

Policy and Programme on Control of Legionnaires' Disease in Singapore

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Ministry of Health

- Local and foreign publicity on the disease
- Legionnaires' disease made administratively notifiable in 1985 and legally notifiable in 2000
- Surveillance initiated in Mar 1986
 - to determine the clinical and epidemiological characteristics
 - to detect clusters of cases
 - to identify sources and mode of transmission

Air-conditioning systems are operated most of the year – large heat load imposed on water cooling systems resulting in an increased rate of colonization and multiplication of *Legionella* spp.



- **Presumptive case** – *Legionella* sp antibody titre >1,024
- **Confirmed case** – 4-fold increase in *Legionella* spp antibody titres, or presence of *Legionella* spp antigen in urine, or positive immunofluorescence or isolation of *Legionella* spp from respiratory specimens



Classification of reported legionellosis cases (indigenous and imported)
in Singapore, 2000-2010*

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2000-2010
Confirmed												
Pontiac fever	0	4	1	3	1	0	0	0	0	0	0	9
Legionnaires' disease	3	15	12	16	4	5	1	0	5	11	4	76
Presumptive												
Pontiac fever	7	12	9	16	4	0	0	4	8	7	4	71
Legionnaires' disease	47	15	15	6	4	13	12	8	2	1	6	129
Total	57	46	37	41	13	18	13	12	15	19	14	285

* Exclude 4 tourists and 59 foreigners seeking medical treatment in Singapore.

Lam MC et al. Emerg Infect Dis 2011;17:1209-15

- Cases present with respiratory illness, cough, breathlessness, fever, chills
- Chest x-ray findings: bronchopneumonia
pleural effusion
- 2%-7% community acquired pneumonia
- Actual incidence difficult to determine
 - picking up severe cases
 - milder case not hospitalised

Clinical presentations (%) of 285 cases of legionellosis (indigenous and imported) in Singapore, 2000 – 2010*

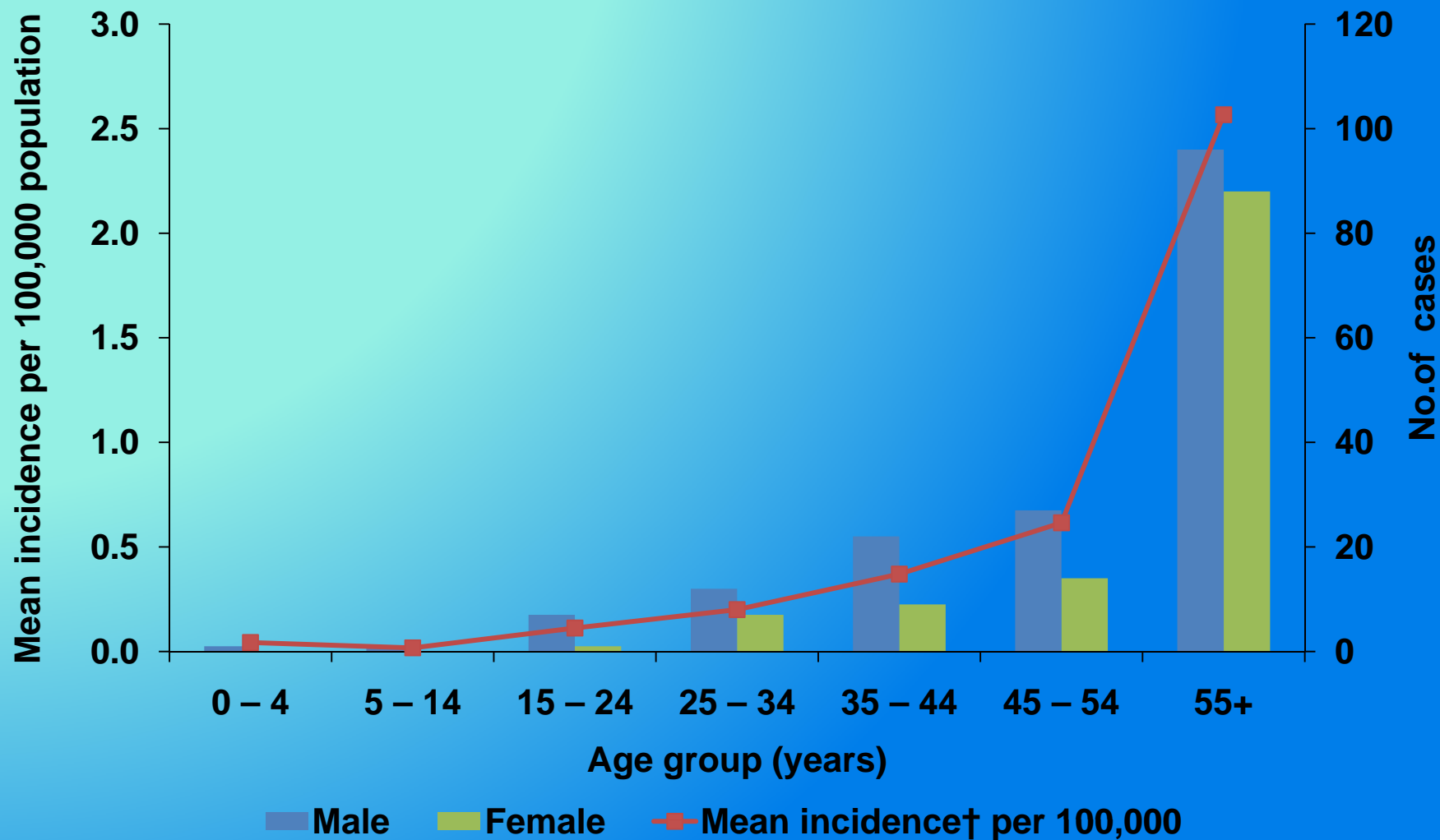
Clinical presentation**	Number	Percentage
Fever (with/without chills and rigors)	208	73.0
<i>Respiratory symptoms</i>		
Cough (productive and non-productive)	222	77.9
Shortness of breath	94	33.0
Chest pain and discomfort	36	12.6
Running nose	8	2.8
Rhinorrhoea	1	0.4
Bronchitis	2	0.7
Sore throat	7	2.5
<i>Gastrointestinal symptoms</i>		
Nausea/vomiting	32	11.2
Abdominal pain/epigastric pain	13	4.6
Diarrhoea	9	3.2
<i>Neurologic symptoms</i>		
Drowsiness/giddiness	15	5.3
Headache	11	3.9
<i>Other signs and symptoms</i>		
Chills	35	12.3
Generalised weakness	10	3.5
Myalgia	5	1.8
Lethargy	8	2.8
Loss of appetite	16	5.6
Others	23	8.1

* Exclude 4 tourists and 59 foreigners seeking medical treatment in Singapore.

** Cases may have one or more clinical presentations.

- rare under 20 years of age
- average age in 50s
- more serious illness with:
 - increasing age
 - smoker
 - chronic disease
 - immuno-compromised
- male:female 2.5:1

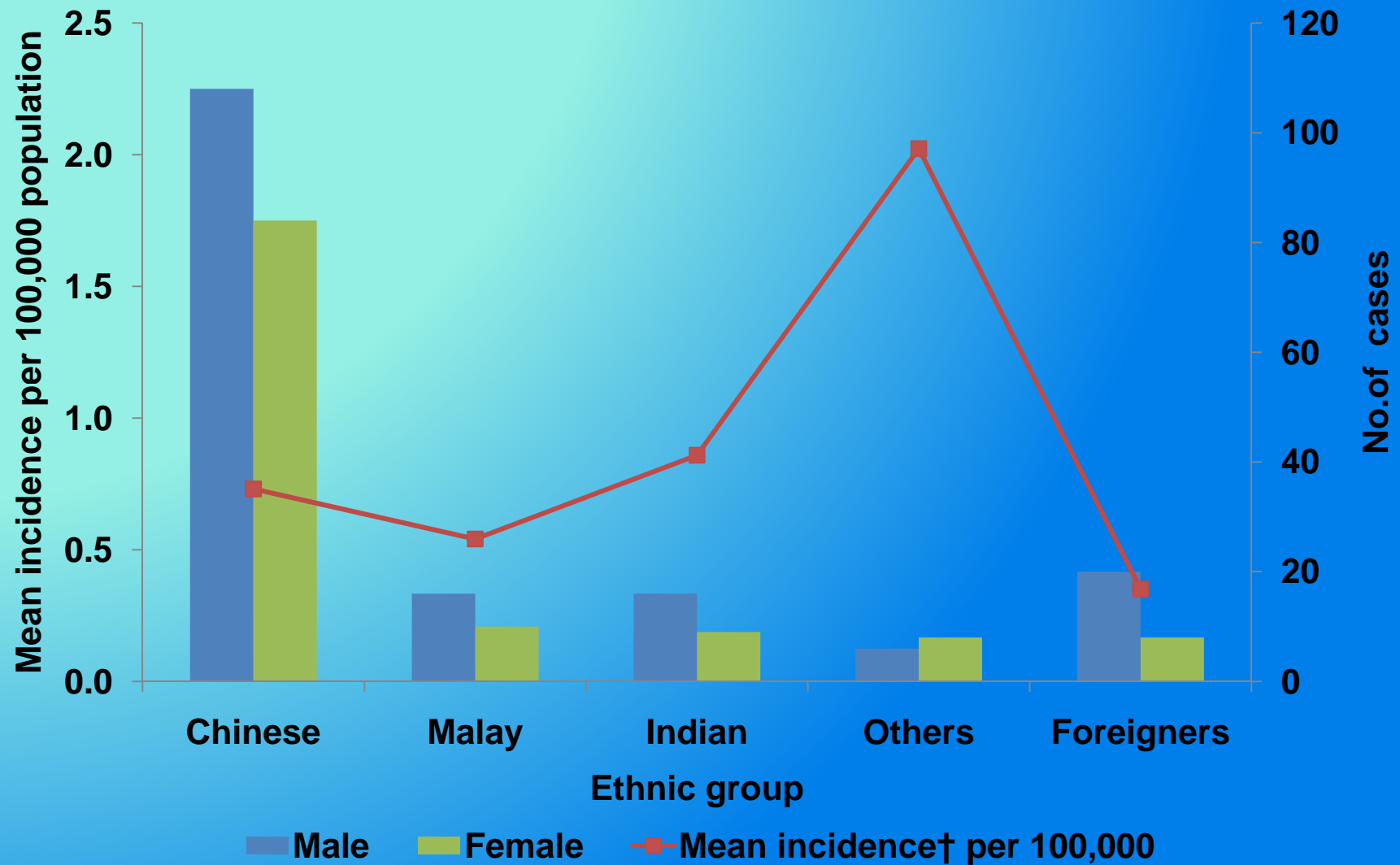
Age-gender distribution and mean age-specific incidence (per 100,000 population) of reported legionellosis (indigenous and imported)** in Singapore, 2000-2010*



* Based on estimated mid-year population of 2005.

** Exclude 4 tourists and 59 foreigners seeking medical treatment in Singapore.

Ethnic-gender distribution and mean ethnic-specific incidence (per 100,000 population) of reported legionellosis (indigenous and imported)** in Singapore, 2000-2010*



* Based on estimated mid-year population of 2005.

** Exclude 4 tourists and 59 foreigners seeking medical treatment in Singapore.

Sero-survey for *L. pneumophila* antibodies

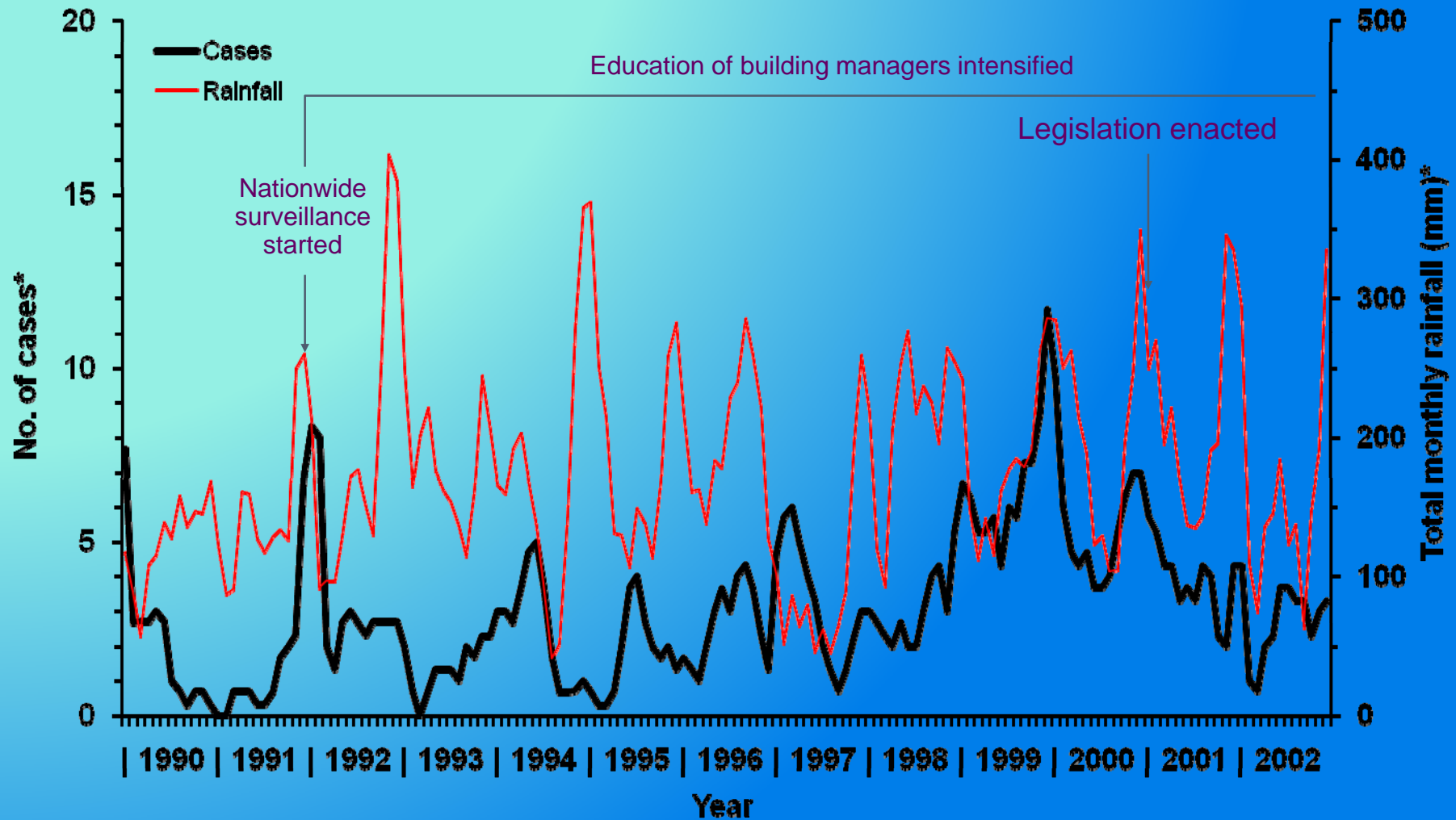
- 20% prevalence in antibodies (IFA >1:16)
- cross reaction with *Mycoplasma* or *Chlamydia pneumoniae* organisms

Nadarajah M, Singam S, Jalil HA.
Sing Med J 1987; 16:583-5

Seroprevalence of indirect fluorescent antibody to Legionella pneumophila in selected population groups, 1992 to 1995

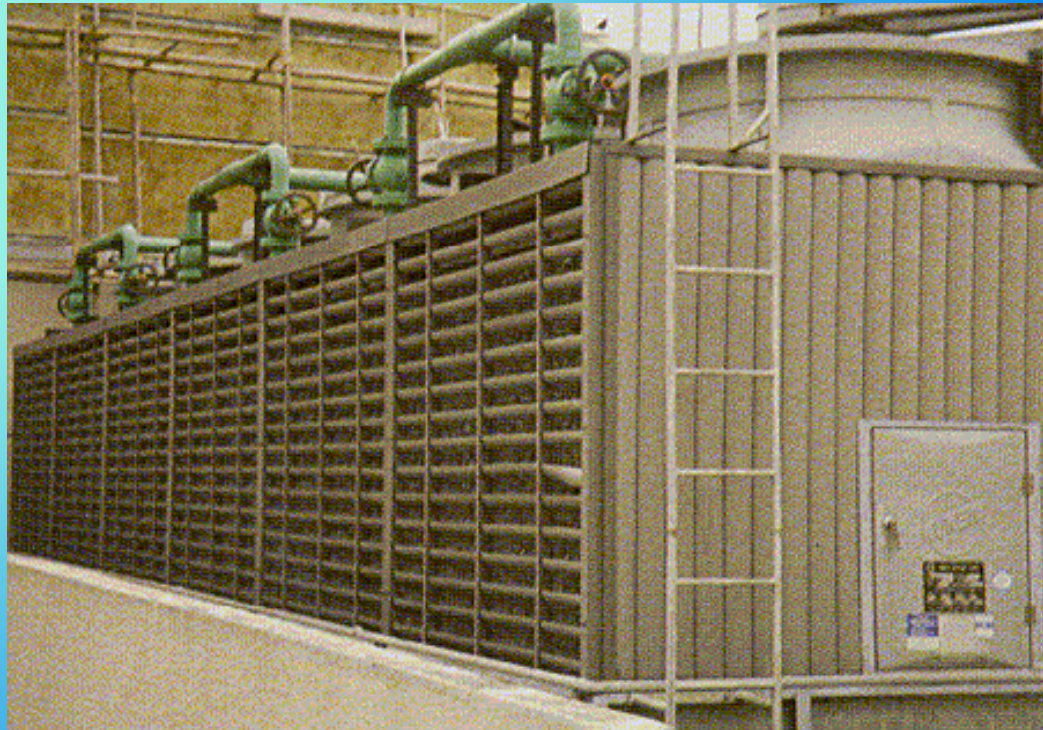
Population group	No. tested	≥1:32		≥1:256	
		No.	(%)	No.	(%)
Construction workers					
Singaporean (1992)	19	2	10.5	1	5.3
Foreigner (1992)	38	20	52.6	14	36.8
Sewage workers (1992)	600	94	15.7	29	4.8
Dumping ground workers (1992)	43	6	14.0	3	7.0
Cooling tower maintenance personnel (1992)	230	44	19.1	18	7.8
Quarry workers (1992)	76	8	10.5	3	3.1
Cemetery workers (1992)	64	7	10.9	3	4.7
Zoo keepers (1992)	150	22	14.7	5	3.3
Occupants of a building investigated for an unusual building-related illness (1995)	46	35	76.1	8	17.4
Healthy population (1993)					
<20 years	271	28	10.3	0	0
≥20 years	448	98	21.9	5	1.1

Monthly distribution of reported local cases of legionellosis and rainfall, 1990 - 2002



* 3-month moving average

Cooling tower



Cooling tower



Legionella bacteria in cooling towers of 3 hospitals (1986)

- 3/20 samples +ve
- 2 serogroup 1 ; 1 serogroup 4

Nadarajah M & Goh KT. Ann Aca Med Singapore 1986; 15: 6-8

Legionella bacteria in the environment (Jan-July 1987)

- 87 samples from 48 cooling towers in 15 sites
- 7 (46.7%) of the sites +ve
- 19 strains which fell into 7 different species, serogroup, subgroup
- 11% *L. pneumophila* serogroup 1, subgroup Pontiac

*Legionella bacteria isolated from cooling towers (Feb-May 2001)**

	No.	%
<i>L. pneumophila</i>	123	65.4
<i>L. bozemanii</i>	28	14.9
<i>L. anisa</i>	12	6.4
<i>L. dumoffii</i>	3	1.6
 <i>L. pneumophila</i>		
Serogroup 1	62	50.4
Subtype - Olda	52	83.9
- Bellingham	3	4.8
- Pontiac	5	8.1

* Total number of legionella bacteria isolated : 188

Isolation of Legionella bacteria from cooling towers (1991-1994)

- Private premises ($n=1924$) – 33.2% +ve
- Statutory board premises ($n=390$) – 29% +ve
- Government premises ($n=181$) – 18.2% +ve

- Water treatment programme ($n=2434$) – 30.9% +ve
- No water treatment programme ($n=61$) – 50.8% +ve

- Registered contractors ($n=1906$) – 29.3% +ve
- Non-registered contractors ($n=393$) – 39.7% +ve

Legionella bacteria and total colony count (1991–1998)(n=2380)

Legionella

<10² cfu/L : 68.7%

10² – 10⁵ cfu/L : 28.7%

>10⁵ cfu/L : 2.7%

Total colony count

mode 10⁷ – 10⁸ cfu/L

Water fountains



Shower heads



Mist fans



wall-mounted mist fans



mist sprays



mobile mist fans

Isolation of Legionella bacteria from the environment (1991-1996)

- Cooling towers ($n=3095$): 35.8% +ve
- Spa pools ($n=48$): 2% +ve
- Indoor ($n=103$)/outdoor ($n=68$) fountains: 29.1%/14.7% +ve
- Artificial waterfalls ($n=26$): 15.4% +ve
- Ponds ($n=14$): 28.6% +ve
- Showers ($n=6$) 33.3% +ve

Isolation rate of Legionella bacteria in the environment, 1998-2002

No. positive/No tested (%)

Cooling towers	550/923 (59.6)
Fountains (outdoor)	41/107 (38.3)
Water taps/shower heads	23/97 (23.7)
Mist fans	6/37 (16.2)

Legionella bacteria in various aerosol-generating water systems, 2003-2010

- mist fans ($n=28$) : 14.2%
- water heaters with storage tank ($n=19$) : 21.1%
- instantaneous water heaters ($n=30$) : 3.3%
- spa pools ($n=29$) : 24.1%
- spas (faucet and jet) ($n=66$) : 13.6%
- faucets, shower heads etc of 34 nursing homes ($n=116$) : 0%

Prevention and control

- Routine inspection of cooling towers, Sep 91
- Code of practice for maintenance of cooling towers published in 1992, and revised in 1994 and 1998
- Legislation enacted in 2001

- Maintenance of good engineering practices
 - regular mechanical cleaning of cooling towers
 - routine treatment with biocides, algicides

For existing installations

- Log book on cleaning, operating and maintenance
- Water treatment specialist responsible for cleaning, disinfecting, chemical dosing, water testing and monitoring efficacy of treatment
- Periodic inspections by National Environment Agency

For new installations

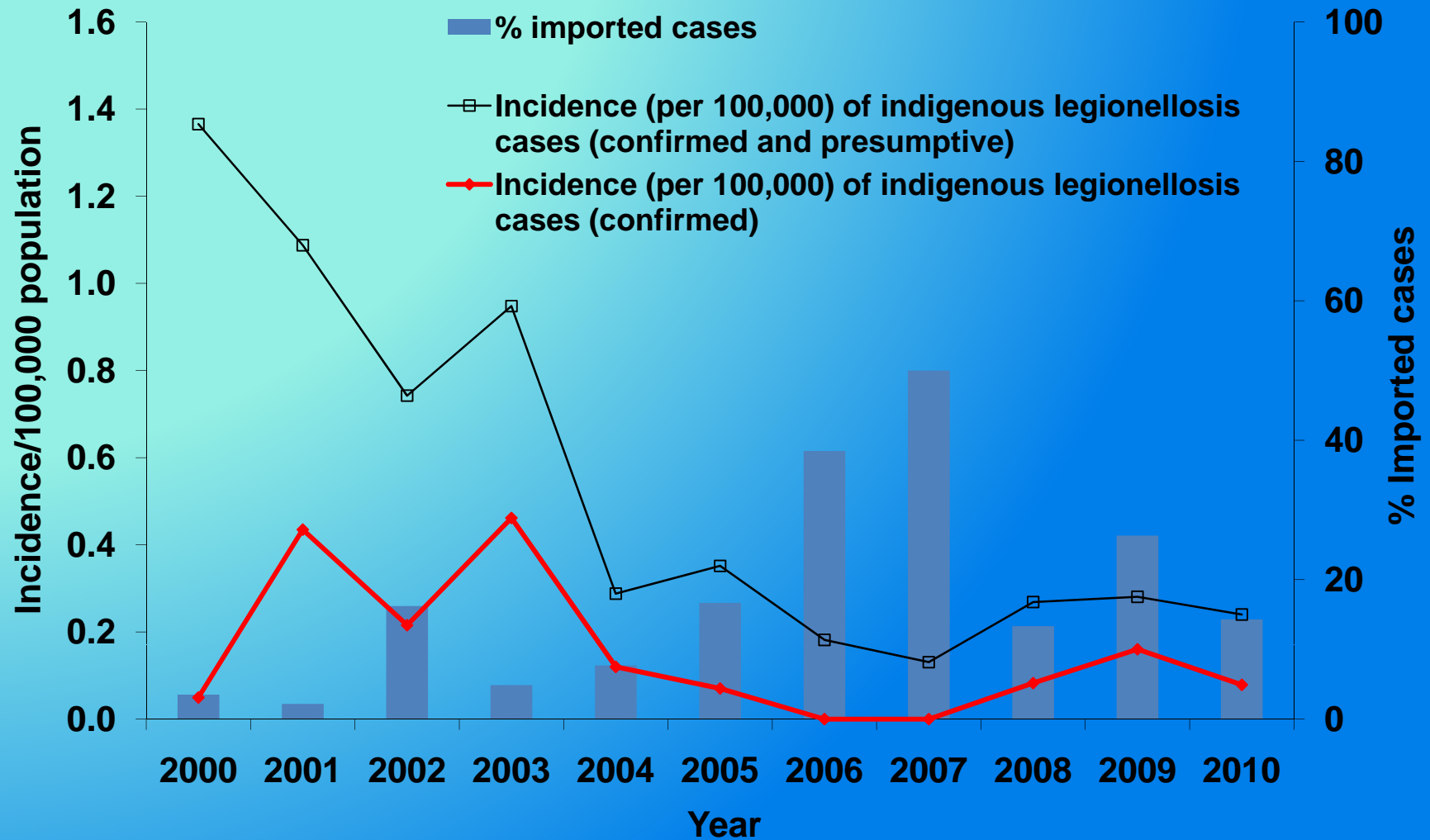
- Air-cooled condensers first choice
- water-cooled condensers only where not possible or not cost-effective to use air-cooled condenser
- Provided with effective spray eliminators
- Sited so that the drift cannot reach public
- Condensate to drain freely to floor traps

EPH (Cooling Towers and Water Fountains) Regulations, 2001

- Owner or occupier

- to ensure that it is kept in a good state of repair and free from sludge, slime, algae, fungi, rust, scale, dust, dirt or any foreign matter
- to thoroughly clean and disinfect it at least once every 6 months
- to inspect at least once a week for any physical defect, general cleanliness, organic fouling and presence of physical debris
- to provide drift eliminator
- to test water for standard plate count ($\leq 100,000$ cfu per ml) - monthly
- to test for legionella bacteria (≤ 10 cfu/ml) – 3 monthly
- to keep proper records
- If not in use for > 5 days, clean and disinfect before re-use

Incidence rate (per 100,000 population) of indigenous cases and proportion (%) of imported cases in Singapore, 2000 – 2010



Isolation rate of Legionella bacteria in environmental samples collected from cooling towers and fountains in Singapore, 2000 – August 2008⁺

Year	No. tested	No. positive	% positive
2000*	193	114	59.1
2001*	323	220	68.1
2002*	291	140	48.1
2004	7284	883	12.1
2005	4160	635	15.3
2006	3073	448	14.6
2007	2711	385	14.2
2008 Jan - Aug	1406	172	12.2

⁺ Data was unavailable for year 2003.

*Data was incomplete.

Limitations

- no epidemiological linkage between reported clinical cases and environmental isolates
- *Legionella* bacteria ubiquitous in the environment
- urinary antigen test detects L.p. serogroup 1 only
- more severe cases reported
- most of the reported cases (70%) classified as presumptive
- changes in testing pattern for clinical cases
- water samples collected not representative of the situation

*Why no nosocomial legionellosis
and community outbreak?*

- *Legionella* count low (21% >10 cfu/ml)
- *Legionella pneumophila* subtype Pontiac comprised around 10%
- Chloramination since 2005
- Absence of reported cases does not equate with absence of cases

