

Combating SARS and H1N1: Insights and Lessons From Singapore's Public Health Control Measures

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Combating the outbreak of infectious diseases is a major public health imperative for the small island-state of Singapore. In this paper we discuss and assess the public health measures taken by the Singaporean government to combat the outbreak of SARS in 2003 and H1N1 in 2009. Most notably, the state introduced a clear line of command and control to monitor the effectiveness and efficacy of public health control measures as well as to oversee their implementation. Meanwhile, it has also employed moral suasion to ensure compliance with draconian health control measures by the population. At the same time, the Singapore government also established a close partnership with the population to ensure the acquiescence of the general public to these measures. Finally, this paper draws on the insights and lessons learned from the two outbreaks to develop a conceptual model for pandemic management.

Keywords: SARS; H1N1; Public Health Control Measures; Infectious Disease; Singapore

Die Bekämpfung des Ausbruchs ansteckender Krankheiten ist ein zentrales Gesundheitsgebot für den Inselstaat Singapur. Im vorliegenden Artikel erörtern und bewerten wir die Maßnahmen, welche die Regierung Singapurs im Bereich der öffentlichen Gesundheitsversorgung traf, um den Ausbruch von SARS im Jahr 2003 und von H1N1 im Jahr 2009 zu bekämpfen. Besonders bemerkenswert ist in diesem Zusammenhang die Einführung einer klaren Weisungs- und Kontrollstrategie, um die Wirksamkeit und Wirkungen der Maßnahmen zu überprüfen sowie ihre Implementierung beaufsichtigen zu können. Zudem wurden moralische Appelle angewendet, um die Einhaltung von drakonischen Maßnahmen zur Gesundheitskontrolle durch die Bevölkerung zu gewährleisten. Gleichzeitig etablierte die singapurische Regierung eine enge Partnerschaft mit der Bevölkerung, die das Einverständnis der Öffentlichkeit zu diesen Maßnahmen sicherstellte. Zum Schluss wird im vorliegenden Aufsatz ein konzeptionelles Modell, das auf Einsichten und Lehren aus den beiden Ausbrüchen beruht, ausgearbeitet.

Schlagworte: SARS; H1N1; Maßnahmen zur öffentlichen Gesundheitskontrolle; Infektionen; Singapur

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Introduction

Situated in South-East Asia, Singapore is fortunate enough to be spared from major natural disasters such as typhoons, earthquakes, and tsunamis. However, as the small city-state is one of the most densely populated countries in the world, Singapore is especially prone to transnational health threats such as pandemics. Indeed, during the last decade, Singapore has been struck by two major pandemics. In 2003, Singapore experienced the outbreak of the Severe Acute Respiratory Syndrome (SARS) (Cutter, 2008; Goh et al., 2006; James, Shindo, Cutter, Ma, & Chew, 2006; Pereira, 2008; Tan, 2003). Then, in 2009, the state had to take additional measures against the novel influenza A (H1N1), which put major parts of its population at risk (Cutter et al., 2010; Ministry of Health, 2009; Tay, Cutter, & James, 2010).

Even though the two major outbreaks were eventually contained through an array of public health control measures instituted by the Ministry of Health (MoH) of Singapore, SARS and H1N1 brought about severe public health and economic consequences for the country as a whole (Leo, 2011). As it turned out, the population's receptiveness to draconian measures was enhanced to a large extent through moral suasion and close partnership between the government and people. Indeed, the efficacy of these public health control measures was profoundly related to these two crucial elements. Meanwhile, it is important to note that these public health control measures were swiftly adjusted to meet contingencies that arose – for example when additional epidemiological cases were uncovered and when a better understanding of the viruses was developed. This happened through the introduction of a clear line of command and control. In terms of capacity building in the design and implementation of health control policies, the insights drawn from these two episodes of disease outbreak are invaluable both from a practical as well as a research perspective. Indeed, beyond adding to the body of knowledge on this subject, these insights also serve to guide the planning of health control policies on a broader level.

In this paper, we discuss the health control measures introduced as well as the insights drawn from the Singapore experience with specific references to SARS and H1N1. To achieve our research objective, we utilised a combination of widely-accepted qualitative methodologies. Firstly, we performed a careful examination of official documents released by key institutions such as the Singaporean Ministry of

Health and the *World Health Organisation* (WHO). Secondly, we also examined relevant literature on public control measures against communicable diseases to establish our conclusions. Thirdly, we evaluated public speeches given by senior leaders in the Singapore government and WHO officials on this particular subject-matter. This broad-based methodological approach ensures that our conclusions are both valid and reliable.

The research contribution of this paper is significant because it offers a fresh perspective on the role of the state in pandemic management. Our research also adds to the body of knowledge on epidemic policy design specific to the region of South-East Asia. Indeed, the dominant perspective in this field holds that the state must be able to exercise brute force and impose its will on the population (Lai, He, Tan, & Phua, 2009). However, as shown in our paper, this dominant perspective is at least incomplete because the exercise of authority and power from the government is not a sufficient condition to contain the transmission of virulent diseases. Success in fighting epidemics is also contingent on a concerted effort of partnership between health authorities and the population at large. Beyond this key finding, this paper also contributes to the health policy field by elucidating a conceptual model for pandemic management that is applicable to a broader context.

This paper contains five main sections. Following this introduction, we provide an overview of the epidemiology of SARS and H1N1 in Singapore to familiarise readers with the chain of events surrounding these two outbreaks. This is then followed by a critical discussion of the command and control structures put in place by the Singapore government to combat SARS and H1N1. In the third section, we evaluate the public health control measures that were implemented in key healthcare sectors during the outbreak of SARS and H1N1. Then, we present the conceptual model for pandemic management that we have constructed from our findings. In the final section, we discuss the implications for pandemic control and management in South-East Asia as well as our conclusions.

Epidemiology of SARS and H1N1 in Singapore

The first case of SARS in Singapore was a 22-year-old female Singaporean, who was detected by clinicians at Tan Tock Seng Hospital (TTSH) in March 2003 (Centers for

Disease Control and Prevention, 2003). But what began as a few isolated cases swiftly turned into a major epidemic within a short period of time. The first Singaporean to contract SARS was hospitalised at TTSH in early March 2003 upon her returning from Hong Kong. As it happened, she had been infected by a super-spreader while staying on the same floor of the Metropole Hotel with the latter. The super-spreader, a Chinese physician named Dr. Liu, was later identified by the WHO to be the primary source of infection for multiple cases of SARS (Yeoh, 2003). Back in Singapore, this Singaporean quickly infected 21 others. Although this individual eventually recovered, a number of those infected by her were not as fortunate and finally succumbed to their illness (Ministry of Health, 2003). In late July 2003, Singapore reported 238 probable cases of SARS and by the time the country was removed from the WHO advisory list, 205 (86%) had recovered while 33 (14%) had died. A further breakdown reveals that 8 cases (3%) were infected while staying

Table 1: Comparison of Characteristics of SARS and H1N1

	SARS EPIDEMICS	H1N1 PANDEMICS
Outbreak period	November 2002 to July 2003	April 2009 to August 2010 (WHO declared a pandemic on 11 June 2010)
First reported case in Singapore	1 March 2003	26 May 2009
Pathogen	SARS Coronavirus (identified on 16 April 2003)	Novel Influenza A virus (identified on 24 April 2009)
Outbreak origin	Hong Kong, China	Mexico and the US
Transmitting pathway	Human respiratory droplets, contagious when with fever	Human respiratory droplets, contagious even when without fever
Total cases in Singapore	238	1,348*
Death toll in Singapore (mortality rate)	33 cases (14%)	18 cases (1.3%)
Rapid diagnostics	Available (RT-PCR/reverse transcription polymerase chain reaction)	Available (RT-PCR/reverse transcription polymerase chain reaction)
Medical treatment	Limited (only supportive)	Available (antivirals)
Medical prevention	Not available	Available (antivirals, vaccines)

* Refers to confirmed cases admitted to hospitals, representing about 0.6% of the estimated number of H1N1 infections in polyclinics and general practitioner clinics.

Source: Authors' Compilation From Various Formal Reports

abroad whereas 97 cases (41%) were healthcare workers (WHO, 2003).

H1N1, on the other hand, presented a different set of challenges altogether, as its main epidemiological characteristic was radically different from that of SARS (see Table 1). Crucially, a H1N1 carrier is contagious even when he or she had mild symptoms. SARS, meanwhile, can only be transmitted by the carrier after he or she had developed a fever. For H1N1, viral shedding begins shortly after infection and before the onset of symptoms. In other words, the H1N1 carrier would begin infecting others at a preliminary stage without even realising that he or she was stricken. Therefore, it is apparent that health control measures to combat SARS and H1N1 had to be customised according to their unique epidemiological characteristics (Leung & Nicoll, 2010).

On 26 May 2009, the first case of H1N1 – also a 22-year-old female Singaporean – was detected at a local clinic and subsequently sent to a local hospital designated to treat H1N1 cases (Ministry of Health, 2009). About three weeks after this case was reported, community transmissions (with no links to the first case) broke out at an alarming rate. Health authorities in Singapore immediately introduced rigorous containment measures which eventually brought down the rate of community transmission. Most notably, at the peak of the H1N1 pandemic (from 26 July to 1 August 2009), community outpatient clinics attended to nearly 24,477 cases for acute respiratory illness. In the week between 2 August and 8 August 2009, 65.5% of influenza-like cases were confirmed to be H1N1. By 9 July 2009, there were 1,301 confirmed cases of H1N1 in Singapore (Ministry of Health, 2009). Although the WHO later categorised the H1N1 pandemic as one of moderate severity, the public health control measures introduced to mitigate the severity of this pandemic undoubtedly contributed in no small part to contain this highly contagious pandemic. We will now examine in detail the command and control structure implemented by the health authorities in Singapore to mitigate the severity of the H1N1 pandemic.

Command and Control Structure

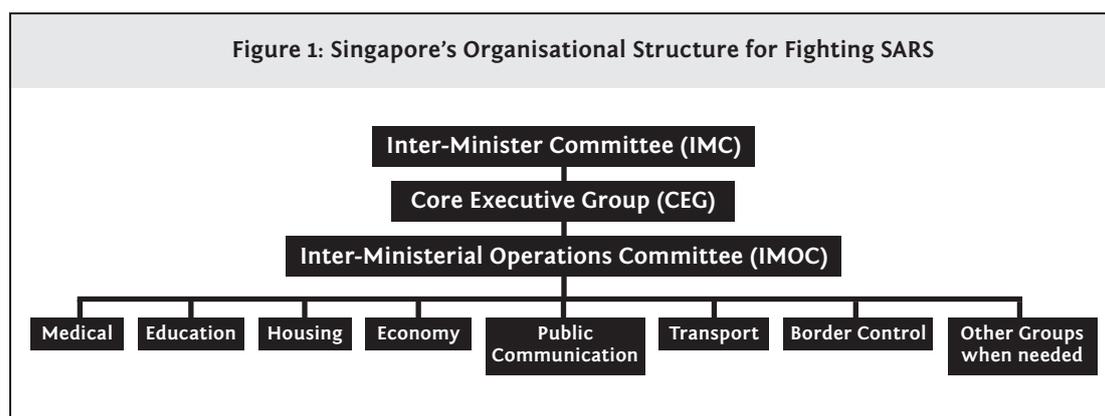
One of the most important lessons the Singapore government learned from the SARS epidemic was the significance of the role of the bureaucracy in crisis management. As it turned out, the bureaucratic structure in place prior to the outbreak in 2003

was wholly inadequate in terms of dealing with a crisis situation that was both fluid and unprecedented (Ansell, Boin, & Keller, 2010; Menon & Goh, 2005; Pereira, 2008); consequently, fighting SARS called for more than a medical approach since resources had to be drawn from a number of government agencies that did not fall under the rubric of the MoH.

On 15 March 2003, when the epidemiological nature of SARS was still unclear, the MoH initiated a SARS taskforce to look into the mysterious strain. Only two days later, after more SARS cases were uncovered and a better epidemiological understanding of the strain was developed, the Singaporean government swiftly declared SARS a notifiable disease under the IDA (Ministry of Health, 2003). In the event of a widespread outbreak, IDA made it legally permissible to enforce mandatory health examination and treatment, exchange of medical information and cooperation between healthcare providers and MoH, and quarantine and isolation of SARS patients (Infectious Disease Act, 2003, chapter 137). On 24 March 2003, the MoH was authorised by the IDA to implement compulsory home quarantine for those who had been exposed to the SARS virus. On 7 April 2003 (approximately five weeks after the first case of SARS was reported), a three-tiered national control structure was created in response to SARS. These tiers were individually represented by the Inter-Ministerial Committee (IMC), the Core Executive Group (CEG), and the Inter-Ministry SARS Operations Committee (IMOC) (Tay & Mui, 2004).

The nine-member IMC³ was chaired by the Minister of Home Affairs (MHA) and fulfilled three major functions: 1) to develop strategic plans, 2) to approve major decisions, and 3) to implement infection countermeasures. Notably, the IMC also played the role of interagency coordinator overseeing the activities of other ministries and their subsidiaries. The CEG was chaired by the Permanent Secretary of Home Affairs and consisted of elements from three other ministries: the MoH, the Ministry of Defence (MoD), and the Ministry of Foreign Affairs (MFA). In particular, the role of the CEG was to manage the SARS epidemic by directing valuable resources to key areas. The IMOC, meanwhile, was seminal in carrying out health control measures issued by the IMC and served as the main operational linkage between the MoH and all healthcare providers (see Figure 1).

³ Besides the Ministries of Home Affairs and Health, the Inter-Ministerial Committee comprised eight more ministries: Foreign Affairs, Defence, Education, National Development, Manpower, Environment, Transport, and Information, Communications and the Arts.

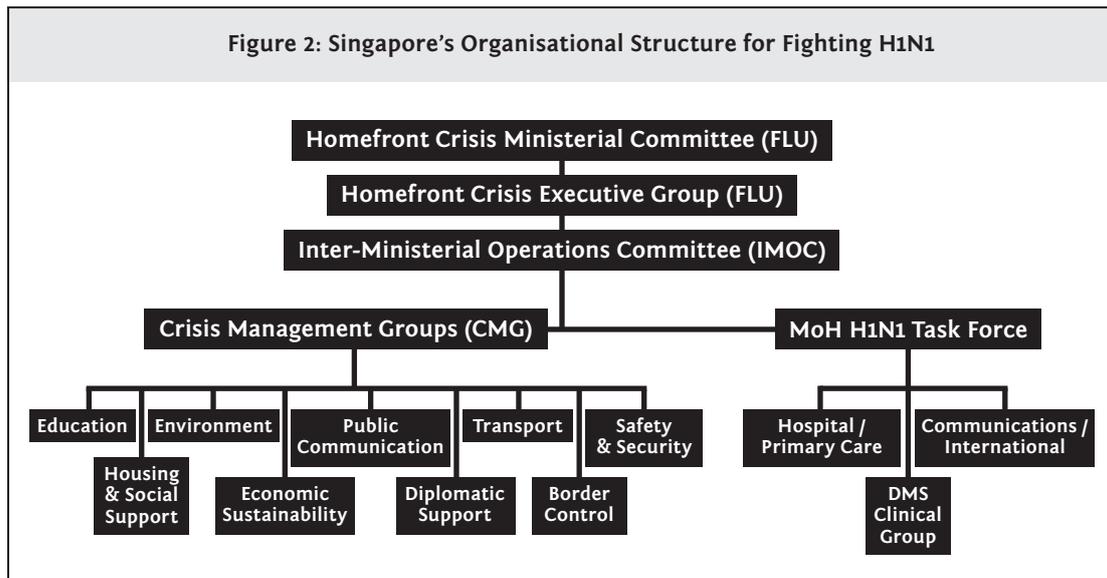


Source: Adapted from Tay & Mui (2004, p. 35)

Following the SARS epidemic, the above command and control structure was revised to adequately reflect the need to create a multi-faceted and robust management approach – one that would be more suited to a fast changing health crisis situation that was both volatile and unheralded. The outcome was the establishment of a Home-front Crisis Management System (HCMS) (Pereira, 2008). Heading this new command and control structure was the Home-front Crisis Ministerial Committee (HCMC). Identical to the IMC, the HCMC served to provide strategic and political directions during health crises. Meanwhile, the functions of the CEG and IMOC were consolidated into the Home-front Crisis Executive Group (HCEG) in order to shorten the time it might take to respond to a health crisis (Pereira, 2008).

During the 2009 H1N1 outbreak, the HCMC for Influenza (HCMC-FLU) was formed and it was supported by the HCEG-FLU (see Figure 2). Various ministries and agencies also formed interagency working groups called Crisis Management Groups (CMGs). Each CMG was in turn headed by a ministry.⁴ Then in each CMG, a senior MOH representative was assigned to bring that ministry's expertise to the group. Unlike during the 2003 SARS outbreak, the 2009 H1N1 outbreak saw the MoH (and not the MHA) taking charge of the fight. Among other notable moves, the MoH established a special taskforce – a joint effort made up of key policy makers, public health practitioners, senior clinicians, and infectious disease specialists – headed by the Permanent Secretary of Health to implement all public health control measures and oversee the provision of medical services (Tay, Ng, Cutter, & James, 2010).

⁴ It is important to point out that during the 2009 H1N1 outbreak various ministries were assigned specific responsibilities such as border screening, vaccination, domestic surveillance, and public education.



Source: Adapted from Tay et al. (2010, p. 316)

The main benefit of this abridged command and control structure was that it dramatically shortened response time and facilitated the implementation of health control measures across various healthcare sectors during the 2009 H1N1 pandemic. Noting this, we now turn our discussion to the ways in which these health control measures were implemented.

Health Control Measures

Case Management

The manner in which SARS cases were managed clearly illustrates the significance of good governance at all levels. In particular, Singapore's command and control structure to combat SARS was modelled after an *All-in-One* approach toward the management of SARS patients. Specifically, all suspected cases of SARS were confined to a single hospital designated by the MoH – Tan Tock Seng Hospital (TTSH) in this case (James et al., 2006; Tan, 2003). This *All-in-One* approach was unique to Singapore and was not found in other SARS-affected countries. Notably, a crucial element of this All-in-One approach to case management was that it required close partnership between three core groups of constituencies: TTSH, the general public, and healthcare

providers (both in public and private practices).

The mechanics of this unique approach can be delineated into three key steps. Firstly, once the government secured full cooperation from TTSH designating it a SARS specific health institution, it made an unambiguous announcement to medical professionals and the general public as to where SARS patients can be treated. In practice, once a suspected SARS patient was detected at a local clinic or emergency department, he or she would be transferred to TTSH immediately for further evaluation and monitoring. Secondly, the government also had to divert non-flu patients away from TTSH so that the sudden surge in the number of flu cases at TTSH would not paralyze its service delivery. As it happened, through the government's relentless public communication and education, this ad hoc measure ended up receiving strong cooperation and support from the general public. Indeed, by seeking medical treatment from other public hospitals for non-flu illnesses, the general public made it possible for TTSH to concentrate its scarce resources on SARS-related cases. Lastly, the government sought the cooperation of other healthcare providers (such as public hospitals and local clinics) so that they would absorb additional cases of non-flu illnesses. There is no doubt that by concentrating all SARS patients in one facility, Singapore's health authority was able to achieve disease containment more rapidly (Centers for Disease Control and Prevention, 2003).

As opposed to the *All-in-One* approach in 2003, the strategy to combat H1N1 in 2009 took the form of a so-called *One-in-All* approach. As its name suggests, this entailed a single all-encompassing strategy to counter H1N1, which was necessary since the characteristic of H1N1 virus was different (Tay et al., 2010). Unlike SARS carriers, H1N1 carriers could be contagious even when they were in the asymptomatic phase of the illness (in other words, not showing any visible signs of illness). To minimise the risk of transmission, MoH imposed *one* standardised infection control measure on *all* healthcare settings (such as primary care clinics, long-term care facilities, and community renal dialysis centres). Given this imperative, the MoH again needed strong compliance from health professionals and the general public. In practice, one triage system was implemented in all frontline settings to streamline the treatment of H1N1 patients. Once patients were laboratory-confirmed to be stricken with H1N1, mandatory isolation orders were issued and quarantine became compulsory. This was in accordance with the IDA, which, it must be pointed out, was amended in a

timely manner to reflect this imperative (Tay et al., 2010). Furthermore, the MoH also established a specific contact tracing centre to track down all laboratory-confirmed cases. This meant that those who came into close contact with H1N1 patients were swiftly tracked down, ordered to undergo mandatory Quarantine Orders (QOs), and were given *Oseltamivir* as a precaution.⁵ However, mandatory isolation in a setting that was external to the traditional healthcare provider did end up raising a wide range of legal, political, and ethical issues that could potentially result in a public backlash at that policy. Indeed, even though the policy of mandatory isolation was arguably quite effective in terms of limiting transmission, such a draconian measure did challenge the public's acceptance of it, especially those who were isolated since that presented an abrupt disruption in their lives and work (Duncanson, 2003). To mitigate such public displeasures, the Singapore government endeavoured to provide the affected a comprehensive livelihood support by enlisting the assistance of non-governmental organisations. At the same time, the population was encouraged to adopt responsible social behaviours (James et al., 2006). We shall discuss this aspect in greater detail in the sections on physical distancing and isolation/quarantine.

Surveillance

Disease surveillance is central to combating pandemics because it can serve three critical functions. Firstly, surveillance helps to identify patterns of disease progression; secondly, it provides advance warning and detection of impending outbreaks; and thirdly, surveillance can even indirectly lower the mortality rate through better understanding of the pandemic on hand (Aledort, Lurie, Wasserman, & Bozzette, 2007; Briand, Mounts, & Chamberland, 2011). At the moment, the surveillance process is predominantly carried out by health authorities at major border-crossings (Ansell, Boin, & Keller, 2010; Briand, Mounts, & Chamberland, 2011; Jebara, 2004; Bhatia & Narain, 2010; WHO, 2009; WHO Writing Group, 2006). Yet, a functional surveillance system must also count on timely and accurate disease identification and reporting. It is also imperative that the surveillance process can be extended beyond border-crossings to that of the community-level and this invariably requires close partner-

⁵ Quarantine orders were served for a period of seven days from the date of last contact with the index case.

ship between the health authorities and healthcare professionals (such as general practitioners at the community level, infectious disease specialists, and laboratory scientists at hospitals).

When SARS first emerged, the nature of the virus was largely unknown (Tan, 2006). As a consequence, health authorities worldwide were mostly ill-equipped to detect suspected cases, let alone monitor them. Similarly, health authorities in Singapore encountered this problem. But with the aid of WHO technical advisors, Singapore managed to establish identification and reporting procedures in a timely manner. Furthermore, the MoH also swiftly expanded on the definitions used by the WHO to identify suspected cases of SARS (to include any healthcare workers with fever and/or respiratory symptoms) in order to widen the surveillance net (Goh et al., 2006; Tan, 2006).

It is important to note that in order to cast a wide surveillance net, the MoH needed the cooperation of various targeted groups, such as healthcare workers with fever, patients with atypical pneumonia, clusters of three or more healthcare workers in the same work area and so forth. As a result, sick leaves of healthcare workers were closely monitored and as the pace of SARS transmission quickened, the Singaporean Parliament even amended the IDA on 24 April 2003, requiring all suspected SARS cases to be reported to the health authority (MoH) within 24 hours from the time of diagnosis (Centers for Disease Control and Prevention, 2003). While these control measures were laudable, SARS also exposed the weakness of the fragmented epidemiological surveillance and healthcare system Singapore had in place at the time (Goh et al., 2006). For example, surveillance of healthcare-associated infections was not fully instituted in all healthcare facilities in Singapore before SARS. As a result, atypical clinical presentation of SARS cases, for example, immunocompromised patients, managed to evade detection by the surveillance net in place at the time (Tan, 2006).

Therefore, when the SARS epidemic was finally put under control, MoH quickly introduced a number of novel surveillance measures to integrate epidemiological data and to identify the emergence of a new virulent strain faster. For example, a rigorous measure of thrice-daily temperature surveillance of all healthcare workers was introduced by MoH in every institution as well as active surveillance for clusters of febrile patients (Goh et al., 2006). Another of MoH's notable innovations was the es-

establishment of an Infectious Disease Alert and Clinical Database system to integrate critical clinical, laboratory, and contact tracing information with a new information technology infrastructure developed to support the surveillance and management of SARS. Drawing heavily on its experience with SARS’s wide-net surveillance, the MoH also introduced an enhanced process that consisted of five major formal operational components – community surveillance, laboratory surveillance, veterinary surveillance, external surveillance and lastly, hospital surveillance (see Table 2). However, it is important to point out that relying exclusively on this formal surveillance system might not be judicious from an operational standpoint. Indeed, in the fight against H1N1, MoH’s external surveillance system did not play a significant role in providing early warning of that outbreak. As it turned out, it was through private partnership with health professionals – an informal global network – that MoH was able to obtain valuable information on H1N1 (Tay et al., 2010). The formal surveillance process in place at the time of the outbreak of H1N1 only fulfilled an ancillary function.

Table 2: Singapore’s Integrative Surveillance System	
TYPE OF SURVEILLANCE	OPERATIONAL COMPONENT
Community surveillance	Community-based reporting of acute respiratory infections
Laboratory surveillance	Laboratory testing of influenza viruses to detect new strains
Veterinary surveillance	Poultry or the wild bird populations
External surveillance	Infectious diseases in the region and globally
Hospital surveillance	Cases of atypical pneumonia, prolonged unexplained fever and sudden death of respiratory infection in all Singapore hospitals

Source: Authors’ Compilation From Various Formal Reports

Physical Distancing

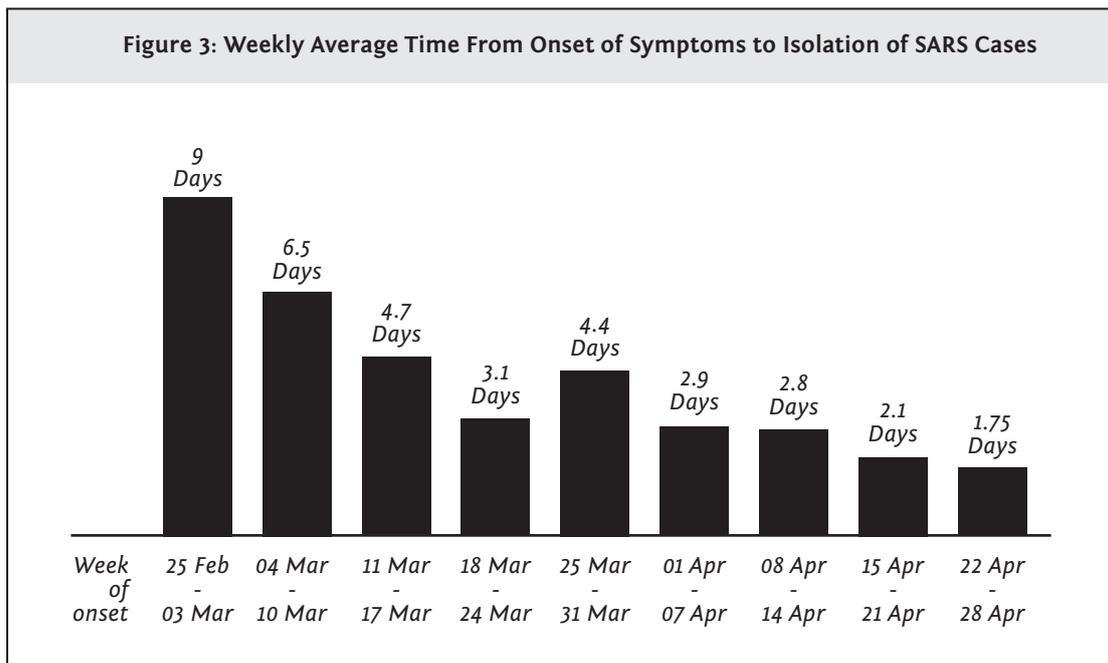
Physical distancing refers to those measures that sought to limit physical contacts at public locations such as workplaces, places of worship, entertainment spots, and schools. Accordingly, MoH advocated the practice of physical distancing during the outbreak of SARS as well as H1N1. The sole intention of physical distancing was of course to limit physical interactions and close contacts in public areas to slow the

rate of disease transmission. During SARS, all kindergartens, after-school centres, primary and secondary schools, and junior colleges were closed for two weeks from 26 March to 6 April 2003. In addition, school children who had stricken siblings were advised to stay home for at least 10 days. Beyond that, students who showed flu-like symptoms or had travelled to other affected countries were automatically granted a seven-day Leave of Absence (Goh et al., 2006). To mitigate the side-effects caused by these disruptions, the Ministry of Education (MoE) instituted a number of home-based learning programmes for those affected. Schools meanwhile were also advised to scale down their extracurricular activities in order to minimise physical contacts. In all, during the outbreak of H1N1, there were 148 class closures (66 at the primary and secondary, 82 in kindergartens) between 28 June and 31 August 2009 (Tay et al., 2010).

During the mitigation period, the MoH also advised businesses within the service sector to adopt physical distancing countermeasures such as split-team arrangements and allowing staff to work from home (Tay et al., 2010). Those who were at higher risk of developing complications if stricken were also removed from frontline work to other areas where they were less likely to contract the viruses. The practice of physical distancing, however, also drew strong criticisms from businesses that suffered economic losses as a result (Duncanson, 2003). It is therefore important to point out that the effectiveness of physical distancing remains controversial and the practice itself relies heavily on the judgement passed by a selected few (see for example, Aledort et al., 2007; Briand, Mounts, & Chamberland, 2006; Gostin, 2006; WHO, 2006). Indeed, few studies have been conducted since the SARS outbreak in 2003 to establish the effectiveness of this control measure. Despite the absence of solid empirical data, the WHO nevertheless established a set of general guidelines for countries that sought to institute physical distancing to follow, and recommended that it should be introduced only in accordance with the severity of the epidemic, risk groups affected, and epidemiology of transmission (WHO, 2005). In other words, physical distancing should only be introduced when it is supplemented by other measures to compensate those who suffered economic losses as a result. Only then will physical distancing, as a public health control measure, receive the broad-based buy-in that is necessary for it to be effective.

Isolation and Quarantine

On 24 March 2003, the MoH invoked the IDA to isolate all those who had been exposed to SARS patients (Ministry of Health, 2003). These “contacts” were quarantined for 10 days either at home or at specific centres and were told to take their body temperatures twice a day. During the quarantine period, contacts who developed a fever (defined as a body temperature higher than 38°C) would automatically be referred to TTSH for further monitoring and investigation. Meanwhile, the MoH also uncovered an old law that granted that ministry the authority to mandate quarantines. As a result, it was able to serve quarantine orders in thousands of suspected cases. Harsh penalties, such as hefty fines of more than USD 4,000 or imprisonment, were imposed on those who defied quarantine orders (“Singapore Imposes”, 2003). In a drastic move reminiscent of a police state, closed circuit cameras were installed in the houses of those ordered to stay home to monitor their compliance with the quarantine order (“Singapore Imposes”, 2003). At the height of SARS, 12,194 suspected cases were ordered to stay home, all of whom were monitored either by cameras or in less severe cases, by telephone calls. Initially, when little was known of the epidemiology of SARS, the average quarantine period for suspected cases was six to eight days. However, as the MoH came to understand the disease better, that was significantly reduced to just one to three days (see Figure 3).



Source: Adapted from Tan (2003)

During the H1N1 pandemic, quarantine and isolation were also mandated as part of the overall containment strategy (Tay et al., 2010). Similar to the approach taken during SARS, patients who demonstrated mild symptoms were ordered by their doctors to stay at home as part of the QO. On the other hand, close contacts of index cases were issued QOs and quickly admitted to public hospitals for isolation. Contacts who were Singaporeans were generally quarantined in their own homes while foreigners were assigned to Government Quarantine Facilities. At the same time, experienced clinicians were elevated to the status of Health Officers under the IDA and given broad authority to issue mandatory isolation orders.

It is important to point out that empirical evidence based on mathematical modelling demonstrated a direct correlation between early quarantine and the number of secondary cases generated in subsequent time periods (Lipsitch et al., 2003). In other words, the sooner an index case was isolated, the fewer subsequent infections could be linked to it. Yet, quarantine, regardless of its effectiveness, received strong criticisms from the general public during the outbreak of SARS and H1N1 due to the invasive nature of that measure (Duncanson, 2003; Menon, 2011). Therefore, it remains an ongoing debate in the public policy realm as to where the balance between the requirement for disease containment and privacy can be struck when quarantine is introduced.

In response to the public complaints, authorities in Singapore provided economic assistance to those individuals and businesses who had been affected by home quarantine orders through a *Home Quarantine Order Allowance Scheme* (Tay & Mui, 2004; Teo, Yeoh, & Ong, 2005). At the same time, the MoH worked together with various ministerial authorities to provide essential social services to those affected by the quarantine order. For example, housing was offered to those who were unable to stay in their own homes (because of the presence of family members) during their quarantine, ambulance services were provided to those undergoing quarantine at home to visit their doctors as well as high-tech communication gadgets (such as webcams) for those undergoing quarantine to stay in touch with relatives and friends.

Healthcare Sector Infection Control Measures

The view that infection control measures implemented in the healthcare sector can

limit the transmission of infectious diseases is widely supported in extant literature on this subject (see for example, Aledort et al., 2007; Jeffries, 1995; Pittet, 2001). Indeed, it is not a matter of dispute that measures that discourage hospital visits in non-essential cases while encouraging better personal hygiene and respiratory etiquette can help to lower the rate of infection. Therefore, to limit the risk of transmission in healthcare institutions, the MoH decided to implement a series of stringent infection countermeasures that called for the cooperation of all healthcare workers (HCWs) and visitors to hospitals during the outbreak of SARS. At the same time, the MoH instructed all HCWs to wear appropriate personal protective equipment⁶ when treating patients. Visitors to public hospitals were also advised not to enter areas where transmission and contraction were most likely. The movements of HCWs in public hospitals were also heavily proscribed during the outbreak. As a result, many physicians and nurses were restricted to working in one specific medical facility at any time (James et al., 2006; Teo, Yeoh, & Ong, 2005). Unfortunately, except for TTSH, these critical measures were not enforced in a number of healthcare sectors until 8 April 2003, and this oversight led to a number of intra-hospital infections (Goh et al., 2006). This oversight taught the MoH an important lesson; consequently, stringent infection control measures were implemented in all healthcare settings during the outbreak of H1N1.

It is important to point out that when H1N1 broke out in 2009, the MoH utilised a combination of *soft* and *hard* tactics to combat that outbreak. As an example, the ministry was *soft-handed* when it simply reminded all healthcare sectors of their social responsibility to limit the transmission of the H1N1 virus (Menon, 2011). It is somewhat unfortunate that this form of moral suasion has been given little emphasis in extant literature even though there is a growing body of evidence which underscores the significance of cooperation between the general populace and the government. Meanwhile, the MoH also introduced *heavy-handed* measures such as restricting the movements of HCWs and visitors to hospitals. Even more drastic than the measure that was taken during the outbreak of SARS in 2003, the movements of HCWs and patients *between* hospitals were restricted during the outbreak of H1N1 in 2009. As a matter of fact, only HCWs who provided essential services were permitted

6 Personal protective equipment includes N95 masks, disposable gloves, gowns, and goggles or visors.

to move freely from one hospital to another. At the same time, patient movement between hospitals was strictly restricted to medical transfers. Moreover, the number of visitors to hospitals was also tightly controlled and their particulars were recorded during each visit (Leo, 2011). Ultimately, it was not a single infection control measure that defeated H1N1 but rather a novel combination of soft-handed and heavy-handed measures that ultimately brought the virulent outbreak under control.

Public Education and Communication

During the SARS and H1N1 outbreaks, the MoH practised a high degree of transparency and forthrightness when it shared information with the general public (Menon, 2011). Information was communicated to the public through every conceivable channel and medium to educate the domestic populace while reassuring the international community. For example, a government information channel dedicated to providing timely updates was created on the same day – 13 March 2003 – when the WHO issued a global alert. A dedicated TV Channel called the SARS Channel⁷ was also launched to broadcast information on the symptoms and transmission mechanisms of the viruses (James et al., 2006). As to reach out to a wider audience, the MoH even advertised epidemic-related information in local newspapers. National TV stations Channel 8 and Channel U even made the rare move of using a range of local dialects such as Hokkien and Teochew to host live call-in SARS forums.⁸ As it happened, the outbreak of SARS prompted the state media in Singapore to permit such broadcasts underscoring the severity of the situation as well as the will of the state. In addition to mass media (for example TV and radio), information pamphlets were distributed to every households in the country via the postal service and the MoH website provided constant updates and health advisories to the general public (Menon, 2011).

Throughout the SARS crisis, a single MoH spokesperson acted as the state's mouthpiece to the media (James et al., 2006). In stark contrast to how the Taiwanese government handled the SARS outbreak – by allowing numerous medical experts and

7 As the health crisis deepened in May 2003, television broadcast competitors *Singapore Press Holdings* (SPH), *Media Corporation of Singapore* (MediaCorp), and StarHub Cable TV joined forces to establish a dedicated SARS Channel, which transmitted from noon to midnight each day.

8 It is noteworthy that Singapore stopped broadcasting TV programs in local dialects since the early 1980s (Menon & Goh, 2005). The temporary reversal of this government policy was the result of initial media criticism that the campaigns needed to be more effectively targeted by reaching out to those people who only understood dialects.

local health professionals to voice their opinions and provide fodder for the local media on a daily basis – the Singaporean government’s strategy of presenting one monolithic voice to the media was indeed sensible and commendable (Ho, 2003). At the same time, the media in Singapore also acted in a sound manner by assuming a social responsible role, which, among others, saw the media establishing a close working partnership with the state to help manage the national crisis.⁹ For instance, the local newspaper, *The Straits Times*, published articles that were largely supportive of the health control measures introduced by the government (Menon & Goh, 2005). In addition to news and articles that supported the state’s actions, news headlines also called on members of the public to change their attitudes and behaviours toward personal hygiene. Unquestionably, these unambiguous messages from the state contributed in no small part towards lowering the risk of public panic. Singapore’s open and responsive risk communication even earned the small nation-state praises from Dr. Osman David Mansoor, a Senior Health Advisor for the UNICEF. Underscoring the efficient and almost mechanical manner in which Singapore had handled the SARS outbreak, Mansoor commented in particular that “if Singapore cannot get it under control, it is going to be very hard to get it under control anywhere else” (Fung, 2003).

It is important to note that during the H1N1 outbreak in 2009, this monolithic strategy of public education was also pursued rigorously. Similar to the strategy adopted during the outbreak of SARS, the MoH worked closely with the media to provide regular and timely updates and health advisories to the general populace (Menon, 2011). The public was educated on how to minimise the risk of contraction and transmission as well as on how to identify symptoms of influenza. Many public and private organisations also displayed prominent signs in front of their building entrances that reminded their staff as well as visitors to be socially responsible. School children were instructed to wash their hands and take their body temperature regularly. The public was told to wear masks and postpone non-essential travels to other countries. Once the H1N1 vaccine became available, the MoH also pushed for the general public to be immunised.¹⁰ However, the vaccination coverage rate in the general public was less than 20 percent, that is lower than the level of herd immu-

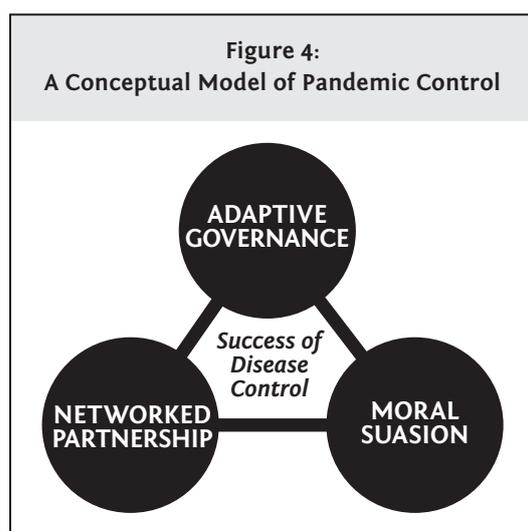
9 Criticisms come in as a self-censored mechanism exists in Singapore’s media coverage. However, the authors argue that the government’s concerted communication serves as a necessary, effective policy instrument to mitigate the public panic at the response stage of fighting pandemics.

10 To be fair, concerns over the vaccines’ safety tempered the general public’s receptiveness toward immunisation.

nity. A survey conducted in November 2009 among Singapore’s healthcare workers (HCWs) revealed fewer than 40 percent of HCWs expressed willingness to receive the H1N1 vaccination. The top two concerns preventing vaccination were “fear of side effects” and “unsure of effectiveness” (Toh et al., 2012). When concerns arose regarding the safety of the vaccines, key politicians and ministers took the lead to assuage such concerns by getting vaccinated themselves (Menon, 2011).

Conceptual Model and Implications for Pandemic Management

The draconian health control measures imposed by authorities in Singapore to defeat SARS and H1N1 have received heavy criticism both from the West and from within Singapore itself (“Singapore Imposes”, 2003; Menon, 2011). Indeed, the use of quarantine orders during the outbreaks is reminiscent of the kind of measures used only by police states. It is conceivable that few countries in the West would have resorted to the use of CCTVs to ensure compliance with home quarantine orders. However, the evidence presented in this paper strongly suggests that such a perspective is incomplete at best. For one, the Singapore government did employ gentler approaches in the form of moral suasion and public-private partnerships to combat SARS and H1N1. Guided by this insight, we hereby delineate a comprehensive model that is better able to capture the essence



Source: Authors' Compilation

of Singapore’s success in combating SARS and H1N1 (see Figure 4). Crucially, this model is composed of three critical components – adaptive governance, networked partnership, and moral suasion – all of which are implicitly or explicitly revealed in the measures that had been discussed so far in this paper. More importantly, this conceptual model offers a valuable framework into the kind of approach needed to combat future pandemics especially in South-East Asia. We will now discuss the significance of each element and its implications.

Adaptive Governance

Adaptive governance, in this context, refers to a clear but flexible command and control structure that can be swiftly adapted to changing circumstances. Among other things, the flexibility endemic to this command and control structure facilitates the building of trust between the state and its people (Lai, 2009). This in turn ensures that government measures are quickly accepted by the general public.

As shown in this paper, the Singapore government practised adaptive governance during the outbreak of SARS and H1N1 by establishing a command and control structure that was able to adapt to rapidly changing circumstances. Indeed, this command and control structure was reorganised swiftly to deal with the uncertainties that stemmed from the outbreaks. When SARS broke out in 2003, the MoH set up a taskforce within that ministry even when the definition of SARS remained unclear. As more SARS cases were uncovered and better epidemiological information became available, the government quickly created the Inter-Ministerial Committee (IMC) and Core Executive Group (CEG) – both of which were instrumental in the design and implementation of all public health control measures – to coordinate the operation to combat the outbreak. While this overarching governance structure is more or less standard worldwide (LaPorte, 2007; 't Hart, Rosenthal, & Kouzmin, 1993), the case of Singapore is unique in that the nation-state was able to overcome bureaucratic inertia and adapt this governance structure to deal with the subsequent outbreak of H1N1 in 2009. Indeed, MoH officials swung into action once they realised that the IMC–CEG structure was inadequate in terms of facilitating close cooperation between various key government agencies to tackle the health crisis on hand (Pereira, 2008). Accordingly, in the post-SARS period, the IMC–CEG structure quickly evolved into an influenza-focused Home-front Crisis Ministerial Committee (HCMC-FLU) and the Home-front Crisis Executive Group (HCEG-FLU). On top of facilitating close inter-agency coordination, the strength of this revamped structure was its ability to ensure swift response to a pandemic outbreak by implementing health control measures more effectively and efficiently.

Singapore's legal framework also played an adaptive role in terms of facilitating a swift response to the outbreak of pandemics. A legacy of Singapore's British colonial past, the Singaporean legislature is well known for passing laws in a swift and ef-

ficient manner. Using the IDA, MoH declared SARS a notifiable disease on 17 March 2003 – a mere two weeks after the first imported case. H1N1 was declared a notifiable disease on 28 April 2009 – just one day after the WHO raised the alert from phase 3 to 4 – even when there were no reported cases of H1N1 in Singapore then. More importantly, Singapore was able to swiftly amend the IDA during the health crises to suit volatile conditions such as when more epidemiological cases were uncovered and the viruses were better understood. In particular, the government amended the IDA on 24 April 2003 requiring all those who had come into contact with SARS patients to remain indoors or report immediately to designate medical institutions for quarantine. Though vitally important, an adaptive governance structure was not the only reason behind the successful defeat of SARS and H1N1 – individual values and the interests of different stakeholders were crucial as well (Teo, Yeoh, & Ong, 2005). This brings us to the second element of our conceptual model: a networked partnership.

Networked Partnership

Combating pandemics requires multiple government agencies and private organisations to work together in close partnership – not unlike that of a network (Lai, 2012; Shalala, 1997; Webby & Webster, 2003). While the health authorities of a country typically lead such efforts, the inclusion of other departments, agencies, and organisations (including non-governmental ones) is necessary and ultimately, inevitable. Indeed, major countermeasures such as public education and surveillance are often made possible with the aid of non-health agencies such as the media and schools. In Singapore, healthcare delivery is carried out through a variety of providers in the public, private, and voluntary welfare organisation sectors. For example, the national vaccination program against H1N1 in 2009 involved not only the MoH but also a number of other ministries such as the MoE, MoD, MFA as well as entities such as the media, public hospitals, and private clinics. Therefore, it is clear that the ability to synergise the capacity of various organisations is central to the fight against infectious diseases (Lai, 2012; Leung & Nicoll, 2010; Voo & Capps, 2010).

In general, every public health control measure introduced by the MoH was well-received by the public for two main reasons: Firstly, the level of trust Singaporeans had for their government was relatively high and support for the party in office was

strong. The general sense was that the government needed *carte blanche* in order to combat the pandemics effectively and this in turn allowed various government agencies and departments to push through a series of draconian measures to contain the outbreaks. Secondly, the government's eagerness to enter into a partnership with various organisations to combat SARS and H1N1 was also a key reason. One dramatic example of this was a joint decision made by both the health and education ministries on 25 March 2003 to close all institutions of learning in Singapore. The decision was not made on medical grounds but because principals and general practitioners have reported that parents continued to be concerned about the risk to their children in schools (Lanard, 2004). Then-education minister Teo Chee Hean assured four groups of stakeholders that they were being heard and taken seriously: principals, general practitioners, parents, and the general public. "The ministers can't do everything the public wants – but the public knows its wishes will be considered," Teo said (Fung, 2003). A shared control with its public not only works for partnership but also for moral suasion.

Moral Suasion

Moral suasion means the use of a persuasion tactic by an authority to influence and pressure but not to force individuals or groups into complicity with a policy (Aimone, 2010; Barrett, 2007). Public education and risk communication are two indispensable components in health crisis management (Reddy et al. 2009; Reynolds & Seeger, 2005). The evidence suggests that draconian government measures, such as quarantine and travel restrictions, are less effective than voluntary measures (such as good personal hygiene and voluntarily wearing of respiratory masks), especially over the long term (Bruine, Fischhoff, Brilliant, & Caruso, 2007). Therefore promoting social responsibility is crucial in terms of slowing the pace of infection through good personal hygiene and respiratory etiquette in all settings (Aledort et al., 2007). This, in large part, has to rely on public education and risk communication. Indeed, getting the right message across to the general public can often be a major challenge, especially when no established and respected organisation can act as the central authority for information collection and dissemination. Hence, it is absolutely necessary to disseminate essential information to the targeted population in a transparent manner.

Moral suasion is best illustrated in the Singaporean government's communication strategy during the outbreak of SARS and H1N1. The lack of knowledge on the epidemiology of SARS and H1N1 at the beginning of the outbreaks inevitably led to public fear and panic. Throughout the pandemic, the Singaporean government relentlessly raised the level of public awareness on social responsibility and personal hygiene. Singapore's approach to manage public fear and panic was through ensuring transparency and building trust (Menon & Goh, 2005). Since earning the trust of the public was not a given, political leaders had to be seen as doing and initiating a series of countermeasures to reassure the public. One good example was demonstrated by Singapore's Senior Minister Lee Kuan Yew who told the media how he never left home without his thermometer while Prime Minister Goh Chok Tong lunched with local media editors at a hotel restaurant to show Singaporeans that it was safe to be in public places ("PM Goh Says", 2003). Goh deliberately used the story of people's sacrifices during SARS to further indicate the type of character that all Singaporeans should embrace:

I believe, however, that Singaporeans are made of sterner stuff. I believe they have fighting spirit. Otherwise, Singapore would have collapsed by now...Take for instance our doctors, nurses and other personnel working to help SARS-infected patients. They have conducted themselves magnificently throughout the crises. They have displayed great resolve, and a noble sense of professional responsibility. They have chosen courage over their fear of SARS...This is the kind of steel in our character that will see Singapore through hard times. We should honour them. (Goh, 2003)

All these stories illustrated to the Singapore public the 'moral virtue' of political leaders setting an example. By showing the people that government leaders practised what they preached, the examples served to 'naturalise' and 'legitimise' the public discourse of 'social responsibility' and 'sacrifice' for all Singaporean citizens.

Conclusion

The world today is more inter-connected than ever before. International travel, transnational trade, and cross-border migration have drastically increased as a consequence of globalisation. In response to these developments, the approach needed to combat a pandemic must also be standardised. Public health control measures such

as case management, surveillance, physical distancing, and school closures require wide-spread support from the general public for them to be effective. Meanwhile, Singapore's experiences with SARS and H1N1 also strongly suggest that a control measure can be effective only when a range of partners and stakeholders (such as government ministries, non-profit organisations, and grass-roots communities) become adequately involved. Unilateral actions are simply insufficient and ineffectual.

This article discussed the health control measures introduced as well as the insights drawn from the Singaporean experience in response to SARS and H1N1. In our study of two public health emergencies, we have shown that there was fairly widespread public support for control measures that other countries were unwilling to adopt (such as social distancing and quarantine order). The two health crises revealed that public compliance is particularly effective and necessary to limit the spread of infectious diseases, especially at the early stage of disease containment. As it turned out, the population's receptiveness to these draconian measures was enhanced to a large extent through moral suasion and networked partnership between the government and the people; indeed, the efficacy of these public health control measures was profoundly related to these two crucial elements. While Singapore may be unique in many aspects, its experience highlighted the critical importance of adaptive governance, networked partnership, and moral suasion in ensuring transparency and public trust when confronting the outbreaks.

Epidemic control in Singapore can therefore lend itself to other countries in the region and beyond: a strong command and control governance structure that imposes clear and transparent orders to shape the crisis mentality of the people. The presence of such a governance structure and the extent to which it is utilised explains and predicts how well an epidemic can be successfully contained. Whether all of these aspects are transferrable elsewhere needs to be assessed in future analysis. Nonetheless, this unique discipline certainly has helped Singapore come out of public health crises on a regular basis.

References

- Aimone, F. (2010). The 1918 Influenza Epidemic in New York City: A Review of Public Health Response. *Public Health Reports, 125*(Suppl 3), 71-79.
- Aledort, J. E., Lurie, N., Wasserman, J., & Bozzette, S. A. (2007). Non-pharmaceutical Public Health Interventions for Pandemic Influenza: an evaluation of the evidence base. *BMC Public Health, 7*, 208. Retrieved 3 April 2012 from <http://www.biomedcentral.com/1471-2458/7/208>
- Ansell, C., Boin, A., & Keller, A. (2010). Managing Transboundary Crises: Identifying the Building Blocks of an Effective Response System. *Journal of Contingencies and Crisis Management, 18*(4), 195-207.
- Barrett, S. (2007). The Smallpox Eradication Game. *Public Choice, 130*(1-2), 179-207.
- Bhatia, R., & Narain, J.P. (2010). The challenge of emerging zoonoses in Asia Pacific. *Asia Pacific Journal of Public Health, 22*(4), 388-394.
- Briand, S., Mounts, A., & Chamberland, M. (2011). Challenges of global surveillance during an influenza pandemic. *Public Health, 125*, 247-256.
- Bruine, de B. W., Fischhoff, B., Brilliant, L., & Caruso, D. (2006). Expert judgments of pandemic risks. *Global Public Health, 1*(2), 1-16.
- Centers for Disease Control and Prevention. (2003, 9 May). Editorial Note to: Y. S. Leo et al., Severe Acute Respiratory Syndrome – Singapore, 2003. *Morbidity and Mortality Weekly Report, 52*(18), 411. Retrieved 8 May 2012 from <http://www.cdc.gov/mmwr/PDF/wk/mm5218.pdf>
- Cutter, J. (2008). Preparing for an influenza pandemic in Singapore. *Annals, Academy of Medicine, Singapore, 37*, 497-503.
- Cutter, J. L., Ang, L. W., Lai, F. Y. L., Subramony, H., Ma, S., & James, L. (2010). Outbreak of pandemic influenza A (H1N1-2009) in Singapore, May to September 2009. *Annals, Academy of Medicine, Singapore, 39*, 273-382.
- Duncanson, J. (2003, 25 April). How Singapore Avoided WHO Advisory. *Toronto Star*. Retrieved 8 May 2012 from <http://www.singapore-window.org/sw03/030425ts.htm>
- Fung, A. (2003, 9 April). SARS: How Singapore outmanaged the others. *Asia Times Online*. Retrieved 8 May 2012 from <http://www.atimes.com/atimes/China/ED09Ad03.html>
- Goh, C. T. (2003, 29 April). Speech by Prime Minister's May Day message 2003. Retrieved 8 May 2012 from [https://gpxsvr3.np.edu.sg/apps5/lib/reference/refenq.nsf/c0ccd7b5848a4643c8256686000eea16/8bafeea05e4180a148256fdb000481f5/\\$FILE/GCTMayDay2003.doc](https://gpxsvr3.np.edu.sg/apps5/lib/reference/refenq.nsf/c0ccd7b5848a4643c8256686000eea16/8bafeea05e4180a148256fdb000481f5/$FILE/GCTMayDay2003.doc)
- Goh, K. T., Cutter, J., Heng, B. H., Ma, S, Koh, B. K. W., Kwok, C., et al. (2006). Epidemiology and Control of SARS in Singapore. *Annals, Academy of Medicine, Singapore, 35*, 301-316.
- Gostin, L. (2006). Public health strategies for pandemic influenza: ethics and the law. *The Journal of the American Medical Association, 295*(14), 1700-1704.
- Ho, K. L. (2003). SARS, Policy-making and Lesson-drawing. In T. Koh, A. Plant, & E. H. Lee (Eds), *The New Global Threat: Severe Acute Respiratory Syndrome and Its Impacts* (pp. 195-206). Singapore: World Scientific Publishing.

't Hart, P., Rosenthal, U. & Kouzmin, A. (1993). Crisis Decision Making: The Centralization Thesis Revisited. *Administration and Society*, 25(1), 12-45.

Infectious Disease Act. (2003). *Singapore Government – Attorney-General's Chambers*. Retrieved 23 April 2012 from <http://statutes.agc.gov.sg/aol/search/display/view.w3p;page=0;query=CompId%3A36018f92-ded1-4567-96aa-4c192da67e58;rec=0>

James, L., Shindo, N., Cutter, J., Ma, S., & Chew, S. K. (2006). Public health measures implemented during the SARS outbreak in Singapore, 2003. *Public Health*, 120, 20-26.

Jeffries, D. J. (1995). Viral hazards to and from health care workers. *Journal Hospital Infection*, 30(Supplement), 140-155.

Lai, A. Y., He, A. J., Tan, T. B., & Phua, K. H. (2009). A Proposed ASEAN Disaster Response, Training and Logistic Centre: Enhancing Regional Governance in Disaster Management. *Transition Studies Reviews*, 16(2), 299-315.

Lai, A. Y. (2009). Shaping the Crisis Perception of Decision Makers and Its Application of Singapore's Voluntary Contribution to Post-Tsunami Reconstruction Efforts. *Journal of Administration and Governance*, 4(2), 1-12.

Lai, A. Y. (2012). Organizational Collaborative Capacity in Fighting Pandemic Crises: A Literature Review from the Public Management Perspective. *Asia-Pacific Journal of Public Health*, 24(1), 1-14.

Lanard, J. (2004). WHO Expert Consultation on Outbreak Communications – Singapore's SARS Outbreak Communications. Retrieved 8 May 2012 from <http://www.psandman.com/articles/sarscomm.htm>

LaPorte, T. R. (2007). Critical Infrastructure in the Face of a Predatory Future: Preparing for Untoward Surprise. *Journal of Contingencies and Crisis Management*, 15(1), 60-64.

Leo, Y. S. (2011). *Pandemic Preparedness and Responses: Lessons from Singapore's Immediate Past Experiences*. Presentation at the International Pandemic Preparedness and Response Conference, Singapore, 18-19 April 2011.

Lipsitch, M., Cohen, T., Cooper, B., Robins, J. M., Ma, S., James, L. et al. (2003). Transmission dynamics and control of severe acute respiratory syndrome. *Science*, 300, 1966-1970.

Leung, G. M., & Nicoll, A. (2010). Reflections on Pandemic (H1N1) 2009 and the International Response. *PLoS Medicine*, 7(10). Retrieved 18 May 2012, from <http://www.plosmedicine.org/article/info%3Adoi%2F10.1371%2Fjournal.pmed.1000346>

Menon, K. U., & Goh, K. T. (2005). Transparency and trust: risk communications and the Singapore experience in managing SARS. *Journal of Communication Management*, 9(4), 375-383.

Menon, K. U. (2011). *Pigs, People and a Pandemic: Communicating Risk in a City-state* (NTS Working Paper Series No. 6). Singapore: RSIS Centre for Non-Traditional Security (NTS) Studies.

Ministry of Health. (2003). Chronology of SARS Events in Singapore. Retrieved 3 April 2012 from <http://www.moh.gov.sg/corp/sars/news/chronology.html>

Ministry of Health. (2009). Outbreak of pandemic influenza A (H1N1-2009) in Singapore, May-September 2009. *Epidemiological News Bulletin*, 35, 39-48.

Pereira, D. (2008). *Crisis Management in the Homefront*. Presentation at Network Government and Homeland Security Workshop, Singapore, 7 January 2008.

Pittet, D. (2001). Improving adherence to hand hygiene practice: a multidisciplinary approach. *Emerging Infectious Disease*, 7(2), 234-240.

PM Goh Says IMH Suspects 99% All SARS Free, Super Good News. (2003, 17 May). *Channel News Asia*. Retrieved 13 May 2012 from <http://www.sgcollect.com/forum/index.php?showtopic=4914>

Reddy, M. C., Paul, S. A., Abraham, J., McNeese, M., DeFitch, C., & Yen, J. (2009). Challenges to Effective Crisis Management: Using Information and Communication Technologies to Coordinate Emergency Medical Services and Emergency Department Teams. *International Journal of Medical Informatics*, 78, 259-269.

Reynolds, B., & Seeger, M. W. (2005). Crisis and Emergency Risk Communication as an Integrative Model. *Journal of Health Communication*, 10, 43-55.

Singapore Imposes Quarantine to Stop SARS Spreading. (2003, 25 March). *ABC News Online*. Retrieved 8 May 2012 from <http://www.abc.net.au/news/2003-03-25/singapore-imposes-quarantine-to-stop-sars-spreading/1823362>

Shalala, D. E. (1998). Collaboration in the Fight against Infectious Diseases. *Emerging Infectious Diseases*, 4(3), 355-358.

Tan, C. C. (2003). *National Responses to SARS: Singapore*. Presentation at WHO Global Conference on Severe Acute Respiratory Syndrome (SARS), 17-18 June 2003. Retrieved 24 April 2012 from http://www.who.int/csr/sars/conference/june_2003/materials/presentations/sarssingapore170603.pdf

Tan, C. C. (2006). SARS in Singapore – key lessons from an epidemic. *Annals, Academy of Medicine, Singapore*, 35, 345-349.

Tay, J., Ng, Y. F., Cutter, J., & James, L. (2010). Influenza A (H1N1-2009) Pandemic in Singapore – Public Health Control Measures Implemented and Lessons Learnt. *Annals, Academy of Medicine, Singapore*, 39, 313-324.

Tay, C. B., & Mui, W. K. (2004). *An Architecture for Network Centric Operations in Unconventional Crisis: Lessons Learnt from Singapore's SARS Experience*. Thesis of Naval Postgraduate School, California, USA.

Teo, P., Yeoh, B. S. A., & Ong, S. N. (2005). SARS in Singapore: surveillance strategies in a globalizing city. *Health Policy*, 72(3), 279-291.

Toh, M. P. H., Kannan, P., Chen, Y., Chng, F. L. C., & Tang, W. E. (2012). Healthcare Workers and H1N1 Vaccination: Does Having a Chronic Disease Make a Difference? *Vaccine*, 30(6), 1064-1070.

Voo, T. C., & Capps, B. (2010). Influenza Pandemic and the Duties of Healthcare Professionals. *Singapore Medical Journal*, 51(4), 275-281.

Webby, R. J., & Webster, R. G. (2003). Are We Ready for Pandemic Influenza? *Science*, 302, 1519-1522

World Health Organization. (2003). Summary of probable SARS cases with onset of illness from; 1 November 2002 to 31 July 2003 (based on data as of the 31 December; 2003). Retrieved 3 April 2012 from http://www.who.int/csr/sars/country/table2004_04_21/en/index.html

World Health Organization. (2005). *WHO guidelines on the use of vaccines and antivirals during influenza pandemics*. Geneva, Switzerland: World Health Organization. Retrieved 23 March 2012 from http://www.who.int/csr/resources/publications/influenza/11_29_01_A.pdf

World Health Organization. (2009). *Global Outbreak Alert & Response Network' Global alert and response*. Retrieved 1 April 2012 from <http://www.who.int/csr/outbreaknetwork/en/>

World Health Organization Writing Group. (2006). Nonpharmaceutical interventions for pandemic flu. *Emerging Infectious Disease*, 12(1), 81-87.

Yeoh, E. L. (2003, 9 April). Singapore Woman Linked to 100 SARS Cases. *Associated Press*. Retrieved 13 May 2012 from <http://www.ph.ucla.edu/epi/bioter/singaporewomanSARS.html>