosis in Singapore, 1987 - 2000

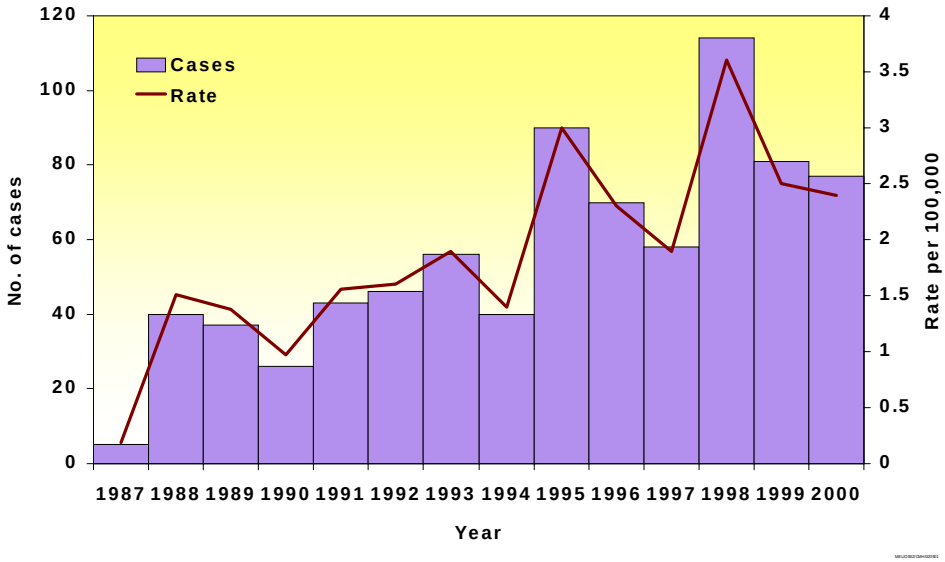


Table 6.17

Laboratory diagnosis of 77 reported cases of melioidosis, 2000

Method of diagnosis	No. of cases	%
Culture:		
Blood	28	36.4
Wound	14	18.2
Pus	3	3.9
Blood and sputum	1	1.3
Lower respiratory aspirate	1	1.3
Blood and lower respiratory aspirate	1	1.3
Sputum	3	3.9
Tissue	3	3.9
Fluid	3	3.9
Urine	2	2.6
Blood, tissue and wound	2	2.6
Blood and urine	2	2.6
Lower respiratory aspirate, peritoneal fluid and blood	1	1.3
Culture and serology*	1	1.3
Serology*	12	15.6
Total	77	100.0

*IHA titre of $\geq$1 : 16

Ten cases were imported. They comprised six Singaporeans who had been to the endemic countries for holiday/business and four foreigners who came to Singapore for medical treatment.

The six Singaporeans consisted of five males and 1 female aged between 30 and 62 years. Three of them were infected in Malaysia, one in Indonesia, one in India and one in Thailand.

The ages of the reported cases ranged from 2 to 77 years. The overall incidence rate was 2.4 per 100,000 population with the highest rate in persons aged above 65 years *(Table 6.18)*. The male to female ratio was 4.5:1. Among the three major ethnic groups, Malays (5.1 per 100,000) had the highest incidence rate as compared to Indians (3.1 per 100,000) and Chinese (1.5 per 100,000) *(Table 6.19)*. Cases occurred sporadically throughout the island (*Fig. 6.6*) with the high-

Table 6.18

Age-gender distribution and age-specific incidence and case-fatality rates of melioidosis in Singapore, 2000

Age-group	Male	Female	Both	Incidence rate per 100,000*	No. of deaths	Case-fatality rate (%)
0 - 4	0	1	1	0.5	0	0
5 - 14	3	0	3	0.6	0	0
15 – 24	9	1	10	2.4	0	0
25 – 34	9	2	11	2.0	1	9.1
35 – 44	12	1	13	2.0	1	7.7
45 – 54	14	2	16	3.4	3	18.8
55 – 64	7	3	10	4.2	2	20.0
65+	9	4	13	5.5	2	15.4
Total	63	14	77	2.4	9	11.7

*Rates are based on 2000 census population
(Source: Department of Statistics, Singapore)

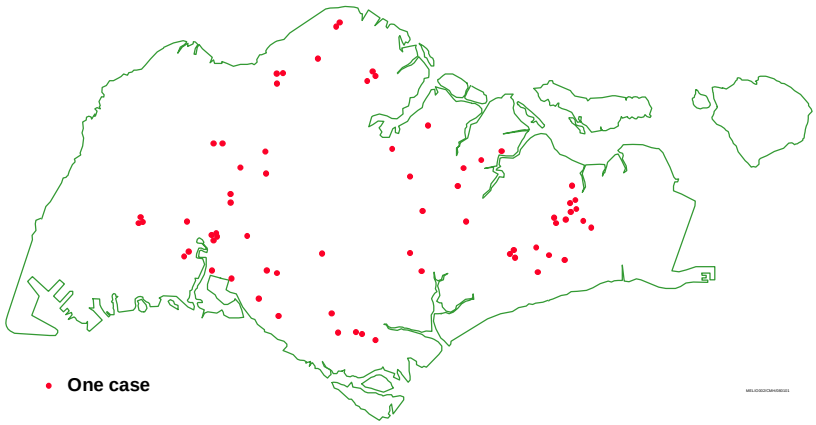
Table 6.19

Ethnic distribution and ethnic-specific incidence and case-fatality rates of melioidosis in Singapore, 2000

Ethnic group	Male	Female	Both	Incidence rate per 100,000*	No. of deaths	Case-fatality rate (%)
Chinese	30	7	37	1.5	5	13.5
Malays	20	3	23	5.1	4	17.4
Indians	6	2	8	3.1	0	0
Others	1	0	1	2.2	0	0
Foreigners	6	2	8	-	0	0
Total	63	14	77	2.4	9	11.7

*Rates are based on 2000 census population
(Source: Department of Statistics, Singapore)

Figure 6.6
Distribution of 67 local sporadic cases of melioidosis by place of residence
2000



est incidence reported in June *(Fig. 6.7).* There was no significant correlation between the incidence of reported cases and rainfall *(Fig. 6.8).* The incidence rate of flat dwellers was not significantly different from that of residents of landed property *(Table 6.20).* Retirees constituted 21% of the cases *(Table 6.21).* The source of infection for most of the cases was unknown. Some could have been infected through exposure to contaminated soil or water either during work or recreational activities *(Table 6.22).*

Figure 6.7
Monthly distribution of reported cases* of melioidosis,
1990 - 2000

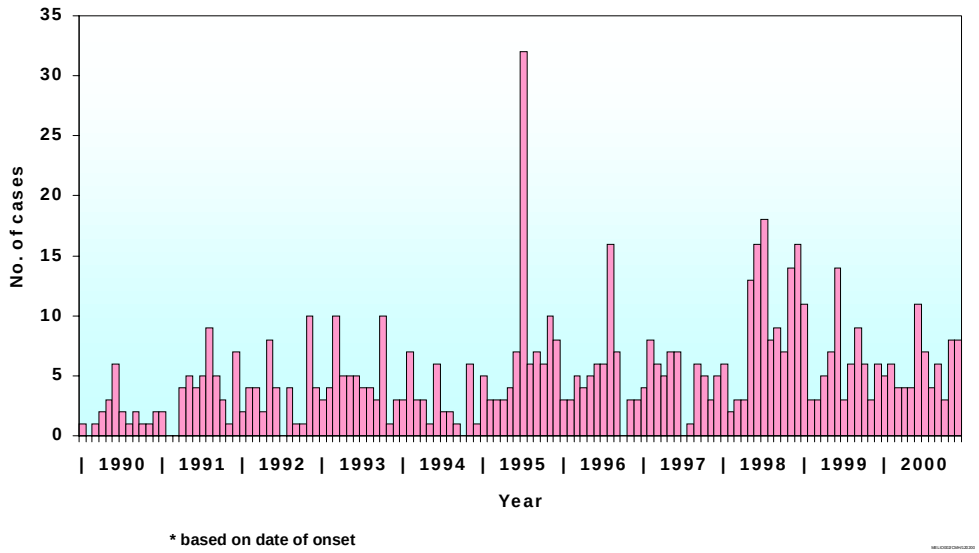
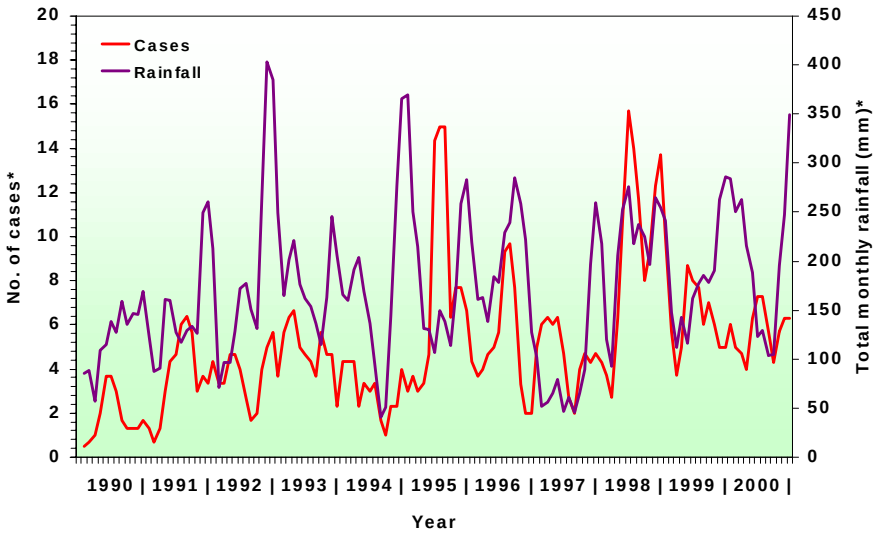


Figure 6.8
Monthly distribution of reported cases of melioidosis and rainfall, 1990 - 2000



*** 3-month moving average**

Table 6.20

Incidence rate of melioidosis by housing type, 1996-2000

Housing type	Population*	No. of cases						Mean annual rate per 100,000 population
		1996	1997	1998	1999	2000	Total 1996-2000	
Flats (public & private)	2,626,638	62	48	86	66	54	336	2.6
Landed property	312,850	6	4	14	5	4	33	2.1
Others	57,738	2	6	14	10	19	51	17.7
Total	2,997,226	70	58	114	81	77	420	2.6

*Based on 1990 census population
(Source: Department of Statistics, Singapore)

Table 6.21

Reported cases, deaths and case-fatality rates of melioidosis by occupation*, 2000

Occupation	No. of cases	Death	Case fatality rate (%)
Cleaners, labourers & related workers	**9**	**1**	**11.1**
Cleaner	1	1	
Construction/general worker	8	0	
Drivers and mobile machinery operators	**3**	**0**	**0**
Lorry driver	1	0	
Taxi driver	2	0	
Service workers & shop/market sales workers	**6**	**0**	**0**
Security guard	4	0	
Policeman	2	0	
Production craftsmen & related workers	**5**	**0**	**0**
Supervisor	5	0	
Working proprietors	**1**	**0**	**0**
Businessman	1	0	
Singapore Armed Forces personnel	**3**	**0**	**0**
Physical and engineering science professionals	**8**	**2**	**25.0**
Manager	4	1	
Accountant	2	1	
Engineer	2	0	
Retirees	**16**	**2**	**12.5**
Others	**26**	**4**	**15.4**
Housewife	8	1	
Student	8	0	
Infant	1	0	
Prisoner	1	0	
Unemployed	8	3	
Total	77	9	11.7

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

Table 6.22

Distribution of reported cases of melioidosis by probable place* of exposure, 1998-2000

Places	1998 (n = 114)		1999 (n = 81)		2000 (n = 77)	
	No.	Deaths	No.	Deaths	No.	Deaths
School/football field	11	0	5	0	9	0
Construction site	15	4	4	1	4	0
Garden/park	3 [1]	0	0	0	2	0
Fishing pond	3	0	2 [1]	1	2	0
Military training site	11	0	4	0	2	0
Farm	1	1	4 [3]	1	5 [1]	1
Golf course	1	0	0	0	1	0
Jungle	0	0	0	0	0	0
Reservoir	0	0	1	0	0	0
Shipyard	0	0	1	0	1	0
Island	5 [2]	0	1 [1]+	0	0	0
Poultry slaughtering yard	0	0	0	0	1	0
Offshore island	0	0	0	0	2	0
Pumping ground	0	0	0	0	1	0
Unknown	71	14	59 [3]	7	47	8

[ ] Imported cases

*Cases may be exposed to more than one probable place

+Imported from Pulau Karimun, Indonesia

The predominant signs and symptoms were fever, cough and dyspnoea *(Table 6.23)*. About one-third presented with localised or multiple abscesses. Those who presented with bacteraemia comprised 36.4% of the cases, an increase from 25.9% in 1999 *(Table 6.24)*.

Almost all the cases had some underlying medical conditions. More than 35% of the cases were diabetic. The other associated medical conditions included hypertension (20.8%), ischaemic heart disease (13.0%), renal failure (11.7%), and asthma (10.4%) *(Table 6.25)*.

Table 6.23

Main presenting signs and symptoms* of reported cases of melioidosis, 1994-2000

Signs and symptoms	1994-1999 (n = 453)		2000 (n = 77)	
	No.	%	No.	%
Fever (with/without chills and rigors)	358	79.0	53	68.8
Respiratory symptoms				
Cough (productive and non-productive)	219	48.3	27	35.1
Dyspnoea	111	24.5	22	28.6
Chest pain	75	16.5	6	7.8
Haemoptysis	5	1.1	2	2.6
Gastrointestinal symptoms				
Abdominal pain/discomfort/epigastric pain	48	10.5	7	9.1
Vomiting	32	7.2	7	9.1
Diarrhoea	33	7.2	7	9.1
Urinary symptoms (dysuria, haematuria)	16	3.5	2	2.6
Abscesses (localised, multiple)	103	22.7	23	29.9

*Cases may have one or more presenting signs and symptoms

Table 6.24

Proportion of reported cases of melioidosis presenting with bacteraemia and abscesses, 1990-2000

Year	Cases	Bacteraemia		Abscesses			
				All		Cutaneous	
		No.	(%)	No.	(%)	No.	(%)
1990	22	20	(90.9)	5	(22.7)	3	(13.6)
1991	43	29	(67.4)	12	(27.9)	7	(16.3)
1992	46	25	(54.3)	13	(28.3)	6	(13.0)
1993	56	40	(71.4)	15	(26.8)	10	(17.9)
1994	40	25	(62.5)	14	(35.0)	9	(22.5)
1995	90	50	(55.6)	17	(18.9)	13	(14.4)
1996	70	30	(42.9)	24	(34.3)	17	(24.3)
1997	58	24	(41.4)	14	(24.1)	4	(6.9)
1998	114	42	(36.8)	18	(15.8)	5	(4.4)
1999	81	21	(25.9)	16	(19.8)	6	(7.4)
2000	77	28	(36.4)	18	(23.4)	11	(14.3)
Total	697	334	(49.4)	166	(23.9)	91	(12.9)

Table 6.25

Concurrent medical conditions* of 702 cases of melioidosis, 1989-2000

Concurrent medical condition	1989-1999 n = 625 (184)	2000 n = 77 (9)	Total n = 702 (193)
Metabolic/nutritional disorders			
Diabetes mellitus	334 (103)	27 (7)	361 (112)
Gout	8 (1)	0	8 (1)
Disorders of the thyroid gland	4 (3)	1	5 (3)
Malnutrition	1 (1)	0	1 (1)
Syndrome of inappropriate secretion of anti-diuretic hormone	1	0	1
Hyperlipemia	2 (1)	0	2 (1)
Disorders of the circulatory system			
Hypertensive disease	114 (34)	16 (7)	130 (41)
Ischaemic heart disease	73 (34)	10(4)	83 (38)
Heart failure	20 (11)	1	21 (12)
Cerebrovascular disease	13 (3)	1	14 (3)
Pulmonary/arterial embolism and thrombosis	6 (2)	0	6 (2)
Disorders of the respiratory system			
Asthma	33 (10)	8 (2)	41 (12)
Chronic obstructive pulmonary disease	21 (9)	0	21 (9)
Bronchiectasis	9 (3)	0	9 (3)
Other lung diseases	13 (2)	7 (1)	20 (3)
Disorders of the genitourinary system			
Renal failure/impairment	42 (24)	9 (7)	51 (31)
Nephrosis	2	1 (1)	3 (1)
Disorders of the digestive system			
Chronic liver disease and cirrhosis	12 (5)	3 (1)	15 (6)
Ulcer of stomach and duodenum	8 (1)	0	8 (1)
Cholecystitis	1	0	1
Infectious diseases			
Tuberculosis	50 (13)	3 (1)	53 (14)
HIV	1 (1)	0	1 (1)
Neoplasms	26 (13)	3 (2)	29 (15)
Mental disorders			
Psychosis	6 (4)	0	6 (4)
Drug dependence	4 (4)	0	4 (4)
Alcohol dependence syndrome	3 (2)	0	3 (2)
Disorders of the blood			
Anaemia	12 (2)	0	12 (2)
ß-thalassaemia	3	1	4
Thrombocytopenia	1 (1)	1	2 (1)
Disorders of the nervous system			
Alzheimer's disease	1	0	1
Parkinson's disease	2	0	2
Disorders of the musculoskeletal system/ connective tissue			
Osteoarthritis	5 (3)	1	6 (3)
Rheumotoid arthritis	2 (1)	0	2 (1)
Cellulitis	1	1	2

( ) Death

*Patients may have one or more concurrent medical condition.

The overall case-fatality rate was 11.7%. Significantly higher case-fatality rates were observed among those with concurrent medical conditions compared with those without such concurrent 0conditions *(Table 6.26).* Significantly higher case-fatality rates were also observed among those with bacteraemia compared with those without bacteraemia *(Table 6.27),* and among smokers and ex-smokers compared with non-smokers *(Table 6.28).*

All *Burkholderia pseudomallei* isolated from clinical specimens were subjected to antimicrobial susceptibility testing. Most isolates were sensitive to imipenem, meropenam, deoxycline (100%), ceftazidime (98.4%), chloramphenicol (98.2%), and tetracycline (97.8%). They were resistant to antibiotics like ampicillin and amikacin (*Table 6.29).*

A total of 48 soil and surface water samples were collected from various parts of Singapore. One soil sample was found to be positive for *Burkholderia pseudomallei* (Table 6.30).

Table 6.26

Case-fatality rate of reported melioidosis cases by history of concurrent medical condition, 1990-2000

Year	Concurrent medical condition					
	Present		Absent		Total	
	Cases	Deaths (%)	Cases	Deaths (%)	Cases	Deaths (%)
1990	17	9 (52.9)	5	4 (90.0)	22	13 (59.1)
1991	39	18 (46.2)	4	1 (25.0)	43	19 (44.2)
1992	39	22 (56.4)	7	2 (28.6)	46	24 (52.2)
1993	40	22 (55.0)	16	7 (43.8)	56	29 (51.8)
1994	32	11 (34.4)	8	1 (12.5)	40	12 (30.0)
1995	73	20 (27.4)	17	8 (47.1)	90	28 (31.1)
1996	53	14 (26.4)	17	5 (29.4)	70	19 (27.1)
1997	41	9 (21.9)	17	0	58	9 (15.5)
1998	92	18 (19.6)	22	1 (4.5)	114	19 (16.7)
1999	61	8 (13.1)	20	1 (5.0)	81	9 (11.1)
2000	51	9 (17.6)	26	0	77	9 (11.7)
Total	538	160 (29.7)[a]	159	30 (18.9)[b]	697	190 (27.3)

a vs b: p = 0.009
Odd ratio = 1.8
95% confidence interval = 1.2 - 2.8

Table 6.27

Case-fatality rate of bacteraemic and non- bacteraemic melioidosis in Singapore, 1990-2000

Year	Bacteraemia					
	Present		Absent		Total	
	Cases	Deaths (%)	Cases	Deaths (%)	Cases	Deaths (%)
1990	20	10 (50.0)	2	2 (100.0)	22	12 (54.5)
1991	29	17 (58.6)	14	3 (21.4)	43	20 (46.5)
1992	25	18 (72.0)	21	6 (28.6)	46	24 (52.2)
1993	40	26 (65.0)	16	3 (18.8)	56	29 (51.8)
1994	25	11 (44.0)	15	1 (6.7)	40	12 (30.0)
1995	50	23 (46.0)	40	5 (12.5)	90	28 (31.1)
1996	30	15 (50.0)	40	4 (10.0)	70	19 (27.1)
1997	24	7 (29.2)	34	2 (5.9)	58	9 (15.5)
1998	42	17 (40.5)	72	2 (2.8)	114	19 (16.7)
1999	21	7 (33.3)	60	2 (3.3)	81	9 (11.1)
2000	28	5 (17.8)	49	4 (8.2)	77	9 (11.7)
Total	334	156 (46.7)[a]	363	34 (9.4)[b]	697	190 (27.3)

$p = <10^{-6}$ Odds ratio = 8.5 95% confidence interval = 5.5 - 13.1

Table 6.28

Case-fatality rate of reported melioidosis cases by history of smoking, 1990-2000

Year	Smoking history					
	Yes[#]		No		Total	
	Cases	Deaths (%)	Cases	Deaths (%)	Cases	Deaths (%)
1990	13	9 (69.2)	9	4 (44.4)	22	13 (59.1)
1991	28	2 (42.9)	15	7 (46.7)	43	19 (44.2)
1992	27	17 (63.0)	19	7 (36.8)	46	24 (52.2)
1993	45	25 (55.6)	11	4 (36.4)	56	29 (51.8)
1994	26	11 (42.3)	14	1 (7.1)	40	12 (30.0)
1995	59	20 (33.9)	31	8 (25.8)	90	28 (31.1)
1996	42	16 (38.1)	28	3 (10.7)	70	19 (27.1)
1997	30	5 (16.7)	28	4 (14.3)	58	9 (15.5)
1998	80	13 (16.3)	34	6 (17.6)	114	19 (16.7)
1999	22	4 (18.2)	59	5 (8.5)	81	9 (11.1)
2000	25	4 (16.0)	52	5 (9.6)	77	9 (11.7)
Total	397	136 (34.2)[a]	300	54 (18.0)[b]	697	190 (27.2)

#Includes smokers and ex-smokers
Odds ratio = 2.4

a vs b: $p = <10^{-5}$
95% confidence interval = 1.6 - 3.5

Table 6.29

Antibiotic sensitivity pattern of *Burkholderia pseudomallei* isolated from different types of clinical specimen in Singapore, 2000

Antibiotic	No. sensitive/No. tested					
	Blood	Pus	Sputum	Urine	Respiratory fluid	Total (%)
Penicillins						
Piperacillin	10/10	4/ 4	0/0	1/2	2/2	17/18 (94.4)
Amoxicillin/clavulanate	28/28	19/20	3/4	3/3	9/9	62/64 (96.9)
Ampicillin	0/19	0/14	1/5	0/3	0/8	1/49 (2.0)
Amoxycillin	0/ 0	0/ 1	0/0	0/0	0/0	0/ 1 (0.0)
Aztreonam	0/ 0	0/ 0	0/1	0/0	0/0	0/ 1 (0.0)
Cloxacillin	0/ 0	0/ 0	0/0	0/1	0/ 0	0/ 1 (0.0)
Cephalosporins						
Ceftazidime	26/26	20/20	3/4	2/2	11/11	62/63 (98.4)
Ceftriaxone	5/ 5	1/ 1	1/2	0/0	0/ 1	7/ 9 (77.8)
Cefaclor	0/ 0	0/ 1	0/0	0/0	0/ 0	0/ 1 (0 0)
Cephalexin	4/ 8	0/ 0	1/2	0/1	0/ 0	5/11 (45.5)
Cefepime	1/ 1	0/ 0	0/0	0/0	0/ 0	1/ 1 (100.0)
Cefuroxime	3/ 6	0/ 0	0/0	0/0	0/ 0	3/ 6 (50.0)
Carbapenam						
Imipenem	14/14	8/ 8	1/1	1/1	2/ 2	26/26 (100.0)
Meropenem	3/ 3	2/ 2	0/0	1/1	0/ 0	6/ 6 (100.0)
Tetracyclines						
Tetracycline	16/16	17/18	4/4	1/1	8/ 8	46/47 (97.8)
Doxycycline	7/ 7	1/ 1	0/0	1/1	2/ 2	11/11 (100.0)
Quinolones						
Ciprofloxacin	5/ 8	0/ 1	0/1	0/0	0/ 0	5/10 (50.0)
Aminoglycosides						
Amikacin	0/13	0/15	1/4	1/3	0/ 8	2/43 (4.7)
Gentamicin	4/19	0/13	1/5	0/3	0/ 8	5/48 (10.4)
Others						
Chloramphenicol	25/25	17/18	3/3	2/2	9/ 9	56/57 (98.2)
Cotrimoxazole	5/23	6/19	1/3	0/4	1/ 8	13/57 (22.8)
Bactrim/Septrin	0/ 1	0/ 1	0/0	0/0	0/ 0	0/ 1(0.0)

Table 6.30

Surveillance of *Burkholderia pseudomallei* in the environment, 1992-2000

Year	No. of samples		No. positive (%)	
	Soil	Surface water	Soil	Surface water
1992	28	10	0	0
1993	138	14	2 (1.4)	0
1994	114	8	0	0
1995	39	10	1 (2.6)	0
1996	76	4	4 (5.3)	0
1997	40	0	0	0
1998	18	2	2 (11.1)	0
1999	54	6	0	0
2000	44	4	1 (2.3)	0
Total	551	58	10 (1.8)	0