Review Article

Twentieth Century Influenza Pandemics in Singapore

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Abstract

Introduction: Singapore was substantially affected by three 20th Century pandemics. This study describes the course of the pandemics, and the preventive measures adopted. Materials and Methods: We reviewed and researched a wide range of material including peer-reviewed journal articles, Ministry of Health reports, Straits Settlements reports and newspaper articles. Monthly mortality data were obtained from various official sources in Singapore. Results: The 1918 epidemic in Singapore occurred in 2 waves – June to July, and October to November – resulting in up to 3500 deaths. The 1957 epidemic occurred in May, and resulted in widespread morbidity, with 77,000 outpatient attendances in government clinics alone. The 1968 epidemic occurred in August and lasted a few weeks, with outpatient attendances increasing by more than 65%. The preventive measures instituted by the Singapore government during the pandemics included the closure of schools, promulgation of public health messages, setting up of influenza treatment centres, and screening at ports. Students, businessmen and healthcare workers were all severely affected by the pandemics. Conclusions: Tropical cities should be prepared in case of a future pandemic. Some of the preventive measures used in previous pandemics may be applicable during the next pandemic.

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Introduction

Tropical countries such as Singapore, although without well-defined influenza seasons, are also affected by influenza epidemics and pandemics.[1-3] Twenty per cent of Singapore's population is clinically infected by seasonal influenza annually,[4] and excess mortality over the past decade was about 14.8 per 100,000 person-years – comparable to temperate United States and sub-tropical Hong Kong.[5] In addition, influenza has substantial cultural, social, and economic impact.

The three 20th century influenza pandemics (1918-9 "Spanish Flu", 1957-8 "Asian Flu", and 1968 "Hong Kong Flu") resulted in 40 millions, 2 millions and 1 million worldwide deaths respectively.[6,7] Although the impact of the 20th century pandemics across the world is well documented, there has not been any comprehensive review in Singapore. This paper thus aims to describe the impact of the past 3 influenza pandemics as represented by local epidemics in Singapore. This will provide healthcare professionals with a better understanding of the impact of pandemic influenza and the public health interventions instituted in Singapore over the last century. The lessons learnt from the impact and management of previous pandemics should be taken into consideration in future pandemic preparedness planning.

Methods

A detailed review was conducted from available data sources to determine the time course and impact of the 20th century pandemics in Singapore. A wide range of material was reviewed, including peer-reviewed journal articles, Ministry of Health reports, Straits Settlements reports, and newspaper articles. To determine the impact of influenza on mortality during the pandemic years, we obtained monthly mortality data from the Straits Settlements reports and the Registry of Births and Deaths, Singapore for the

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respective years. To calculate the mortality rates, we relied upon additional data from the Registry of Births and Deaths, Singapore for the population statistics. Major pandemic events are presented in addition to mortality and mortality rates for the pandemic and surrounding years.

Results

The 1918 Pandemic in Singapore

The 1918 pandemic was caused by the influenza A H1N1 subtype first noticed in Western Europe. The 1918 Straits Settlements Annual Report (which included Singapore, Penang, Malacca and Labuan – the latter 3 are now part of Malaysia) described an epidemic in June and July of a relatively mild form with high morbidity but low mortality, peaking during the week ending 6 July.[8] A second, more intense epidemic wave occurred in October and November 1918, peaking during the week ending 26 October, with 97.6 deaths per 1,000,000 (Table 1). The second wave resulted in frequent pneumonia and high mortality.[19]

The recorded annual mortality rate was 43.85 per 1000 in 1918 when the influenza epidemic struck the country,[19] in contrast to the immediate pre- and post-pandemic years (Table 2). The 1918 Report indicated only 844 recorded influenza deaths, but admitted that this poorly represented actual influenza deaths, which were estimated at 3500.[8] The 1921 Report admitted that "many of the (reported pneumonia) deaths were due primarily to influenza".[19] Figure 1 shows that the epidemic's excess mortality occurred during May to June and October to November 1918, with excess mortality of 7.76 per 1000 (2870 out of a population of 369,800).[25]

Public health measures: Although there was incomplete knowledge about the virology and epidemiology of influenza in 1918, the government used available evidence to institute a series of measures to prevent its spread. Influenza was reported to be highly infectious and easily spread by breathing, coughing and spitting, and carried by letters and parcels, with an incubation period from a few hours to 3 days.[15,26] The government and physicians thus advised infected persons to isolate themselves, to seek treatment early, and to avoid crowded places. Floors of public premises were disinfected daily.[15,27] In addition, visits to hospitalised patients were restricted and prohibited. Schools were also closed for a week at the peak of the second wave.[17]

The government also recommended prophylactic measures like reducing the amount of fatigue and maximising ventilation, and together with disinfection of the nose, mouth and throat with potassium permanganate and sodium chloride.[26,27]

By the end of November 1918, media reports of influenza epidemics across Asia and other parts of the world were still streaming in even though the local epidemic was over.

Table 1. Reported Timeline for the 1918 Epidemic in Singapore

Date (1918)	Event	References
1st wave		
June 18	First mention of "Mysterious epidemic" appearing in Singapore.	9
July 8	Influenza rages in Singapore.	10
July 9	Influenza continues in Singapore, Hong Kong, and Manila, affecting businesses.	11
July 27	Municipal meeting in Singapore noted a rise in mortality rates for the weeks ending June 29, July 6, 13 and 25, with the peak of 60.8 per million occurring during the week ending July 6.	12
2nd wave		
October 3	Spain and Ceylon (present day Sri Lanka) are hit by the 2nd wave and there is also "a recrudescence" in Singapore.	13
October 14	A military event is cancelled due to influenza. Many house servants are ill with influenza.	14
October 15	Municipal President announced that Spanish Influenza is prevalent in Singapore and has already had fatalities.	15
October 16	Pneumonia is more frequent now than it was when the epidemic first occurred (1st wave).	16
October 19	Weekly mortality rate is 69.1 per million, with most deaths occurring in the 25 to 35 years age group.	8
October 21	Schools in Singapore are closed for the week to prevent spread among children.	17
October 25	Signs of epidemic are abating in Singapore.	18
October 26	Peak mortality during the 2nd wave occurs during the week, with 97.6 deaths per million.	19
October 28	Singapore General Hospital is handicapped, with 12 out of 19 nurses ill with influenza.	20
November 2	Influenza epidemic is abating, but medical practitioners warn against neglecting precautions.	21
November 8	Mild recrudescence of influenza with fresh cases reported by local authorities.	22
	No further reports of influenza in Singapore. Reports on 9 and 22 November mention that influenza epidemic practically disappeared in Penang and Kuala Kangsar (Malaysian towns) respectively.	23, 24

There was no report of a third wave in Singapore similar to that which occurred in temperate countries in early 1919.[28]

The 1957 Pandemic in Singapore

The 1957 pandemic was touted as the "worst ever in colony (Singapore) history" by the media.[29] The virus was named Influenza A/Singapore/1/57 (H2N2), as it was first isolated in Singapore by Professor KA Lim (of the University of Malaya in Singapore) and typed by the World Health Organization's World Influenza Centre.[30]

Table 2. Population Vital Statistics Reported in the Annual Reports of the Straits Settlements* from 1915 to 1921

Year	Population	Deaths from all causes	Crude death rate (per thousand population)
1915	776,444	22,633	29.15
1916	797,739	24,371	30.55
1917	809,869	29,950	36.98
1918	827,719	36,294	43.85
1919	846,083	27,957	33.04
1920	864,858	28,710	33.20
1921	881,939	28,000	31.79

* The Straits Settlements included Singapore, Penang, Malacca and Labuan, of which the population of Singapore was 417,859 (47.4% of the overall population) according to a census in 1921.

Epidemiology: The outbreak was first recognised at the end of April and early May among 30 infected inhabitants in the settlements on Pulau Brani (an offshore island of Singapore) by Dr WK Ng, a rural health officer, who reported these cases to Professor Lim.[31] The virus was purported to have spread through Hong Kong from its origins in North Asia.[32] By 5 May, the outbreak had become an epidemic, reaching its peak in mid-May and tapering off by the end of the month (Table 3). At its peak, influenza accounted for more than 65% of the public outpatient attendance.[30] In May 1957, 77,211 (47.6%) out of 162,093 attendances at government and City Council clinics were due to influenza-like illnesses (ILI), with 326 requiring hospital admission and 28 influenza deaths recorded (22 from pneumonia and 6 from cardiac complications). Deaths due to the epidemic were probably higher than suggested, as many may have been misclassified. Monthly mortality reports clearly show the epidemic in May 1957 (Fig. 2), and the excess mortality calculated was 0.47 per 1000, or 680 deaths among a population of 1,445,900.[25]

The best epidemiologic representation of the 1957 epidemic was a study on the captive population within the Singapore Naval Base at Sembawang,[34] where 2493 out of 9020 workers had clinical influenza infection (attack rate of 27.6%). In contrast, the attack rate among dependents was 10%; this was attributed to their different health-seeking behaviour (Asian women may have been generally uncomfortable being treated by European male doctors) and a tendency to seek traditional treatment outside the public health surveillance system. Attack rates decreased with increasing age, exceeding 80% for those below 20 and 11% for those above 40. However, older patients experienced more complications.

The epidemic in workers preceded that in dependents by 3 days, suggesting that the workplace was the primary source of transmission, while dependents were infected by workers.[34] Indoor workers, who were of a higher socio-economic status, had a lower attack rate compared to outdoor workers (20.4% versus 29.8%). Similarly, the attack rate among Europeans was lower than Asian workers (6% versus 29%). This observation occurred throughout Singapore as upper-class Asians were less likely to be affected, suggesting that socio-economic status has a role in disease transmission.[30] Overworked workers with poor

Table 3. Reported Timeline for the 1957 Epidemic in Singapore

Date (1957)	Event	Reference
End April/ Early May	Outbreak of influenza in Pulau Brani.	32
May 4	Doctors report an "enormous increase" in influenza cases over the past few days.	32
May 5	Minister of Health, Mr A.J. Braga, says that the Ministry is "keeping a very close watch" on the epidemic.	33
May 6	25,000 pupils are absent from school, prompting the Health and Education Ministries to consider closing schools. Outpatient attendances at the government and city council clinics reach a peak of 8940 cases, with 5528 diagnosed with influenza.	29,30
May 7	The Straits Times suggests that the epidemic is the "worst ever in colony history". Outpatient cases at the Singapore General Hospital reached a peak of 2000 cases on May 6/7.	29,34,35
May 8	Schools across Singapore are closed due to the epidemic. The epidemic also spreads to Johor, where 515 patients are treated at the Johor Bahru General Hospital.	30,36,37
May 11	The Minister of Health is satisfied with the treatment of patients, even with the strain on resources caused by the increase in cases and staff absenteeism.	38
May 13	Influenza outpatient cases at the government and city council clinics reached a peak of 5866 cases.	30
May 14	Influenza spreads across the Federation of Malaya.	39
May 16	Epidemic on the decline in Singapore with fewer number of influenza cases (1216 cases at the Singapore General Hospital).	35,40
May 18	Further decreases in the number of influenza cases.	40
May 20	Schools in Singapore reopen. The Minister of Health says that the epidemic is "definitely on the decline", and that it will be over by the end of May.	30,41
May 21	The epidemic in Singapore is coming to an end, with good attendances at schools.	42
May 22	Only 824 flu cases are seen at the Singapore General Hospital outpatient clinics.	43
End May	Outpatient visits to the Singapore General Hospital and the government and city council clinics decline towards baseline levels.	30,34

Table 4. Reported Timeline for the 1968 Epidemic in Singapore

Date (1968)	Event	Reference
8 August	Medical authorities in Malaysia alert for any signs of an outbreak, but reiterate that there is no evidence of an epidemic occurring.	51
9 August	Singapore Director of Medical Services, Dr Ho Guan Lim says that there is no epidemic in Singapore.	52
14 August	Singapore Ministry of Health investigating a "mild outbreak" in Singapore. Clinics have seen a large number of ILIs (influenza-like illness) over the past 3 days.	50
16 August	Out-patient influenza cases rise by 20% from 12 August, but cases have stabilised.	53
18 August	No increase in the number of cases; epidemic thought to be tapering off.	54
21 August	Another 20% increase in influenza patients, but the Ministry of Health declares the epidemic as contained as it has already affected a large proportion of the community.	55
22 August	Schools report between 10% and 20% absenteeism. Overall there is no increase in influenza cases.	56
25 August	Extension of school holidays are considered but decided against. Ministry of Health indicates that the number of influenza cases has decreased over the past week.	57
Early September	End of the epidemic in Singapore.	58

nutrition and lower immunity may be at higher risk of infection.[44]

Clinical features: Most cases had a sudden onset of fever (37.2°C to 40.6°C) and cough (up to 90%), accompanied by severe headache, arthralgia, nausea and vomiting, sore throat and giddiness.[34,44] A study among 298 hospitalised cases found that all had fever lasting an average of 2.4 days,[34] while 65% had a headache, 45% had a sore throat and 31% had a cough. Many experienced lethargy up to a week post-onset. Complications such as pneumonia and bronchitis occurred frequently in children under 5 and adults over 50 (22% and 43% respectively), but less frequently among those between 15 and 30 years old (7%).[34]

Another study among 250 hospitalised children found that those aged 1 to 5 years were most likely to be affected, with a sudden onset of high fever ranging from 38.7°C to 41.7°C and cough.[45] Fits lasting several minutes (44%) were common as many admissions were due to severe illness. A third had bronchitis or broncho-pneumonia, and there were 30 deaths, mostly from pneumonia. There were 196 deaths out of 1231 paediatric admissions to the Singapore General Hospital; representing a doubling of the baseline mortality rate.[45] Autopsy uncovered 98 cases of pneumonia, suggesting the possibility of additional influenza deaths.

Public health interventions: The government closed schools for almost 2 weeks due to illness and absenteeism, and advised the public to keep away from crowded places – 670 schools were affected together with 262,000 students,[46] and commercial firms reported staff absenteeism between 10 % and 30% which severely impacted the economy.[47]

Professor Sreenivasan, the founding president of the Singapore Medical Association, professed the slogan "*no movement of persons – no spread of influenza*".[44]

At the hospitals, elective surgery was minimised to release staff to manage the epidemic. School health clinics, maternal and child health clinics and voluntary clinics were set up as influenza treatment centres.[34] There were also free clinics for influenza treatment, which were met with enthusiastic demand.[48,49]

Although no quarantine measures were required by law at the customs, the airport health officers checked outward bound passengers for at least 1 airline upon request.[34] Similarly, at least 1 shipping line was screened for all passengers boarding the ships. Individuals who failed the screening were denied embarkation.[34]

The 1968 Pandemic in Singapore

The 1968 pandemic was the mildest of the 3 pandemics. The virus was believed to have spread to Singapore from a major outbreak in Hong Kong,[50] resulting in an epidemic in early August, lasting a few weeks.

Epidemiology and clinical features: The outbreak in Singapore peaked between 16 and 25 August (Table 4). Attendances at outpatient dispensaries increased over a 2-week period, and at the peak there was a 65% increase in daily attendances (from 6052 to 9966).[59] From the monthly mortality rates (Fig. 3), excess mortality occurred during the months of August and September 1968, and was 0.27 per 1000 for a population of 2,012,000.[25]

The 1968 epidemic had an impact on morbidity and absenteeism from work.[58] However, due to the relatively mild epidemic, no substantial public health measures were adopted. The Ministries of Education and Health considered the option of school closure but decided against this due to the waning epidemic.[57]

Dr Kadri described an outbreak at the University of Singapore where 522 students and 443 non-academic staff and their dependents were affected.[58] The overall attack rate was 19.2%; ranging from 12.8% in female students to 36.4% in adult non-academic staff. The illness was characterised by fever (37.4°C to 40.3°C) for 4 to 5 days, a hiatus for 24 to 36 hours, and fatigue and lethargy for 5

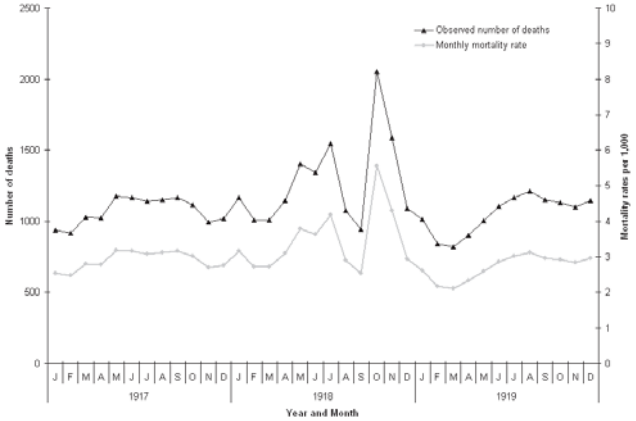

Fig. 1. All cause monthly mortality in Singapore, 1917 to 1919. Source: Registry of Births and Deaths, Singapore.

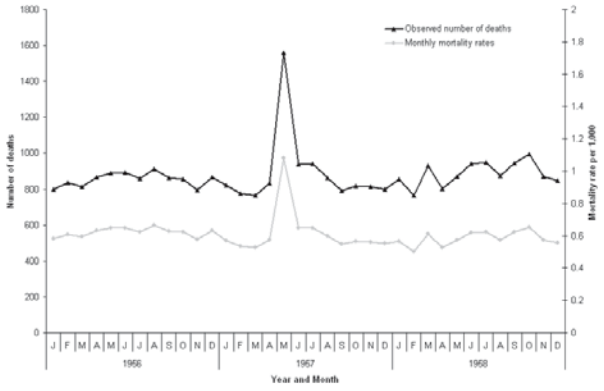

Fig. 2. All cause monthly mortality in Singapore, 1956 to 1958. Source: Registry of Births and Deaths, Singapore.

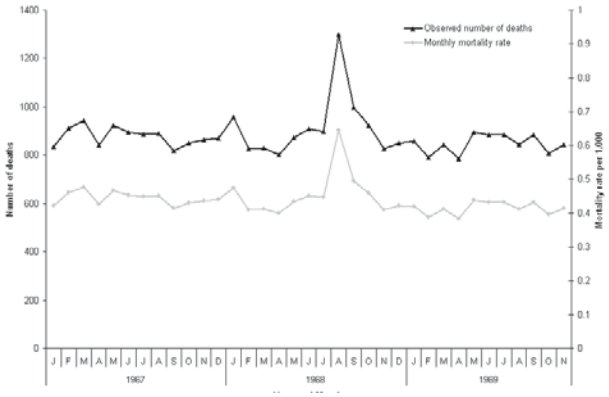

Fig. 3. All cause monthly mortality in Singapore, 1967 to 1969. Source: Registry of Births and Deaths, Singapore.

to 10 days thereafter. Other common symptoms included cough, headache, body ache, coryza, lassitude and lethargy, anorexia and nausea.

Professor Wong reported on 60 children who were hospitalised with clinically-suspected influenza, of which only 47 were laboratory-diagnosed via culture or serology.[60] Most laboratory-diagnosed children were less than 1 year of age, all had fever (38.9°C to 40.0°C, lasting 2 to 6 days). Seventy-two per cent had an injected throat, 53% had fits and 34% had dry cough. The illness started with a sudden onset of fever and occasionally febrile fits; and broncho-pneumonia was detected in 9 patients. In addition, there were 10 hospital deaths from suspected influenza – most from viral pneumonia.

Professor Yin-Murphy found that the virus causing the Singapore epidemic was similar to the influenza A/Hongkong/1/68 (H3N2) virus which affected half a million in Hong Kong.[61] Tests on 103 paired sera (acute and convalescent) from clinical-diagnosed patients showed no immunity to the novel viral subtype prior to infection. However, only 66 of the 103 convalescent sera showed serological evidence of influenza infection, suggesting that not all ILI were due to influenza. Professor Yin-Murphy also vaccinated 12 subjects with the prevailing influenza vaccine and tested their serum for antibodies to the A/Singapore/68 virus isolated from local patients. All non-infected subjects did not have antibodies, showing that the epidemic strain was unrelated to vaccine strains, and that antigenic shift had indeed occurred.

Public Health and Policy Implications

To prevent an influenza pandemic in the future, it is important to identify the onset of the pandemic for early intervention. However, influenza remains a difficult surveillance target because it manifests in a variety of non-specific symptoms. The severity of fever described varied widely, making influenza difficult to diagnose clinically, especially during non-epidemic periods where ILIs from respiratory syncytial viruses, parainfluenza viruses, and adenoviruses occur at higher incidence, particularly in children.[61] Influenza may also present as asymptomatic or sub-clinical infection,[7] while the accuracy of clinical diagnosis was only about 66%.[60,61] Good laboratory surveillance will enable accurate diagnosis and viral identification, but is expensive if all ILI cases are tested. Epidemiological surveillance, taking into account the number of ILI presenting at healthcare facilities over time, may be combined with virological surveillance through sampling for early detection of a pandemic.

Important sub-populations were also severely affected by the pandemics. Apart from students who were affected by school closures, healthcare workers were affected not only by illness but also by vastly increased workloads. Clinics were frequently overhelmed, especially at the children's hospital. Clinics stayed open late to cope with the increased demand.[20,29] Available healthcare workers were recalled to cope with the surge. They were at high risk of infection. In 1918, 12 out of 19 nurses at the Singapore

General Hospital were concurrently ill.[62] This placed a strain on healthcare workers as they coped with personal illness and the surge in the number of patients. Healthcare workers must therefore be given priority for protection and treatment to enable them to perform their duties.

Although the impact of pandemic influenza is well accepted, it may be masked by other endemic infectious diseases.[25] In 1918, the reported overall mortality rate of 43.85 per 1000 was in fact lower than 1911, "a very malarious year" where the rate was 46.46 per 1000 in 1911.[19] Deaths during the first epidemic wave in May to July 1918 in Singapore were initially attributed to an outbreak of malaria.[63] As such, the early impact during the epidemic's first wave in Singapore, especially in May 1918, may have been missed due to the high background mortality from infectious diseases and other causes.[25] The relative change in excess mortality during the 1918 and 1957 pandemics were similar, about double the baseline rates (Fig. 1 and 2), even though the excess mortality was substantially different.[25]

Although pandemic detection now depends on surveillance with viral samples and less on crude mortality rates, with the low baseline mortality in developed countries, the impact of even a mild pandemic will be keenly noticed. Conversely, if a pandemic were to originate in less developed regions with high baseline mortality rates, the signal may be missed if viral samples are not routinely collected. A good surveillance, sampling, and data collection network is thus important to ensure that the origins of a pandemic are detected early for successful contingency plans. The 1957 and 1968 influenza pandemics, as well as the recent SARS epidemic, were believed to have originated in rural East Asia, reaching the global cities of Hong Kong and Singapore within weeks and later to the rest of the world. Global surveillance efforts should therefore focus on frontline surveillance in East-Asian farms, together with surveillance in global Asian cities.[25]

In addition to surveillance, disease prevention has been the focus during the past 3 pandemics. In 1968, in the absence of anti-viral therapies, mass immunisation was touted as the only mean of prevention.[50] However, vaccination against prevailing influenza strains did not confer protection against pandemic strains.[57] Vaccines that can improve heterotypic immunity, together with improved techniques for vaccine production, and effective anti-viral therapies which may reduce the pandemic's spread are now available.

Simple public health measures are also important in addition to pharmaceutical interventions. In 1918, prophylaxis with potassium permanganate and sodium chloride was encouraged, while in 1968, the head of the Japanese Influenza Centre said that "drinking whisky might help *(fight the new virus)"*.[64] These measures were used possibly due to the lack of information on the virus and its transmission. However, the general principles for managing influenza and infectious diseases remain. Even in 1918 when there was a lack of knowledge in influenza, measures such as self-isolation, disinfection, and increased ventilation were used. During all 3 pandemics, the public was advised to avoid public places[15,2744,56] and schools were closed in 2 of the pandemics. Some measures were used decades later during the SARS outbreak in Singapore in 2003. Combinations of public health measures have been modelled to be effective in reducing the impact of a pandemic.[65] With our increase knowledge of influenza, and the availability of anti-virals and possibly pre-pandemic vaccines, it will be possible to further reduce the impact of a future pandemic by combining pharmaceutical and non-pharmaceutical interventions based on available evidence.[65]

The 20th century pandemics swept through Singapore within 4 to 6 weeks; and future plans must be able to weather this full impact over a short period of time. The low baseline mortality in modern Singapore will also likely amplify the impact of the next pandemic. In 1957, Dr Doraisingham, Singapore's Director of Medical Services, mentioned that "no known measure which could have succeeded entirely in preventing the spread of the disease".[66] As shown by the past 3 pandemics, the SARS epidemic, and various modeling studies, public health measures such as anti-virals, vaccination, and non-pharmaceutical interventions must be performed in concert to reduce the impact of a future pandemic.

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REFERENCES

1. Lee VJ, Phua KH. Cultural, social, and economic influences of the flu. In: Tambyah P, Leung PC, editors. Bird Flu – A Rising Pandemic in Asia and Beyond. Singapore: World Scientific, 2006:99-119.
2. Doraisingham S, Goh KT, Ling AE, Yu M. Influenza surveillance in Singapore: 1972-86. Bull World Health Organ 1988;66:57-63.
3. Chew FT, Doraisingham S, Ling AE, Kumarasinghe G, Lee BW. Seasonal trends of viral respiratory tract infections in the tropics. Epidemiol Infect 1998;121:121-8.
4. Ng TP, Pwee KH, Niti M, Goh LG. Influenza in Singapore: assessing the burden of illness in the communit. Ann Acad Med Singapore 2002;31:182-8.

5. Chow A, Ma S, Ling AE, Chew SK. Influenza-associated deaths in tropical Singapore. Emerg Infect Dis 2006;12:114-21.
6. Simonsen L, Clarke MJ, Schonberger LB, Arden NH, Cox NJ, Fukuda K. Pandemic versus epidemic influenza mortality: a pattern of changing age distribution. J Infect Dis 1998;178:53-60.
7. Lee VJ, Fernandez GG, Chen MI, Lye D, Leo YS. Influenza and the pandemic threat. Singapore Med J 2006;47:463-70.
8. Medical department report. Annual Departmental Reports, Straits Settlements, for the year 1918. Singapore: Government printing office, 1920:333-457.
9. The Straits Times. June 18, 1918, page 6, column 3.
10. The Straits Times. July 8, 1918, page 8, column 4.
11. The Straits Times. July 9, 1918, page 8, column 2.
12. Phenomenal rise in local death-rate. The Straits Times. July 27, 1918, page 10, column 3.
13. The Straits Times. October 3, 1918, page 8, column 5.
14. The Straits Times. October 14, 1918, page 8, column 5.
15. The Straits Times. October 15, 1918, page 8, column 6.
16. The Straits Times. October 16, 1918, page 8, column 5.
17. Influenza. The Straits Times. October 26, 1918, page 10, column 1.
18. The influenza scourge. The Straits Times. October 26, 1918, page 10, column 2.
19. Medical department report. Annual Departmental Reports, Straits Settlements, for the year 1921. Singapore: Government printing office, 1923:301-431.
20. The Straits Times. October 28, 1918, page 8, column 5.
21. The Straits Times. November 2, 1918, page 8, column 4.
22. The Straits Times. November 8, 1918, page 8, column 5.
23. The Straits Times. November 9, 1918, page 10, column 4.
24. The Straits Times. November 22, 1918, page 8, column 5.
25. Lee VJ, Chen MI, Chan SP, Wong CS, Cutter J, Goh KT, et al. Influenza pandemics in Singapore, a tropical globally-connected city. Emerg Infect Dis 2007;13:1052-7.
26. Influenza precautions. Command Orders, Singapore. October 22, 1918.
27. The Straits Times. Influenza epidemic. Government inquiry at Kuala Lumpur. Opinions of medical men. October 25, 1918, page 12, column 1.
28. Taubenberger JK, Morens DM. 1918 influenza: the mother of all pandemics. Emerg Infect Dis. 2006;12:15-22
29. The Straits Times. Singapore flu scare. May 7, 1957, page 1, column 1.
30. Ministry of Health. Chapter 13 – Influenza Epidemic. In: Report of the Ministry of Health for the year ended 31st December 1957. Singapore: Government Printing Office, 1959:90-5.
31. The Straits Times. Dr. Lim, the flu fighter, says: it was a case of teamwork really. May 25, 1957, page 4, column 2.
32. The Straits Times. Flu strikes Singapore. May 5, 1957, page 1, column 1.
33. The Straits Times. Watch on flu epidemic. May 6, 1957, page 1, column 1.
34. Lim KA, Smith A, Hale JH, Glass J. Influenza outbreak in Singapore. Lancet 1957;273:791-6.
35. The Straits Times. But end in sight in Singapore: 'Over by June'. May 18, 1957, page 7, column 2.
36. The Straits Times. Flu closes schools. May 8, 1957, page 1, column 1.
37. The Straits Times. Flu spreads to Johore: 500 are hit. May 9, 1957, page 1, column 5.
38. The Straits Times. Flu fear: the worst is yet to come. May 11, 1957, page 7, column 3.
39. The Straits Times. 12,000 down with the flu. May 15, 1957, page 1, column 1.
40. The Straits Times. Flu virus flown to America in iced thermos flask for study at Walter Reed. May 19, 1957, page 4, column 4.
41. The Straits Times. Flu report goes to assembly. May 20, 1957, page 1, column 3.
42. The Straits Times. Flu fizzling out now. May 21, 1957, page 1, column 1.
43. The Straits Times Flu bug beaten says Ministry. May 23, 1957, page 2, column 5.
44. Sreenivasan BR. The recent influenza epidemic in Singapore. Proceedings of the Alumni Association Malaya 1957;10:211-5.
45. Dourado H Swee Yo. Influenza epidemic in Singapore children; clinical impressions. Br Med J 1957;29:1523-5.
46. The Straits Times. Over – the flu holiday. May 18, 1957, page 1, column 7.
47. The Straits Times. Singapore's flu has spread to Johore. May 9, 1957, page 9, column 6.
48. The Straits Times. The first free clinic for flu opens: 130 treated. May 16, 1957, page 7, column 4.
49. The Straits Times. Another clinic opens to treat flu victims. May 19, 1957, page 4, column 1.
50. The Straits Times. Singapore concerned about a new outbreak of flu. August 14, 1968, page 6, column 5.
51. The Straits Times. Asian flu? No, says chief. August 8 1968, page 12, columns 2-4.
52. The Straits Times No flu epidemic in Singapore. August 9 1968, page 8, column 3.
53. The Straits Times. No change in number of flu cases: ministry. August 16, 1968, page 11, column 3.
54. The Straits Times. Flu outbreak similar to epidemic in Hong Kong. August 18, 1968, page 2, column 3.
55. The Straits Times. Peking bug cause of recent epidemic of Asian flu? August 21, 1968, page 22, column 4.
56. The Straits Times. Close watch on flu in schools. August 22, 1968, page 6, column 4.
57. The Straits Times. Ministry: why the holidays were not extended. August 25, 1968, page 16, column 3.
58. Kadri ZN. An outbreak of "Hong Kong Flu" in Singapore, part 1 – clinical study. Singapore Med J 1970;11:30-2.
59. Ministry of Health Annual Report 1968. Singapore: Ministry of Health, 1969.
60. Wong HB. A clinical study of proved cases of influenza affecting children. J Singapore Paediatr Soc 1969;11:108-14.
61. Yin-Murphy M. An outbreak of "Hong Kong Flu" in Singapore, part 2 – Virological and serological report. Singapore Med J 1970;11:33-7.
62. The Straits Times. Flu patients again swamp clinics. May 8, 1957, page 5, column 2.
63. The Straits Times. Phenomenal rise in local death-rate. Malaria and Mosquitoes. July 27, 1918, page 10, column 3-4.
64. The Straits Times. Flu outbreak similar to epidemic in Hong Kong. August 18, 1968, page 2, column 3.
65. Ferguson NM, Cummings DA, Fraser C, Cajka JC, Cooley PC, Burke DS. Strategies for for mitigating an influenza pandemic. Nature 2006;442:448-52.
66. The Straits Times. Union asks Chief Minister for flu inquiry. May 16, 1957, page 7, column 3.