

Preparing for an Influenza Pandemic in Singapore

Jeffery Cutter,¹*MMed (PH), MSc, FAMS*

Abstract

The national strategy against pandemic influenza essentially consists of 3 prongs: (i) effective surveillance, (ii) mitigation of the pandemic's impact, and (iii) render the population immune through vaccination. When the pandemic hits Singapore, the response plan aims to achieve the following 3 outcomes: (i) maintenance of essential services to limit social and economic disruption, (ii) reduction of morbidity and mortality through antiviral treatment, and (iii) slow and limit the spread of influenza to reduce the surge on healthcare services. The biggest challenge will come from managing the surge of demand on healthcare services. A high level of preparedness will help healthcare services better cope with the surge.

Ann Acad Med Singapore 2008;37:497-503

Key words: Essential services, Healthcare, National preparedness, Non-pharmaceutical measures

Introduction

The last influenza pandemics occurred in 1957 and 1968. Few remember the pandemic in 1968 in Singapore as it was relatively mild. The Ministry of Health reported in its Annual Report of 1968 that attendance at outpatient dispensaries increased over a 2-week period and, at the peak, daily attendance increased 65% from 6052 to 9966.¹ There were no official reports of significantly increased hospital admissions or deaths. The 1957 pandemic was slightly more severe compared to the 1968 pandemic. A special report on the effects of the pandemic in Singapore was published in the Ministry of Health's Annual Report of 1957. This report stated that 77,211 cases, 326 hospital admissions and 28 deaths occurred during the pandemic of 1957 in Singapore.² This translates to a case fatality rate of only about 3 in 10,000. However, Lee et al³ reported that there may have been as many as 680 and 543 excess deaths in Singapore during the 1957 and 1968 pandemics respectively.

In more recent times, there was widespread alarm when Thailand and Vietnam reported human cases of avian influenza A/H5N1 in early 2004. The disease presentation was severe and case fatality exceedingly high.⁴ Since then, the World Health Organization (WHO) has confirmed 371 cases of avian influenza A (H5N1) from 14 countries (as at 5 March 2008). The case fatality rate has remained high at 63%.⁵ The outbreak of human cases of avian influenza A (H5N1) led WHO to urge countries to draw up national influenza pandemic preparedness plans. WHO declared that all the factors necessary for an influenza pandemic has

occurred, save one – that of efficient human-to-human transmission.⁶ The Ministry of Health (MOH) in Singapore drew up its influenza pandemic preparedness plan from scratch in 2004 and 2005. The first version of the Influenza Pandemic Preparedness and Response Plan was published on the Ministry of Health's website in June 2005. The current version was published in May 2007.⁷

Impact of the SARS Epidemic

Singapore was one of the countries badly hit by the outbreak of severe acute respiratory syndrome (SARS) in 2003. Between March and May 2003, a total of 238 confirmed cases of SARS with 33 deaths were reported.⁸ SARS was a wake-up call that infectious disease outbreaks could cause severe disruption to the economy. A positive impact of the SARS epidemic was the significant strengthening of public health and clinical infrastructure against infectious diseases. MOH created an Operations Group to strengthen infectious disease surveillance, outbreak management and emergency response capabilities. Isolation facilities in all public sector hospitals were expanded. The Communicable Diseases Centre (CDC) at Tan Tock Seng Hospital also expanded its isolation facilities in the form of CDC1 and CDC2. There were only 11 Infectious Diseases specialists in Singapore at the time of the SARS epidemic but this had increased to 29 as at the end of October 2007.⁹

As a result of the SARS epidemic, other Government Ministries and Agencies in Singapore also became more attuned to planning for severe infectious diseases outbreaks.

¹ Ministry of Health, Singapore
Address for Correspondence: Dr Jeffery Cutter, Ministry of Health, College of Medicine Building, 16 College Road, Singapore 169854.
Email: Jeffery_cutter@moh.gov.sg

High-level inter-Ministry and Agency committees at the Permanent Secretary and Ministerial levels met regularly to coordinate efforts to combat SARS. These coordination committees were headed by the Ministry of Home Affairs. After SARS, these committees continued to oversee pandemic influenza preparedness.

Planning for Pandemic Influenza – How it Began

The outbreak of avian influenza A (H5N1) in Thailand and Vietnam and WHO's statements of concern that this could precipitate an influenza pandemic provided the impetus for the Singapore Government to begin planning for such a pandemic in 2004. Planning was not confined to the Ministry of Health but through the coordination of the Ministry of Home Affairs, involved other Ministries and Agencies.

National Strategy Against Pandemic Influenza

The national strategy against pandemic influenza essentially consists of 3 prongs: (i) effective surveillance, (ii) mitigation of the pandemic's impact, and (iii) render the population immune through vaccination. When the pandemic hits Singapore, the response plan aims to achieve the following 3 outcomes: (i) maintenance of essential services to limit social and economic disruption, (ii) reduction of morbidity and mortality through treatment, and (iii) slow and limit the spread of influenza to reduce the surge on healthcare services.

The Ministry of Health's National Influenza Pandemic Preparedness and Response Plan

At MOH, planning for an influenza pandemic was led by the Operations Group. Planning involved the following major areas:

- i) Medical response
- ii) Surveillance
- iii) Isolation, contact tracing and quarantine
- iv) Provision of outpatient and inpatient care
- v) Pharmaceutical response measures
- vi) Non-pharmaceutical response measures

Planning Assumptions

Several assumptions had to be made to aid planning. This included the likely impact of the pandemic in terms of the number of cases who will require outpatient care, the number who will be hospitalised and the number of deaths. The MOH made use of the US CDC's FluAid modelling software¹⁰ for this purpose. Default parameters for hospitalisation rates in FluAid were used. These hospitalisation rates were based on the US experience in the 1968 pandemic. Projections based on attack rates of 15%, 25% and 35% were calculated but the "average" attack rate of 25% was chosen for planning purposes. Using this 25% attack rate and a population of 4.2 million,

FluAid predicted that 554,000 persons (range, 414,000 to 775,000) would require outpatient care, 11,200 persons (range, 3100 to 13,700) would need to be hospitalised and 1900 deaths (range, 900 to 3200) will occur.

Based on the experience of the 1918 pandemic, another planning assumption was that there would be 2 or more waves of infections each lasting 6 weeks, spaced 3 to 9 months apart.

Other planning assumptions used were that the pandemic would start outside Singapore, that any warning period before the onset of a pandemic would be short, that it will spread quickly and cause high morbidity and mortality, that it would spread to Singapore within days to weeks, that pandemic vaccine would take at least 4 to 6 months to be developed and that neuraminidase inhibitors, e.g. oseltamivir, would be the only effective drugs.

Pandemic Alert Phases

A colour-coded alert system was drawn up during the SARS epidemic in 2003 to describe different states of the epidemic (SARSCON). This ranged from Green (no SARS cases) to Red (community transmission).¹¹ A similar alert system has been adopted for pre-pandemic and influenza pandemic phases. The Flu alert phases are as follows and correspond to WHO's Pandemic Alert Phases.¹²

Alert GREEN 0. (corresponding to WHO phase 1-2). There is no circulating novel influenza subtype that has affected humans.

Alert GREEN 1. (~ WHO phase 3). Singapore's current status. The public health threat to Singapore is minimal and the disease is an avian disease without any human-to-human transmission.

Alert YELLOW and ORANGE. (~ WHO phases 4 and 5). There is inefficient human-to-human transmission of influenza outside Singapore. In ORANGE, human-to-human transmission becomes more efficient compared to YELLOW and there is a larger cluster of cases outside Singapore, but it is still localised. The risk of importation of cases into Singapore is elevated. Where there are isolated imported cases, such cases have not resulted in sustained transmission locally.

Alert RED. (WHO phase 6). The pandemic is underway and has spread to Singapore. There is significant risk of acquiring the disease from the community.

Alert BLACK. (WHO phase 6). Morbidity and mortality rates are high, and emergency measures are needed to bring the situation under control.

A summary of the Flu alert phases and the responses to be taken at each level is shown in Table 1.

Medical Response

The medical response covers aspects of diagnosis and medical management. In the pre-pandemic period, a

Table 1. Summary of Flu Alert Phases and Responses To Be Taken At Each Level

Flu alert phase	Description	Response
Green 0	No circulating novel influenza subtype that has affected humans.	Continue routine surveillance.
Green 1	Novel influenza subtype affecting humans. Isolated human infections. Human-to-human spread rare.	Enhance surveillance against possible imported cases. Suspect cases to be managed with respiratory precautions. Maintain antiviral stockpile. Conduct preparedness exercises.
Yellow	Inefficient human-to-human transmission, requiring close and sustained contact.	As above plus further enhance surveillance in hospitals. Border screening of travellers from affected area.
Orange	More efficient human-to-human transmission.	As in Yellow. Healthcare facilities increase preparedness.
Red	Pandemic reaches Singapore.	Implement social distancing measures. Antiviral prophylaxis of essential workers. Management of flu patients.
Black	Pandemic in Singapore with high levels of morbidity and mortality.	Stronger social distancing measures. Possible expansion of healthcare facilities.

diagnosis of avian influenza A (H5N1) has to be confirmed through laboratory testing by polymerase chain reaction (PCR) methods. In the pandemic period, it was recognised that it would not be possible to confirm the diagnosis via laboratory testing due to the very large numbers of cases and the diagnosis would have to be based on clinical criteria. Medical management at the outpatient level would mainly involve treatment with oseltamivir, a neuraminidase inhibitor and other symptomatic treatment. Patients who are prescribed oseltamivir will have their personal particulars entered into a web-based database, the Health Check System. Inpatient management would in addition involve possible care for acute respiratory distress syndrome (ARDS) in the intensive care unit (ICU). Criteria for hospital admission and ICU care are being drawn up.

Surveillance

During the pre-pandemic period, the diagnosis could be suspected on the basis of symptoms and signs of pneumonia with a history of exposure to live poultry in countries affected by avian influenza. MOH issued a circular in December 2004 to inform all medical practitioners that

human cases of avian influenza A (H5N1) had been made notifiable under the Infectious Diseases Act. Clinical and epidemiological criteria for a suspect diagnosis of avian influenza was also specified in the circular.¹³ These criteria were revised in May 2007.¹⁴

During an influenza pandemic, presumptive diagnosis of influenza would be made on clinical criteria, with or without an exposure history. In addition, surveillance activities during an influenza pandemic will include monitoring the number of patients seen for influenza symptoms at outpatient clinics, the number of hospital admissions, the number of ICU admissions and the number of deaths from influenza. Other surveillance measures to be monitored during a pandemic will include the attack rate and the case fatality rate.

The Health Check System would facilitate the reporting of influenza cases. However, this would be limited to persons who are prescribed oseltamivir.

Isolation, Contact Tracing and Quarantine

During the pre-pandemic period, confirmed cases of influenza A (H5N1) will be isolated in negative pressure rooms at the CDC in Tan Tock Seng Hospital. It was decided that centralisation of cases would facilitate management by focusing expertise in one place. This measure will also limit the risk of spread to healthcare workers. This was in part influenced by Singapore’s experience handling the SARS outbreak.⁸ Suspected cases will initially be isolated in their primary hospital of admission while awaiting the results of laboratory testing for influenza A (H5N1).

Contact tracing and quarantine was instrumental in controlling the SARS epidemic in 2003.⁸ It is believed that it will also play an important role in preventing the spread of avian influenza before a pandemic and possibly also at the early stages of an influenza pandemic. Contacts were successfully quarantined in their own homes during the SARS epidemic. This policy was decided upon early in the SARS epidemic due to the realisation that there would be insufficient dedicated quarantine facilities. This model has also been adopted in planning for an influenza pandemic. Identified contacts will be given 10 days of prophylaxis with oseltamivir.

Provision of Outpatient and Inpatient Care

A cardinal feature of influenza pandemics is the huge surge of patients requiring both outpatient and inpatient care. Healthcare facilities are likely to be overwhelmed. Initially, provision of outpatient care for pandemic influenza was planned to be provided only at the 18 public polyclinics. The polyclinics would function as dedicated “flu clinics” and the role of private clinics would be to manage patients with medical conditions other than influenza. Polyclinic

patients who require care for non-influenza conditions would be transferred to the care of these private clinics. This was mainly for logistics reasons so as to have better control over the usage of the national stockpile of oseltamivir.

Subsequently, it was decided that it was better to include all private clinics in the provision of outpatient care as (i) patients would have to travel to the flu clinics to get treatment for influenza and could spread influenza during their journey, (ii) patients seeking treatment for “non-influenza conditions” may also be infected with influenza and could thus spread the infection in the non-flu clinics and (iii) this would make better use of scarce health manpower during a pandemic. This model will require strict infection control measures to minimise the risk of non-influenza patients from being infected by influenza patients. Among the strategies to be used are, patients with chronic medical conditions will be given their prescription medication for longer periods than usual e.g. for 3 months so that they need not visit the clinic, and separate appointments for patients with influenza and other medical conditions.

All hospitals, both public and private, will be managing influenza patients during a pandemic. It is likely that a single dedicated hospital model as used during SARS in Singapore would be insufficient to cope with the large number of patients who need inpatient care. All hospitals will postpone elective procedures and discharge as many patients as possible to create bed capacity when the pandemic is imminent e.g. when WHO declares Pandemic Phase 5 / MOH declares Alert ORANGE or when a pandemic has been declared but the pandemic has not yet reached Singapore. Hospitals have drawn up detailed plans on how they would manage their operations during a pandemic, including manpower deployment.

A critical resource that is highly likely to be insufficient will be intensive care beds. A significant proportion of patients who are hospitalised due to pandemic influenza may require intensive care (ICU). MOH worked with intensivists and respiratory physicians from the public sector hospitals to review how intensive care facilities could best be expanded during a pandemic. The main limiting factor found was the availability of trained personnel (personal communication). As a result, expansion of ICU beds during a pandemic would be limited. Some ICU beds will also have to be set aside for non-influenza conditions e.g. injuries and myocardial infarcts. It is hoped that widespread treatment of patients with pandemic influenza with oseltamivir will reduce the demand for inpatient and ICU care by 50% (see below). This would help reduce the daily patient load and enable hospitals to cope better with the anticipated surge.

Pharmaceutical Response Measures

Antiviral Drugs

Singapore has stockpiled the neuraminidase inhibitor, oseltamivir, as part of its influenza pandemic preparedness strategy. Only 2 neuraminidase inhibitors are available – oseltamivir and zanamivir. As oseltamivir can be taken orally but zanamivir has to be inhaled, it was decided that oseltamivir should be stockpiled in preparation for an influenza pandemic. The amount of oseltamivir to be stockpiled took the following factors into account :

- the projected number of persons that would need outpatient care during a pandemic from the FluAid model (about 550,000);
- the estimated number of persons who usually seek outpatient care for upper respiratory tract infections over a 6-week period (300,000)
- the number of essential personnel who would require pre-exposure prophylaxis over 6 weeks (50,000).

The estimated number of persons with upper respiratory tract infections per week was estimated by multiplying the minimum number of patients seen in public sector polyclinics per week (10,000, rounded down to the nearest thousand) by a factor of 5 as previous surveys had shown that public sector polyclinics managed about 20% of the national outpatient workload for patients presenting with acute illnesses.¹⁵ Essential personnel would each receive 4 boxes of oseltamivir each, sufficient for nearly 6 weeks of prophylaxis – the estimated duration of the first wave of the pandemic. The number of boxes of oseltamivir to be stockpiled for essential personnel was thus 200,000 (50,000 x 4). This brought the total size of the national stockpile of oseltamivir to 1,050,000 boxes (ten 75 mg capsules in each box).

The purchase order for oseltamivir was made in 2004. At that time, many other countries were also placing orders for oseltamivir and demand far exceeded supply and manufacturing capacity. Delivery of the oseltamivir was only finally completed at the end of 2005. Subsequently, other Government Ministries and agencies also placed orders to cover additional essential personnel in terms of 6-week prophylaxis. Another 40,000 boxes of oseltamivir was also ordered by the Health Ministry to cover 2500 General Practitioners and their clinic staff (7500 staff) after General Practitioner clinics were included in the plan to provide outpatient care during an influenza pandemic.

The bulk (over 75%) of the national stockpile of oseltamivir will be used for treatment of patients with influenza. It is projected that treatment of pandemic influenza cases with oseltamivir will reduce the number of cases with severe illness and complications by 50%,¹⁶ thus reducing the demand for hospital care. It is assumed that

each treatment course will only need 10 capsules (75 mg bd x 5 days). In current cases of avian influenza A (H5N1), WHO has stated that the daily dosage and duration of treatment may need to be increased to 300 mg and 7 to 10 days respectively in patients who do not show a clinical response.¹⁷ This may put a strain on oseltamivir stocks. However, the number of patients who require such higher dosages and longer treatment duration is not expected to be large. It may be limited to patients who require hospital care (estimated 11,200 patients). In addition, many patients who normally seek outpatient care for upper respiratory tract infections may not do so during a pandemic and self-medicate instead. The 300,000 boxes of oseltamivir which was ordered for such patients could thus serve as a useful buffer.

The prescription of oseltamivir during a pandemic needs to be controlled, or the stockpile of the drug could be depleted before the pandemic is over. One concern is prescribing the drug to patients who may be having upper respiratory tract infections from other viruses e.g. rhinoviruses and adenoviruses. However, doctors would find it difficult to differentiate between the infections as they may share similar symptoms. MOH will issue criteria for prescribing oseltamivir at the onset of the pandemic when presenting symptoms are reported from first-affected countries. Persons with mild symptoms, e.g. those without any fever, may be advised to rest at home and self-medicate.

Another concern is that some persons may go to different clinics to procure oseltamivir with the intention of selling the drug for profit. Doctors will thus be required to check whether a patient has recently been prescribed oseltamivir through a web-based database (Health Check System).

The shelf-life of oseltamivir has been lengthened from 3 years to 5 years from the date of manufacture through positive results from drug potency studies (personal communication). However, the shelf-life of the first batch of the drug is due to expire in 2008. These will have to be replaced.

110,000 treatment courses of oseltamivir in bulk powder form has been stockpiled for paediatric use. It will have to be reconstituted during the pandemic. A small quantity of zanamivir (50,000 treatment courses) was also procured when stocks were available in 2005. It was thought prudent to purchase some zanamivir, especially with reports of the influenza A (H5N1) virus exhibiting possible resistance to oseltamivir.¹⁸ However, it is thought that the pandemic virus would take some time to develop resistance to oseltamivir as the virus has to be first exposed to the drug through widespread use. No further purchases of zanamivir are planned.

Peramivir is a new neuraminidase inhibitor that is currently undergoing clinical trials.¹⁹ The advantage of peramivir

over oseltamivir and zanamivir is that it can be administered parenterally. This would be very useful in the management of patients with severe illness. This new drug may also be stockpiled if the results of clinical trials show that the drug is superior to oseltamivir for the treatment of patients with severe illness or that combination therapy (peramivir and oseltamivir) is superior to monotherapy with oseltamivir alone. The amount to be stockpiled is likely to be limited to the estimated number of hospitalised patients.

Vaccines

Up to 10 million doses of pandemic influenza vaccine were ordered in 2005. This will allow 2 doses of pandemic vaccine for each person in a population of 5 million. As the first doses of pandemic vaccine will not be available until 4 to 6 months into a pandemic, such vaccines will most likely arrive after the first wave of the pandemic. Vaccine protection for the first wave would have to rely on “pre-pandemic vaccines”, i.e. vaccines that are produced before a pandemic.

Pre-pandemic vaccines can be stockpiled and used when a pandemic is imminent. The efficacy of these vaccines will depend on their ability to cross-protect against a drifted strain of the same sub-type of the influenza A virus. Cross-protection in a influenza A (H5N1) vaccine with a novel adjuvant has recently been reported.²⁰ The European CDC also recently reported that it was likely that human H5N1 vaccines could provide cross-protection against a future pandemic strain.²¹ MOH is studying the possible stockpiling and use of pre-pandemic influenza vaccines.

Personal Protective Equipment

During the SARS epidemic in 2003, personal protective equipment (PPE) such as masks, gloves and waterproof gowns were in short supply. After SARS, the Health Ministry has maintained stockpiles of PPE sufficient for at least 5 to 6 months use by all frontline healthcare workers (personal communication).

Non-pharmaceutical Response Measures

Delaying the Spread of Pandemic Virus to Singapore

At the earliest sign that an influenza pandemic has begun, border controls would be stepped up in an attempt to delay the spread of the pandemic virus to Singapore. It has been reported that such measures may have limited usefulness²² but measures such as temperature and health screening were used during the SARS epidemic and will be used again during an influenza pandemic. The effectiveness of temperature and health screening in preventing persons with influenza from entering the country would be limited as infected persons who are pre-symptomatic or asymptomatic would pass through. Such persons are also infectious.

Depending on the severity of the pandemic, other border control measures that could be implemented include the imposition of immigration visa requirements and quarantine of incoming travellers, including residents. These would minimise non-essential travel to Singapore.

Social Distancing

Limiting social contact will slow the spread of influenza in the community and will reduce the height of the peak of the epidemic, although overall attack rates may remain the same.²² This will help healthcare services to cope and minimise the likelihood that healthcare services would be overwhelmed.

Social distancing measures will take the form of closure of all educational institutions and most public places e.g. shopping malls, cinemas and swimming pools. Public gatherings at mass events such as concerts and sporting events will also be cancelled. Visits to closed communities, e.g. nursing homes and prisons, may also be banned. Such measures would be instituted when the pandemic arrives in Singapore and would last for the duration of the local epidemic.

Other Non-pharmaceutical Measures

Other non-pharmaceutical measures that could be instituted during a pandemic include public advice on good personal hygiene such as good cough etiquette and frequent washing of hands. The public could also be advised to stay home as much as possible and wear surgical masks whenever they are in public places including when travelling on public transportation. Members of households with influenza cases will be asked to practice voluntary home quarantine to prevent possible transmission during the pre-symptomatic phase. The effectiveness of such measures are, however, unknown.

Sustaining Essential Services

Workers in essential services such as healthcare, energy supply, water supply, waste disposal and law enforcement will be provided with 6 weeks of prophylaxis with oseltamivir to minimise their likelihood of being infected with influenza. These services have also planned for the provision of services with a certain level of staff absenteeism, e.g. 20% to 30%. It is anticipated that this level of staff absenteeism will not have a major adverse impact on service operations as this would be similar to staffing levels during the major holiday periods in June and December.

Food Supplies

The Government has encouraged households to stock at least 2 weeks of food at home as part of preparedness for an influenza pandemic.²³ There are also national stockpiles of food essentials such as rice and infant milk powder. As Singapore imports almost all of its food requirements,

alternative sources of food supplies are also being looked at in case supply from usual sources is disrupted during a pandemic.

Management of the Dead

The management of dead persons will follow usual procedures as much as possible. WHO has said that the bodies of persons who had died from influenza are not infectious and can be managed in the usual manner.²⁴ The relevant Government agencies have also drawn up contingency plans in the event that the numbers of dead exceed normal capacity.

Public Communications

The Ministry of Information, Communications and the Arts (MICA) will coordinate public communications during a pandemic. Useful lessons were learnt during SARS such as transparency and the provision of regular updated information. MICA issued a Flu Pandemic Guide in the 4 official languages to all households in 2006.²³ A public exhibition on infectious diseases, including flu pandemics, was organised by MICA in 2007 to raise public consciousness about the impact of major epidemics and the need for tough measures to be taken.

Private Sector

In addition to preparations by Government agencies, private sector companies have been encouraged to also draw up Business Continuity Plans (BCPs) to maintain their operations during an influenza pandemic. Many large companies and multinationals have developed BCPs for pandemic influenza. The Standard, Productivity and Innovation Board, Singapore (SPRING) has also produced a Flu Pandemic Business Continuity Guide for small and medium companies.²⁵

Pandemic Exercises

Government agencies have carried out exercises to test their pandemic preparedness plans. A large exercise (Exercise Sparrowhawk) was carried out in mid-2006 to test preparedness in healthcare settings and at the borders. The exercise was useful in enabling healthcare providers to fine-tune their operational plans for an influenza pandemic.

Discussion

It has been 40 years since the last influenza pandemic in 1968. It took 39 years after the pandemic of 1918 before the next pandemic occurred in 1957 and just 11 years after that to the 1968 pandemic. By this measure, another pandemic is overdue. However, it is impossible to predict when the next pandemic will begin. In addition, although the leading candidate for the pandemic strain is the influenza A (H5N1) subtype, this is by no means a certainty. Other influenza A subtypes that may also precipitate the next pandemic are the H2N2, H7N7 and H9N2 subtypes.

Uncertainty in both the timing and the subtype of the next influenza pandemic present major challenges for health authorities around the world as they prepare for such a pandemic. Uncertainty in the timing impacts upon stockpiles of antiviral drugs and vaccines as these need to be replaced at considerable cost. Uncertainty in the subtype makes it difficult to stockpile a “pre-pandemic” vaccine as cross-protection of newly developed human H5N1 vaccines extends only to drifted strains within the same subtype. Thus a stockpiled H5N1 vaccine would be ineffective against a pandemic caused by H2N2 or H9N2. Despite these uncertainties and challenges, many governments have purchased large quantities of antiviral drugs for stockpiling and some governments have already announced or are considering the purchase of H5N1 vaccines for stockpiling.

The re-emergence of influenza A (H5N1) in early 2004 in the wake of SARS precipitated unprecedented preparations for an influenza pandemic around the world, including Singapore. We have had 4 years since then to prepare. Are we better prepared to cope with a pandemic if one begins tomorrow? I believe so. Antiviral and PPE stockpiles are in place and hospitals and the primary care system have drawn up systems and protocols to cope with the anticipated surge in demand for care. Preparations to maintain essential services and implement widespread social distancing measures are also in place. The public have also been prepared. These represent the most important components of preparedness.

Possible weak links in the system are private hospitals, community hospitals and nursing homes. With the exception of one hospital, the other private hospitals do not employ their medical specialists. Command and control issues may thus arise. Community hospitals have minimal medical staff while nursing homes do not have any in-house medical staff and rely on external consultations. Such lack of staff may make it difficult for these institutions to cope should outbreaks occur during a pandemic. Gaps in preparedness and response plans in these institutions will need to be reviewed.

These preparations will be severely challenged when the pandemic eventually arrives in Singapore, especially if there is high morbidity and mortality. Healthcare facilities can be quickly overwhelmed and the economy can go into deep recession. There can be widespread public anxiety and fear. It is thus vital to ensure that preparedness plans are regularly reviewed and updated to incorporate the latest research findings and technology where feasible. Equally important are exercises to test and fine-tune procedures and plans.

Conclusion

At the time of writing, 4 years have passed since the re-emergence of influenza A (H5N1). This has given the

world an unprecedented opportunity to prepare for an influenza pandemic. Preparations must continue to be improved and fine-tuned to ensure that the impact of the coming influenza pandemic is minimised as much as possible.

REFERENCES

1. Ministry of Health, Singapore. Annual Report, 1968.
2. Ministry of Health, Singapore. Annual Report, 1957.
3. 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;13:1052-57.
4. World Health Organization. Situation updates – Avian influenza. Archives (2004). Available at: http://www.who.int/csr/disease/avian_influenza/updates/en/index.html. Accessed December 2007.
5. World Health Organization. Cumulative number of confirmed human cases of influenza A(H5N1) reported to WHO. Available at: http://www.who.int/csr/disease/avian_influenza/en/. Accessed March 2008.
6. World Health Organization. Responding to the avian influenza pandemic threat: recommended strategic actions. 2005. WHO/CDS/CSR/GIP/2005.8.
7. Ministry of Health, Singapore. Details of Influenza Pandemic Plan. Available at: <http://www.moh.gov.sg/mohcorp/currentissues.aspx?id=16134>. Accessed December 2007.
8. Goh KT, Cutter J, Heng BH, Ma S, Koh BKW, Kwok C, et al. Epidemiology and control of SARS in Singapore. *Ann Acad Med Singapore* 2006;35:301-16.
9. Singapore Medical Council. Annual Report, 2007.
10. Centres for Disease Control and Prevention, Atlanta, Georgia, USA. FluAID 2.0. Available at: <http://www.cdc.gov/flu/tools/fluaid/>. Accessed December 2007.
11. Ministry of Health, Singapore. Singapore’s preparedness to deal with possible winter resurgence of SARS. *Epidemiological News Bulletin* 2004;30:1-5.
12. WHO. WHO Global Influenza Preparedness Plan – The role of WHO and recommendations for national measures before and during pandemics. 2005. WHO/CDS/CSR/GIP/2005.5
13. Ministry of Health, Singapore. Mandatory notification of suspected avian influenza under the Infectious Diseases Act. MOH Directive No. 2A/2005; 15 December 2005.
14. Ministry of Health, Singapore. Revised case definitions for human cases of influenza A/H5N1. MOH Directive No. 2A/2007;16 May 2007.
15. Emmanuel SC, Phua KH, Cheong PY. 2001 survey on primary medical care in Singapore. *Singapore Med J* 2004;45:199-213.
16. Jefferson T, Demicheli V, Rivetti D, Jones M, Di Pierantonio C, Rivetti A. Antivirals for influenza in healthy adults: systematic review. *Lancet* 2006;367:303-13.
17. WHO. Avian influenza (“bird flu”) – Fact sheet, February 2006.
18. De Jong Menno D, Tran TT, Truong HK, Vo MH, Smith Gavin JD, Nguyen VC, et al. Oseltamivir resistance during treatment of influenza A (H5N1) infection. *N Engl J Med* 2005;353:2667-72.
19. Biocryst pharmaceuticals. Peramivir facts. Available at: www.biocryst.com/pdf/peramivirfacts.com. Accessed December 2007.
20. Leroux Roels I, Borkowski A, Vanwolleghem T, Drame F, Clement F, Hons E, et al. Antigen-sparing and cross-reactive immunity with an adjuvanted rH5N1 prototype pandemic influenza vaccine: a randomized controlled trial. *Lancet* 2007;370:580-9.
21. European Centre for Disease Prevention and Control. Technical Report. Expert Advisory Groups on Human H5N1 Vaccines. Scientific Questions August 2007.
22. Ferguson NM, Cummings DAT, Fraser C, Cajka JC, Colley PC, Burke DS. Strategies for mitigating an influenza pandemic. *Nature* 2006;442:448-52.
23. Ministry of Information, Communications and the Arts, Singapore. Flu Pandemic. A Guide for You and Your Family. 2006. Available at: www.crisis.gov.sg. Accessed December 2007.
24. World Health Organization, Western Pacific Regional Office. Avian influenza, including influenza A (H5N1) in humans: WHO interim infection control guideline for health facilities. 10 May 2007. Available at: http://www.who.int/csr/disease/avian_influenza/guidelines/infection_control1/en/index.html. Accessed December 2007.
25. SPRING Singapore. A Flu Pandemic Business Continuity Guide for SMEs. 2006. Available at: www.crisis.gov.sg. Accessed December 2007.