

Outbreak of Pandemic Influenza A (H1N1-2009) in Singapore, May to September 2009

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Abstract

Introduction: The first case of pandemic influenza A(H1N1) was detected in Singapore on 26 May 2009, 1 month after the first cases of novel influenza A(H1N1) was reported in California and Texas in the United States. The World Health Organization declared the first influenza pandemic of the 21st century on 11 June 2009. **Materials and Methods:** Confirmed cases notified to the Ministry of Health between 27 May and 9 July 2009 were analysed. Various indicators of influenza activity were monitored throughout the study period. Estimates of the number of cases of H1N1-2009 were made using the number of polyclinic attendances for acute respiratory infection and influenza-like illness and the weekly prevalence of H1N1-2009. **Results:** Cases in Singapore affected mainly young adults, youths and children. By the end of September 2009, it was estimated that at least 270,000 persons had been infected by pandemic influenza A (H1N1) in Singapore. The peak number of cases occurred during E-week 30 (26 July-1 August) when an estimated 45,000 cases were seen in polyclinics and GP clinics. The hospitalisation, severe illness and mortality rates were estimated at 6 per 1000 cases, 0.3 per 1000 cases and 6.7 per 100,000 cases, respectively. The most common risk factors among hospitalised adult cases were asthma and diabetes. For hospitalised children, the most common risk factors were being under 5 years of age and asthma. The most common risk factors among persons with severe illness were diabetes in adults and epilepsy and being under 5 years of age in children. About half of cases with severe illness required mechanical ventilation. In addition, one-fifth of cases with severe illness had acute respiratory distress syndrome. **Conclusions:** The first wave of the influenza pandemic lasted about 10 weeks. Morbidity and mortality resulting from pandemic influenza were low.

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Key words: Comorbidity, Epidemiology, Hospitalisation, Risk factors

Introduction

The first cases of infection with a novel influenza A (H1N1) strain were reported in 6 cases in California and 2 cases in Texas in the United States in late April 2009.¹ This was linked to outbreaks of influenza in Mexico, which included reports of large numbers of cases of severe pneumonia.² The World Health Organization (WHO) declared the outbreak in Mexico and the United States as a Public Health Emergency of International Concern on 26 April 2009,² raised its Influenza Pandemic Alert to Phase 4 on 27 April³ and then to Phase 5 just 2 days later on 29 April.⁴ The first influenza pandemic of the 21st century was declared by the WHO on 11 June 2009.⁵

Materials and Methods

Swine influenza/Influenza A (H1N1-2009) was made a notifiable disease under the Infectious Diseases Act on 27 April 2009.⁶ All laboratory confirmed cases of influenza A (H1N1-2009) (*hereafter referred to as H1N1-2009*) notified to the Ministry of Health between 26 April 2009 and 9 July 2009 were analysed. Epidemiological investigations were also conducted on all these cases.

Various indicators of influenza activity were monitored by the Ministry of Health. The indicators included (i) weekly attendances for acute respiratory infection (ARI) seen in polyclinics, (ii) proportion of attendances for influenza-like illness (ILI) (defined as fever >38°C and cough and/or sore

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throat) among ARI attendances in polyclinics, and (iii) prevalence of H1N1-2009 in community samples of ILI from polyclinics and General Practitioner (GP) clinics. Two warning triggers were set based on the mean number of ARI cases seen in the 5 years preceding the current calendar year. These are the “Warning Level” set at 1 standard deviation from this mean and the “Epidemic Level” set at 2 standard deviations from the mean. Laboratory diagnosis of H1N1-2009 was made through reverse transcription polymerase chain reaction (RT-PCR).

The cumulative number of cases of H1N1-2009 was estimated as follows:

- (i) The number of ARI cases seen in polyclinics each week were separated into cases with ILI and those without.
- (ii) The estimated number of H1N1-2009 cases among cases with ILI seen in the polyclinics each week was calculated by multiplying the number of ILI cases with the prevalence of H1N1-2009 from the biosurveillance survey for the corresponding week.
- (iii) Step (ii) was repeated for non-ILI cases of ARI taking the prevalence of H1N1 as one-quarter that of ILI cases for the corresponding week. This ratio was determined through a study of cases of ARI which did not fulfill the criteria for ILI. The study was done during the week, 3 to 7 August 2009. The study was repeated during the week, 5 to 9 October 2009. The ratio of 1:4 among non-ILI and ILI cases was found in both periods.
- (iv) The number of H1N1 cases seen in GP clinics was then estimated by assuming that 86% of all cases of ARI were seen in GP clinics. This ratio comes from the Primary Medical Care Survey 2005.⁷ Steps (i) to (iii) were repeated to derive the estimated number of H1N1-2009 cases seen in GP clinics each week.

All hospitals were required from 15 July 2009 to report confirmed H1N1-2009 cases who had been admitted into hospital for medical indications to the Ministry of Health. Data on demographic characteristics, comorbid conditions, hospitalisation events (including admission to intensive care and use of mechanical ventilation) and final outcome were reported on a real-time basis. Hospitals were required to report all severe cases (defined as requiring intensive care or resulting in death) to the Ministry of Health since the epidemic began locally. The presence of acute respiratory distress syndrome (ARDS) was recorded if this was mentioned consistently in the medical case records of severe cases (79 case records reviewed). Risk factors were analysed separately for children (taken as persons under 20 years of age) and adults (persons aged 20 years and above).

Results

Confirmed Cases of Influenza A (H1N1-2009) in Singapore from 26 May to 9 July 2009

Epidemiological investigations were carried out on 1301 laboratory-confirmed cases of H1N1-2009 from 27 May (the first imported case) to 9 July 2009 (when containment measures gave way to mitigation measures). Nearly two-thirds (834 or 64%) of these cases arose from local transmission while about one-third (467 or 36%) were imported.

Imported Cases

The first imported case of H1N1-2009 (also the first known case) was a 22-year-old Singaporean female university student. Her infection was detected in Singapore on 26 May 2009 – 1 month after WHO’s announcement of the novel virus outbreak on 24 April 2009. She was in New York from 14 to 24 May and arrived back in Singapore on the morning of 26 May. She had begun to feel unwell on the plane. She consulted a GP upon her return and was sent by a 993 ambulance to Tan Tock Seng Hospital (TTSH)’s Emergency Department where she was subsequently admitted and her diagnosis confirmed as H1N1-2009 via RT-PCR tests.

Three distinct waves of importation of cases of H1N1-2009 can be described (Fig. 1):

- First wave: 27 May to 7 June with cases imported mainly from the United States.
- Second wave: 8 to 19 June with cases imported mainly from Australia.
- Third wave: 20 June onwards with cases imported mainly from Southeast Asia.

The third wave of imported cases coincided with the beginning of local transmission.

Most of the imported cases had travelled to Australia (24%), Philippines (23%), Indonesia (21%), Thailand (10%) and the United States (9%). These 5 countries accounted for 87% of imported cases reported between 27 May and 9 July 2009. The source of infection of 2 imported cases was on a cruise ship (Table 1).

Not surprisingly, nearly 90% of local cases comprised Singapore residents while foreigners made up over 40% of imported cases. A large proportion of the imported cases were probably tourists, highlighting the vulnerability of Singapore to infectious diseases brought in by travellers (Table 2).

Local Cases

The first case of H1N1-2009 who was infected locally was reported on 18 June 2009. This case was a 26-year-old

Imported & local cases

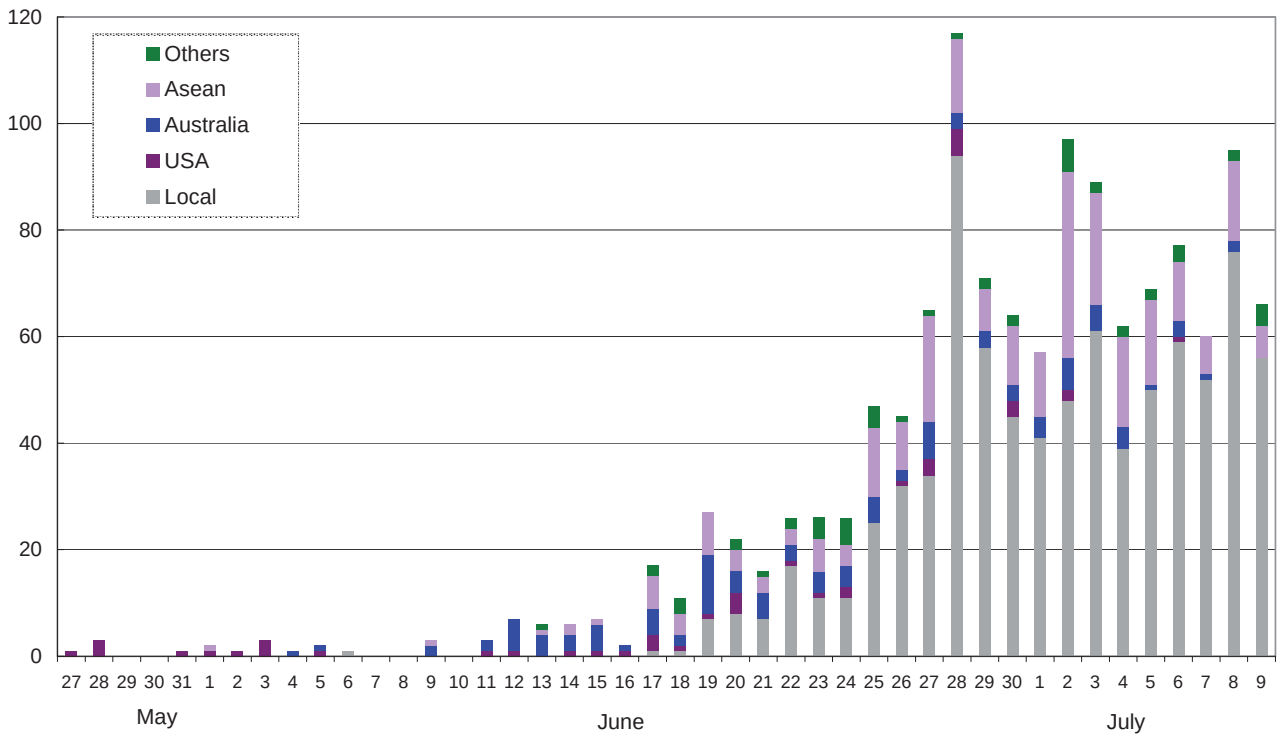


Fig. 1. Imported and local cases of Influenza A (H1N1-2009) by date of reporting, 27 May-9 July 2009.

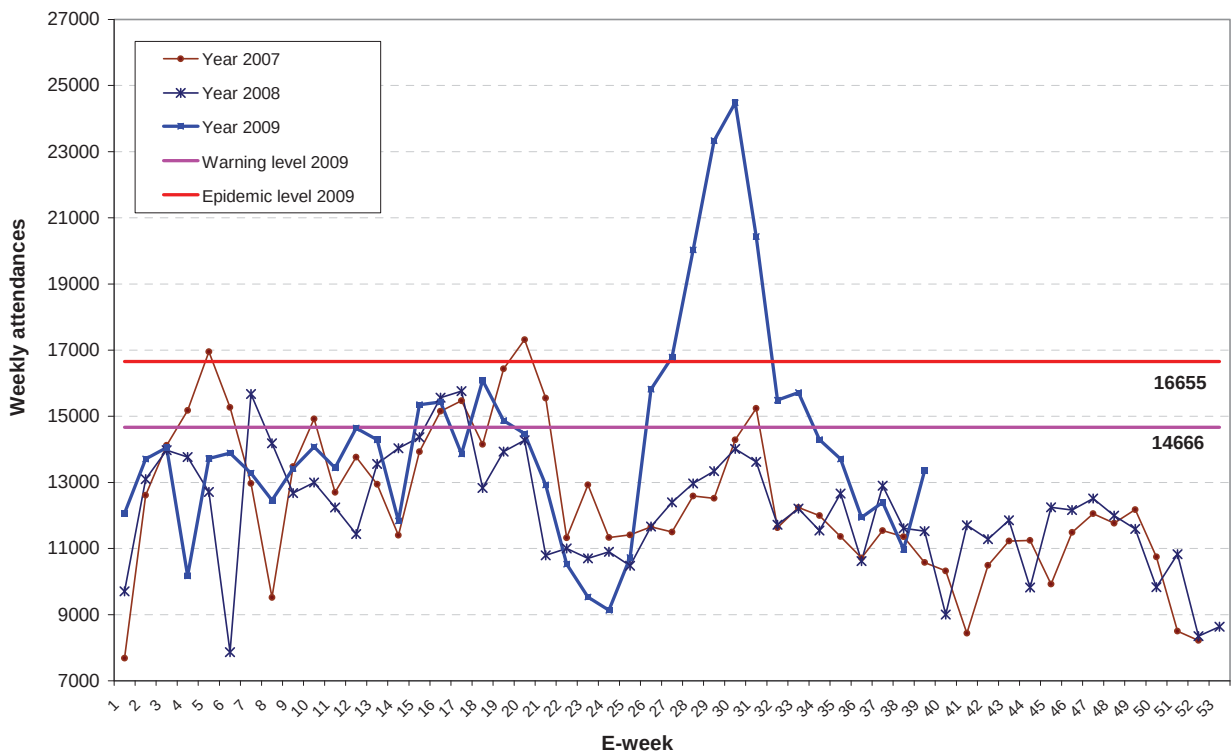


Fig. 2. Weekly polyclinic attendances of acute respiratory infection, year 2007 to 2009.

Table 1. Country of Origin of Imported Cases, May-July 2009

Country	No.	%
Australia	112	24.0
Canada	2	0.4
Chile	1	0.2
China	2	0.4
Cruise	2	0.4
Hong Kong	16	3.4
India	1	0.2
Indonesia	98	21.0
Japan	4	0.9
Korea	1	0.2
Malaysia	4	0.9
New Zealand	4	0.9
Philippines	106	22.7
Thailand	48	10.3
UK	19	4.1
US	44	9.4
Vietnam	3	0.6
Total	467	100.0

Malaysian male who is a Permanent Resident in Singapore. He departed from Singapore to Kuala Lumpur for work on 14 June. Later that evening, he developed symptoms while he was having dinner at a restaurant. He returned to Singapore from Kuala Lumpur on 17 June. When he arrived at Changi Airport, he immediately approached the airport staff and a 993 ambulance was called to send him to TTSH where he was diagnosed with H1N1-2009.

Of the 834 local cases, 22 were infected from imported cases, 425 were linked to other local clusters and 387 were unlinked. The first local clusters of cases were reported on 20 June. These were clusters arising from a church function held on 13 to 14 June with total of 10 cases and a night club

Table 2. Nationality of 1301 Imported and Local Cases, May-July 2009

Nationality	Imported	Local	Total
Singaporean	43.5	85.1	70.2
Singapore PR	13.1	4.2	7.4
Foreigners	43.5	10.7	22.4
Total	100.0	100.0	100.0

Table 3. Early Local Clusters of Cases of Influenza A (H1N1-2009)

Cluster	Cluster size	Earliest date of onset of symptoms
Polytechnic	116	15 June 2009
SAF Camp 1	29	15 June 2009
Nightclub (17 June)	46	16 June 2009
Church	13	17 June 2009
SAF Camp 2	28	18 June 2009
University	36	20 June 2009
SAF Camp 3	67	24 June 2009

on 17 June with a total of 46 infected. The largest cluster of 116 cases was related to one of the polytechnics. Early clusters were also detected in Singapore Armed Forces (SAF) camps (Table 3). No large clusters were reported in healthcare institutions, probably due to the implementation of comprehensive infection control measures from the beginning of the alert period in late April 2009.

Age-distribution

Most (84%) of the 1301 cases were below the age of 30 years. Only 3% were between 50 and 59 years of age and less than 1% were above 60 years of age. A similar age-distribution was seen even when Singapore residents and foreigners were analysed separately (Table 4).

Cases in the age group of 10 to 29 years old made up 80% of local transmission cases compared to 59% among imported cases. The proportion of cases below 10 years of

Table 4. Age Distribution (%) of 1301 Local and Imported Cases by Residency

Age group (y)	Singapore residents			Foreigners			Total		
	Imported	Local	All	Imported	Local	All	Imported	Local	All
0-9	17.8	8.2	10.7	19.2	5.6	15.1	18.4	7.9	11.7
10-19	31.1	33.8	33.1	31.5	39.3	33.9	31.3	34.4	33.3
20-29	28.0	46.6	41.7	26.6	40.4	30.8	27.4	45.9	39.3
30-39	9.1	4.4	5.6	10.3	12.4	11.0	9.6	5.3	6.8
40-49	10.2	3.6	5.4	6.9	2.2	5.5	8.8	3.5	5.4
50-59	2.7	2.7	2.7	5.4	0.0	3.8	3.9	2.4	2.9
60+	1.1	0.7	0.8	0.0	0.0	0.0	0.6	0.6	0.6
All	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table 5. Ethnic Distribution of 1009 Confirmed Cases who were Singapore Residents, May-July 2009

Ethnic group	No. of cases	Distribution among cases (%)	Distribution in the resident population 2009 (%)
Chinese	598	59.3	74.2
Malay	241	23.9	13.4
Indian	59	5.8	9.2
Others	111	11.0	3.2
Total	1009	100.0	100.0

age among imported cases (18%) was more than double that of local transmission cases (8%). This is probably related to parents bringing their young children overseas during the school holidays in June.

Sex and Ethnic Group Distribution of Singapore Residents

Of 1009 cases who were Singapore residents, males were more affected than females (males 60% vs females 40%). Malays and other ethnic groups (besides Chinese, Malay and Indian) were over-represented compared to their distribution in the population (Table 5).

Indicators of Influenza Activity

ARIs Seen in Polyclinics

The number of ARI cases exceeded the Warning Level during E-week 26 (28 June-4 July 2009), exceeded the

Epidemic Level during E-week 27 (5-11 July) and peaked during E-week 30 (26 July-1 August). It subsequently fell below the Epidemic Level during E-week 32 (9-15 August) and then below the Warning Level during E-week 34 (23-29 August). The number of ARI cases seen in polyclinics remained below the Warning Level from E-week 34 to E-week 39 (27 September-3 October) (Fig. 2).

Proportion of Cases with ILI among ARI Cases Seen in Polyclinics

The proportion of cases with ILI among ARI cases seen in polyclinics rose from 14.8% during E-week 28 (12-18 July 2009) to a peak of 22.9% during E-week 30 (26 July-1 August). It then fell below 20% during the following week and then below 10% during E-week 36 (6-12 September). The proportion of ILI cases was 5.8% during E-week 39 (27 September-3 October) (Fig. 3).

Prevalence of Influenza A (H1N1) Among Cases with ILI

Influenza A (H1N1-2009) was first detected among surveillance samples of patients with ILI seen at polyclinics and GP clinics during E-week 24 (14-20 June 2009) when it was 1%. It then steadily rose to go beyond 50% in E-week 28 (12-18 July) to reach a peak of 65.5% (95% CI, 62.0%-68.8%) in E-week 31 (2-8 August). The prevalence of H1N1-2009 among ILI cases seen in polyclinics and GP clinics stayed above 50% for 9 consecutive weeks from E-week 28 to E-week 36 (6-12 September). The prevalence fell to 18.1% (95% CI, 13.0%-24.6%) in E-week 39 (27 September-3 October) (Fig. 4).

Estimated Number of Cases of H1N1-2009 from June to September 2009

The daily public updates of the number of confirmed cases stopped on 9 July 2009 when containment measures were gradually replaced by mitigation measures. Contact tracing and other containment measures were stopped in recognition of widespread community transmission by then.

Using the methodology described in the methods section, it is estimated that between E-week 24 (14-20 June 2009) and E-week 39 (27 September-3 October) a total of 270,000 cases of H1N1-2009 were seen in polyclinics and GP clinics

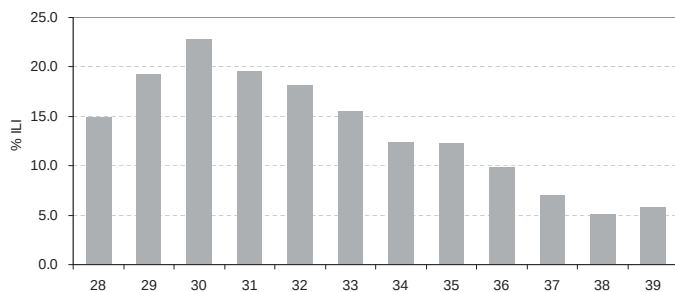


Fig. 3. Weekly proportion of influenza-like-illness (ILI) among acute respiratory infection polyclinic attendances in 2009.

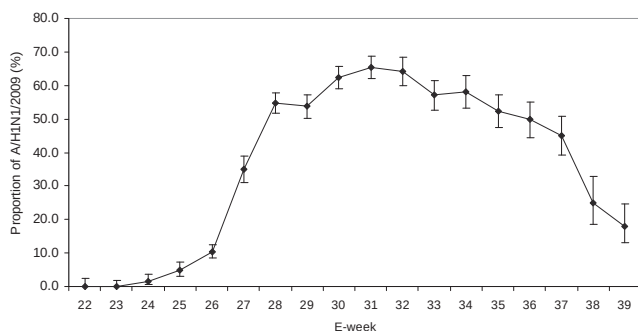


Fig. 4. Prevalence of Influenza A (H1N1-2009) among influenza-like-illness cases by E-week in 2009.

Table 6. Risk Factors of 1348 Hospitalised Cases by Age-group, 15 July-28 September 2009

Risk factor (no, %)	All patients (n = 1348)		Aged 20 and above (n = 805)		Aged below 20 (n = 543)	
Asthma	258	(19%)	184	(23%)	74	(14%)
Diabetes	169	(13%)	164	(20%)	5	(1%)
Cardiovascular disease*	94	(7%)	90	(11%)	4	(1%)
Immunosuppressed	70	(5%)	53	(7%)	17	(3%)
Renal diseases	71	(5%)	61	(8%)	10	(2%)
Malignancy	54	(4%)	41	(5%)	13	(2%)
Autoimmune disease	42	(3%)	37	(5%)	5	(1%)
Pregnancy	46	(3%)	42	(5%)	4	(1%)
Chronic obstructive pulmonary disease	30	(2%)	29	(4%)	1	(0.2%)
Epilepsy	27	(2%)	9	(1%)	18	(3%)
Neuromuscular disorder	12	(1%)	6	(1%)	6	(1%)
Obesity	13	(1%)	11	(1%)	2	(0.4%)
Aged 5 and younger	173	(13%)	-	-	173	(32%)
Aged 65 and older	100	(7%)	100	(12%)	-	-
One or more of the above	787	(58%)	506	(63%)	281	(52%)

* excluded hypertension

Note: one patient may be listed more than once in the above categories

throughout Singapore. As the total population of Singapore at the end of June 2009 was reported as 4.99 million,⁸ this would give a cumulative clinical attack rate of 5.4% by the beginning of October 2009. If we further assume that only half of clinical cases sought care in polyclinics and GP clinics, the total number of cases would double to 540,000 and the clinical attack rate would also double to nearly 11%.

The peak number of cases occurred during E-week 30 (26 July-1 August) when an estimated 45,000 cases were seen in polyclinics and GP clinics.

Hospitalised Cases

All hospitals were required from 15 July 2009 to report confirmed H1N1-2009 cases who had been admitted for medical indications. Between 15 July and 28 September 2009, a total of 1348 confirmed cases, who were admitted into hospitals, were reported. This represents about 0.6% of the estimated number of H1N1-2009 infections seen in polyclinics and GP clinics (n = 245,000 between E-week 28 and E-week 38, that is between 12 July and 26 September 2009) or a rate of 6 per 1000 cases.

Three-fifths (60%) of the 1348 hospitalised cases were adults while two-fifths (40%) were children. The median age among hospitalised cases was 25 years with a range of 24 days to 95 years. Hospitalisation rates were highest among young children aged below 10 years (60.6 per 100,000 population) and older children aged 10 to 19 years (46.1 per 100,000 population). In contrast, the hospitalisation rate among the elderly aged 60 and above was 26.1 per

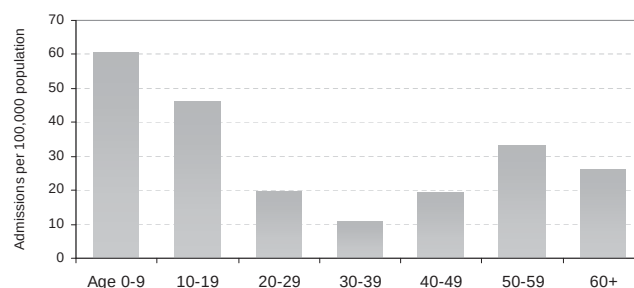


Fig. 5. Age-specific hospital admission rates (n = 1348 as of 28 September 2009).

100,000 population (Fig. 5).

Of the 1348 hospitalised cases, 787 (58%) were reported to have one or more risk factors with asthma being the most common medical condition seen in both children and adults (Table 6). Among children, 281 (52%) were reported to have one or more risk factors. The most common risk factor was being under 5 years of age (32%) and asthma (14%). Among adults, 506 (63%) were reported to have one or more risk factors. The most common risk factors were asthma (23%), diabetes (20%), being 65 years of age or older (12%) and cardiovascular disease (11%).

Among the hospitalised cases, 46 (5%) were pregnant women. Two of them suffered from severe illness. There were no deaths among pregnant women.

As of 26 October 2009, 5 of the 1348 cases remained in hospital. The median length of stay in hospital was 3 days with 90% of patients staying 8 days or less.

Table 7. Risk Factors of 92 Severe Cases by Age Group

Risk factor	All severely ill (n = 92)		Aged 20 and above (n = 76)		Aged below 20 (n = 16)	
Diabetes	20	(22%)	20	(26%)	0	(0%)
Cardiovascular disease*	11	(12%)	11	(14%)	0	(0%)
Renal disease	9	(10%)	9	(12%)	0	(0%)
Asthma	9	(10%)	8	(11%)	1	(6%)
Epilepsy	7	(8%)	0	(0%)	7	(44%)
Neuromuscular disorder	7	(8%)	4	(5%)	3	(19%)
Immunosuppressed	7	(8%)	5	(7%)	2	(13%)
Malignancy	6	(7%)	5	(7%)	1	(6%)
Obesity	4	(4%)	4	(5%)	0	(0%)
Chronic obstructive pulmonary disease	3	(3%)	3	(4%)	0	(0%)
Autoimmune disease	3	(3%)	2	(3%)	1	(6%)
Pregnancy	2	(2%)	2	(3%)	0	(0%)
Aged 5 and younger	5	(5%)	-	-	5	(31%)
Aged 65 and older	12	(13%)	12	(16%)	-	-
One or more of the above	65	(71%)	53	(70%)	12	(75%)

* exclude hypertension

Note: one patient may be listed more than once in the above categories

Table 8. Risk Factors of 18 Deaths by Age Group

Risk factor	All deaths (n = 18)		Aged 20 and above (n = 16)		Aged below 20 (n = 2)	
Diabetes	5	(28%)	5	(31%)	0	(0%)
Cardiovascular disease*	3	(17%)	3	(19%)	0	(0%)
Neuromuscular disorder	2	(11%)	2	(13%)	0	(0%)
Immunosuppression	2	(11%)	1	(6%)	1	(50%)
Malignancy	2	(11%)	1	(6%)	1	(50%)
Epilepsy	1	(6%)	0	(0%)	1	(50%)
Asthma	1	(6%)	1	(6%)	0	(0%)
Chronic obstructive pulmonary disease	1	(6%)	1	(6%)	0	(0%)
Renal disease	1	(6%)	1	(6%)	0	(0%)
Obesity	1	(6%)	1	(6%)	0	(0%)
Age 65 and older	5	(28%)	5	(31%)	-	-
One or more of the above	14	(78%)	12	(75%)	2	(100%)

* exclude hypertension

Note: one patient may be listed more than once in the above categories

Severe Cases

Hospitals were required to report all severe cases [i.e. admitted into intensive care units (ICU) or who died] to the Ministry of Health since the epidemic began locally. The Ministry received reports on 92 severe cases. This represented about 6% to 7% of hospitalised cases (including some cases hospitalised for medical indications before formal reporting began on 15 July) or a rate of about 0.3

per 1000 cases (with n = 270,000 estimated clinical cases as the denominator). Most of the severe cases were among adults (83%). The median age of the severe cases was 44 years with a range of 3 months to 95 years. While the hospitalisation rates were highest among the children, the incidence of severe cases was highest among adults aged 50 to 59 years (3.4 cases per 100,000 population) and the elderly aged 60 years and above (3.1 cases per 100,000

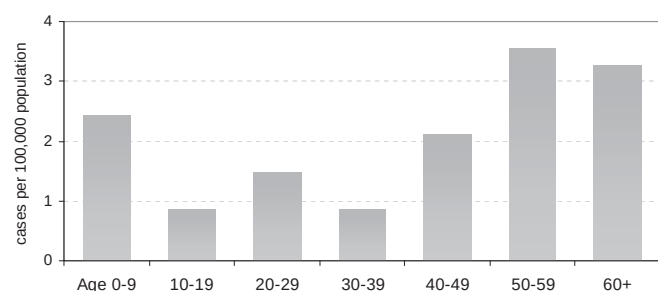


Fig. 6. Age-specific incidence of severe cases ($n = 92$ as of 28 September 2009).

population) (Fig. 6). About half (54%, $n = 50$) required mechanical ventilation.

Nearly three-quarters (71%) of the 92 severe cases were reported to have one or more risk factors (Table 7). Among adults, the most common risk factors were diabetes (26%), being 65 years and above (16%) and cardiovascular disease (14%). Among children, the most common risk factors were epilepsy (44%) and being under 5 years of age (31%). One-fifth (16/79) of the severe cases reviewed were reported to have ARDS. Of the 16 cases with ARDS, 6 (38%) died.

Deaths

The first death from H1N1-2009 was reported on 18 July 2009. This was a 49-year-old man with multiple comorbidities (diabetes, hypertension and high cholesterol). He was admitted to Changi General Hospital on 16 July after 4 days of flu-like symptoms. He died of acute myocardial infarction, contributed by severe pneumonia with underlying H1N1-2009 infection.

A total of 18 H1N1-related deaths were reported up to 28 September 2009. This represents slightly more than 1% of hospitalised cases and a case fatality rate of 6.7 per 100,000 cases (using $n = 270,000$ estimated clinical cases as the denominator). The vast majority of deaths occurred among adults (16 of the 18 deaths). The median age among H1N1-related deaths was 50 years with a range of 7 to 95 years. Nearly 80% of the fatal cases had one or more risk factors (Table 8). The most common risk factors among adults were diabetes (31%), being 65 years and above (31%) and cardiovascular disease (19%). There were 2 deaths in children. One had epilepsy and the other had acute lymphocytic leukaemia.

Discussion

Singapore received over 9 million tourist arrivals in 2008.⁸ In addition, a large number of persons travel to Singapore for business and many Singapore residents travel abroad for pleasure, business or study. It was thus expected that as H1N1-2009 spread in North America, it would very quickly spread to Singapore through air travel. Eventually, it did but it took about 1 month for it to do so. Given the

mild nature of the illness, it is entirely possible that cases of H1N1-2009 had entered Singapore before the first case was detected on 27 May 2009. Nonetheless, the 3 waves of imported cases followed the pattern of spread around the globe and the volume of travel between the affected areas and Singapore. The first wave of imported cases came from the United States, followed by a second wave from Australia as H1N1-2009 spread there. After that, a third wave of imported cases largely came from Southeast Asia following the spread of H1N1-2009 among Singapore's neighbours where there is a high volume of travel (e.g., Indonesia and the Philippines).

The first case of H1N1-2009 involving local transmission was detected on 18 June 2009. Again, it is entirely possible that there were already such local transmission cases earlier. Evidence of this comes from the rapid detection of local clusters involving churches, army camps and educational institutions. Epidemiological investigations of these local clusters revealed that the earliest cases had their onset of illness as early as 15 June 2009. The multiple local clusters which were unrelated and which were detected around the same time suggest that a certain level of community transmission was already occurring in the community by then.

The vast majority (85%) of H1N1-2009 cases occurred in persons under 30 years of age. In contrast, less than 1% of cases were found in persons aged 60 years and above. Such concentration of cases of H1N1-2009 among children and young adults and the relative sparing of the elderly has also been reported elsewhere.⁹ This differs from seasonal influenza, where general susceptibility across all age groups occurs. It has been suggested that the relative sparing of the elderly is due to their exposure to an antigenically similar H1N1 strain prior to 1957 when an influenza pandemic caused by a strain of the influenza A (H2N2) subtype occurred.¹⁰

An analysis by ethnic group showed that Malays were over-represented compared to their distribution in the resident population. A possible reason could be the relatively larger household size of Malays compared to other ethnic groups.⁸

The Ministry of Health has been monitoring the weekly attendances due to ARI in polyclinics on a continuous basis. This indicator proved to be a sensitive indicator of influenza activity during the pandemic, rising rapidly from the third week of June 2009 to a peak at the end of July, before settling down at the end of August 2009. This indicates that the duration of the first pandemic wave in Singapore lasted approximately 10 weeks, longer than the projected 6 weeks in Singapore's pandemic preparedness and response plan.¹¹ ARIs comprise both cases of ILI and cases which do not fulfill the WHO ILI case definition (fever of

>38°C and cough and/or sore throat).¹² Testing of non-ILI cases confirmed that H1N1-2009 can also present as a mild illness which does not fulfil the ILI case definition. This contributed to the sensitivity of the weekly ARI polyclinic attendances as an indicator of influenza activity during the pandemic. However, the weekly ARI polyclinic attendances cannot be used as the sole indicator of influenza activity as its movements are also driven by circulation of other viruses in the community such as rhinoviruses, coronaviruses and adenoviruses.

Two other indicators were therefore also monitored during the pandemic. The first was the proportion of attendances for ILI among the weekly ARI attendances. The other was the prevalence of H1N1-2009 among ILI samples in the community in samples from polyclinics and GP clinics. These 2 indicators complemented the weekly ARI indicator and together gave a fairly accurate indicator of the level of influenza activity in the community.

The number of ARI and ILI attendances in polyclinics together with the prevalence of H1N1-2009 in ILI and non-ILI ARIs enabled an estimation of the number of persons who sought care in polyclinics and GP clinics due to H1N1-2009. This estimation is important to provide a more realistic estimate of the severity of the pandemic. After the early containment phase, the vast majority of infected cases were not tested and hence not confirmed. It was thus shown that even under the most conservative estimate where it is assumed that all persons who were infected with H1N1-2009 were symptomatic and sought care in a primary care facility, the severity of the H1N1 pandemic in terms of hospitalisation, severe illness and mortality was low. It is reasonable to assume that given the mild nature of the illness, that up to half of all symptomatic cases did not seek care. This means that the number of symptomatic cases may be up to twice the estimates. This would reduce the rates of hospitalisation, severe illness and mortality by up to 50%. An additional dimension is the occurrence of asymptomatic infections. WHO had suggested that for the purposes of pandemic planning, countries assume that one-third of infections are asymptomatic.¹³ If we include asymptomatic cases using this assumption, the estimated number of cases would increase by 50% (as symptomatic cases would only account for two-thirds of cases) and the rates of hospitalisation, severe illness and mortality using the estimated number of cases as the denominator would decrease by 33% (when the estimated number of cases increase by 50%).

As reported elsewhere,¹⁴ rates of hospitalisation were highest in children and teenagers. Hospitalisation rates across the different age-groups followed a U-shaped pattern, with higher rates in persons aged below 20 years and in persons aged 50 years and above. It was lowest in

persons aged 30 to 39 years. The finding that children and teenagers have the highest hospitalisation rates is partially explained by the concentration of infections among the young. During the containment phase, nearly half (45%) of confirmed cases occurred in persons aged below 20 years. However, 40% of cases occurred in persons aged 20 to 29 years during the same period and the hospitalisation rate in this age group was only about a third that of children under 10 years of age.

An analysis of the risk factors for hospitalisation and severe illness reveals that the risk factors are mostly similar to that for seasonal influenza, except for obesity in adults and epilepsy in children. More studies should be done to better characterise and confirm whether these are true risk factors for influenza complications.¹⁵

The case fatality rate appears to be significantly lower than that normally quoted for seasonal influenza (about 0.1%).¹⁶ At a rate of about 7 per 100,000 cases, the case fatality rate of H1N1-2009 is more than 10 times lower. This rate is similar to the estimated case fatality rate in New Zealand.¹⁷ Some deaths due to H1N1-2009 may have been missed, leading to an under-estimation of the true case fatality rate. However, it is unlikely that more than 90% of deaths could have been missed during an influenza pandemic when most suspect cases are tested for H1N1-2009 in hospitals.

Conclusion

The first wave of the H1N1-2009 influenza pandemic in Singapore occurred from mid-June to August 2009, lasting about 10 weeks. It was preceded by imported cases for about 3 weeks. H1N1-2009 continued to circulate in the community at low levels after the end of the first wave. It is estimated that up to 11% of the population were infected during the first wave, assuming up to half of symptomatic cases did not seek care. The severity of the H1N1 pandemic in Singapore was mild in terms of rates of hospitalisation, severe illness and case fatality.

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