

# Controlling SARS: a review on China's response compared with other SARS-affected countries

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## Summary

**OBJECTIVE** To summarise the major control measures implemented by severe acute respiratory syndrome (SARS)-affected countries and to compare distinctive features of the Chinese approach to other affected Asian countries and Canada.

**METHOD** Literature review.

**RESULTS** The realisation in March 2003 that SARS was spreading led affected countries to introduce measures such as rapid dissemination of information, early case detection and isolation, tracing and quarantining of SARS contacts, traveller screening, raising public awareness of risk and institution of stricter infection control in health care settings. SARS became a notifiable disease in China in mid-April 2003, after which introduction of efficient nationwide control measures led to containment within 2 months. Countries differed in the timeliness of implementing control measures, the mode and extent to which these were enforced and in the resources available to do so.

**CONCLUSION** SARS challenged the political and public health systems of all affected countries. It demanded rapid and decisive action to be taken, yet the comparison shows how difficult this was for an unknown new disease. Guangdong reacted rapidly but this pace was not continued by China for some time, which facilitated national and international spread. Once the Chinese government changed its policy, it developed an impressive control strategy involving the public which culminated in containment. The significance of timely information was perhaps the main lesson which the SARS epidemic taught.

**keywords** severe acute respiratory syndrome in China, severe acute respiratory syndrome, pandemic control measures, severe acute respiratory syndrome containment, response to severe acute respiratory syndrome

## Introduction

Newly emerging infectious diseases can disrupt public health systems, national economies and social life with wide-ranging consequences. Severe acute respiratory syndrome (SARS) was such a new disease caused by a previously unknown coronavirus sub-type which crossed the species barrier with subsequent human-to-human transmission.

Retrospectively, the atypical pneumonia cases which appeared in the southern Chinese Province of Guangdong in mid-November 2002 marked the beginning of the SARS epidemic (WHO 2003a). The Guangdong health authority officially informed about this outbreak on 11 February 2003. The first atypical pneumonia cases outside China were reported to WHO on 3 March from Hanoi, Vietnam (Whaley & Mansoor 2006), followed by similar reports from Hong Kong on 11 March (Tomlinson & Cockram

2003) and from Canada, Singapore and Taiwan on 14 March (Merianos *et al.* 2005). In Beijing, the outbreak began around 5 March (2nd March according to WHO), with the importation of several cases and subsequent spread in health care facilities (Pang *et al.* 2003). By 11 July, 8437 cases and 813 deaths were reported from 32 countries (WHO 2003e); these figures were later corrected to ultimately 8096 SARS cases and 774 deaths in 29 countries and areas between November 2002 and July 2003 (WHO 2003b). More than 95% of cases occurred in 12 countries of the Western Pacific Region with mainland China being the worst affected (WHO 2003c). A comprehensive analysis of the Chinese SARS database led to some duplicate cases being removed and other new cases being added so that mainland China ultimately counted a total of 5327 probable SARS cases (Feng *et al.* 2009). Beijing had the largest outbreak, harbouring nearly 50% of China's SARS cases (Pang *et al.* 2003).

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As the new contagious respiratory disease SARS began to spread outside China in 2003, national governments, public health authorities and international organisations began recommending and introducing measures to contain the outbreak. In response to the hospital clusters and the realisation that SARS had spread via air travel, WHO issued global alerts on 12 and 15 March 2003, providing case definitions based on clinical signs and symptoms, recommending isolation and barrier nursing of suspect cases and reporting such cases to national authorities (Heymann 2005). For a new rapidly spreading disease that did not respond to the classic antiviral therapies and for which no vaccines were available, traditional public health interventions, such as early case detection, case isolation, tracing and quarantine of contacts, strict infection control, decreasing social interaction and keeping the public informed were the only options available (Bell and WHO Working Group on Prevention of International and Community Transmission of SARS 2004). In less than 4 months on 5 July 2003, WHO announced the interruption of human-to-human SARS transmission (Merianos *et al.* 2005).

The risk of infectious diseases recurring and spreading is high, especially in today's interconnected world, and requires national and international public health authorities to take rapid and decisive steps towards containment. SARS control measures were implemented by affected countries, both in response to WHO recommendations and as considered appropriate and feasible by the national governments (Bell and WHO Working Group on Prevention of International and Community Transmission of SARS 2004), yet the countries differed in their outbreak management strategies and the speed with which the epidemic was contained. For this review, a comparative approach was chosen owing to China's unique situation, as it was the first and most severely affected country where SARS emerged, and it showed an initial reluctance to deal openly with the situation. This review summarises and compares the major control measures implemented in mainland China, to those in Singapore, Vietnam, Hong Kong (SAR), Taiwan (RoC) and Canada and thereby aims to highlight distinctive features of the Chinese approach. The lessons could help policy makers to modify outbreak management strategies for a better preparedness and earlier response in future.

### Methods

A comprehensive literature search formed the basis for this review on the SARS intervention measures applied by the most affected countries. Countries included in the analysis were selected from the WHO list 'summary of probable

SARS cases with onset of illness from 1 November 2002 to 31 July 2003' (WHO 2003b). For this review, only countries listed in Table 1, which experienced local SARS transmission within the country and reported more than 15 cases, were chosen. Using this strategy, six countries/areas, which together harboured 98% of the world SARS cases, were identified.

A list of control categories covering the major SARS control measures was developed by reviewing SARS reports: organisational and administrative measures, case detection and contact tracing, quarantine, hospital containment measures, community containment measures, travel-related measures, guidance and information to the public.

For the literature review, the online database Pubmed and the general Google search instrument were used to identify studies and reviews published in English up to December 2006. Search terms included 'SARS control measures', 'SARS containment measures', 'public health measures and SARS' and 'response to SARS' along with the name of the respective country. In addition, official websites of the Ministries or Departments of Health, Public Health Agency and the Centres for Disease Control of the respective countries were searched for documents on SARS chronology, SARS control policies and directives, SARS fact sheets and guidelines related to the SARS control measures implemented. Information provided by the WHO and the US CDC websites and textbooks served as additional sources of information. Personal communication with experts in Vietnam and China helped to identify additional published literature. The reference lists of retrieved articles and abstract books of international workshops served as additional sources of information.

To analyse the sequence and the differences in China's approach to control SARS in comparison to the other countries, information on China's political decision making structure was extracted from workshop summaries, books and reports published in English (Rothstein *et al.*

**Table 1** Countries selected for comparison of SARS control measures (WHO 2003b)

| Countries with local SARS transmission                 | Number of SARS cases reported |
|--|-------------------------------|
| China mainland   | 5327                          |
| Hong Kong, special administrative region (SAR) – China | 1755                          |
| Taiwan, Republic of China (RoC)                        | 346                           |
| Canada   | 251                           |
| Singapore  | 238                           |
| Vietnam  | 63                            |

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2003; Abraham 2004; Huang 2004) and the results discussed in this context.

**Results**

Intensive national and international efforts and the relentless use of public health interventions contained the SARS epidemic. The following seven control categories represent the major areas where containment efforts were concentrated.

**Organisational and administrative measures**

The realisation that a new infectious disease was spreading led health ministries of all reviewed countries to set up SARS task forces at central and regional level by mid-March 2003 for coordinating surveillance, response and communication activities. In China, a 'SARS control and prevention headquarter' to co-ordinate the national SARS control efforts was set up on 23 April. Earlier, on 6 April a 'Beijing Joint SARS Group' comprising of 10 task forces was established to manage the SARS outbreak in Beijing (Liang *et al.* 2004; Pang *et al.* 2003).

**Mandatory notification**

All countries made legislative amendments in their infectious disease acts making SARS a notifiable disease. In Vietnam, Singapore, Hong Kong, Taiwan and Canada, SARS became a notifiable disease by the end of March and they all reported cases to the WHO as they were identified (Table 2). In China's Guangong Province, case reporting of atypical pneumonia cases using a standard case definition and reporting form was already mandatory from 3 February 2003. All hospitals had to report the cases to the local centre for disease control, which in turn reported it to the provincial centre (Xu *et al.* 2004). The Chinese Ministry of Health (MOH) approved the listing of SARS as an infectious disease on 8 April. This action was the legal authority for health departments to institute the rules of the 'Prevention and Treatment Law', for example, quarantine, isolation, etc., to control spread (Rothstein *et al.* 2003). Hereafter, health authorities from all provinces were required to daily collect and report all probable SARS cases and deaths using a standardised case report form (Pang *et al.* 2003). To ensure complete reporting, a 'zero reporting' system was adopted, i.e. all hospitals had to report even if they had no SARS cases (Shan 2003). Violating reporting rules or concealing information was punishable under the law (Rothstein *et al.* 2003).

Complete reporting of cases from China to WHO on a regular basis started around 20 April (Balasegaram & Schnur 2006).

**Case detection and contact tracing**

Early case detection followed by rapid and effective isolation was a key measure to control SARS spread (Bell and WHO Working Group on Prevention of International and Community Transmission of SARS 2004). All countries affected by local SARS transmission instituted various intensive case finding activities, which began with alerting health care providers and providing a case definition and diagnostic protocols. Singapore, Canada, Vietnam and Taiwan alerted hospitals and other concerned authorities after WHO's global alert on 15 March. Hong Kong had already alerted hospitals in February about a severe community acquired form of pneumonia (SARS 2003). China CDC first officially issued information on SARS prevention and treatment to hospitals on a nationwide scale on 3 April (Huang 2004).

A report giving a first case description for the disease named 'atypical pneumonia' or *feidian* in Chinese with symptoms and treatment options was developed and distributed by the end of January 2003 in Guangdong hospitals (Abraham 2004). On 15 March, WHO named the new disease SARS and formulated a case definition based on clinical signs and symptoms and a history of contact or travel to a SARS affected area. This case definition, which closely resembled the Guangdong definition, was used by most countries but often in a modified version. Singapore, for example, expanded on the WHO's case definition and adopted a 'wide-net' surveillance policy to detect cases with atypical presentations early (Tan 2006). In China, initially having close contact with a SARS case or having infected another person was essential for the diagnosis, later a history of stay or travel to an area with SARS transmission (e.g. Beijing) or contact with a health care facility was sufficient (Wu *et al.* 2004). In Canada's case definition Toronto was not included in the list of affected areas, only contact to a health care setting (Health Canada 2003a).

**Contact tracing**

All reviewed countries started epidemiologic investigation of probable and suspect cases as soon as possible (Table 2), by interviewing cases for exposure, travel and contact history, followed by active contact tracing of close contacts. Guangdong had developed a meticulous contact tracing system in early February, requiring a standard questionnaire to be completed within 24 h of reporting

**Table 2** Summary of the main SARS control measures implemented in the reviewed countries/regions, by date of onset (if available)

| Milestones in the control of SARS  |  | China mainland<br>(Beijing & other (Guangdong Province)†††) |                  |                             |                             |                                  |                                  | Hong Kong (SAR)*                 | Singapore†                       | Taiwan (RoC)‡              | Vietnam§                   | Canada¶                     |
|--|--|---|------------------|-----------------------------|-----------------------------|----------------------------------|----------------------------------|----------------------------------|----------------------------------|----------------------------|----------------------------|-----------------------------|
| Control measures   |  |   |                  |                             |                             |                                  |                                  |                                  |                                  |                            |                            |                             |
| Date of SARS onset†††  |  | 2 March 2003  | 16 November 2002 | 15 February 2003            | 25 February 2003            | 25 February 2003                 | 25 February 2003                 | 25 February 2003                 | 25 February 2003                 | 23 February 2003           | 23 February 2003           | 23 February 2003            |
| Removed from WHO list of areas with recent local transmission§             |  | 18 June 2003  | 7 June 2003      | 22 June 2003                | 31 May 2003                 | 5 July 2003 (outbreak contained) | 5 July 2003 (outbreak contained) | 5 July 2003 (outbreak contained) | 5 July 2003 (outbreak contained) | 27 April 2003              | 27 April 2003              | 2 July 2003                 |
| Start of mandatory SARS notification                                       |  | 8 April 2003  | 3 February 2003  | 27 March 2003               | 17 March 2003               | 28 March 2003                    | 28 March 2003                    | 28 March 2003                    | 28 March 2003                    | 3 March 2003               | 3 March 2003               | 25 March 2003               |
| Mandatory quarantine for SARS  |  | Y   | Y                | Y                           | Y                           | Y                                | Y                                | Y                                | Y                                | Y                          | Y                          | Y                           |
| Regular SARS case reporting to the WHO                                     |  | Approximately 20 April 2003                                 | NA               | Approximately 11 March 2003 | Approximately 14 March 2003 | Approximately 14 March 2003      | Approximately 14 March 2003      | Approximately 14 March 2003      | Approximately 14 March 2003      | Approximately 3 March 2003 | Approximately 3 March 2003 | Approximately 14 March 2003 |
| Epidemiologic investigation of SARS cases and active close contact tracing |  | Y   | Y                | Y                           | Y                           | Y                                | Y                                | Y                                | Y                                | Y                          | Y                          | Y                           |
| Dissemination of case definition as per WHO or modified version            |  | Y   | Y                | Y                           | Y                           | Y                                | Y                                | Y                                | Y                                | Y                          | Y                          | Y                           |
| Home quarantine of close contacts of probable SARS cases 10-14 days        |  | 21 April 2003   | 27 March 2003    | 10 April 2003               | 24 March 2003               | 18 March 2003                    | 18 March 2003                    | 18 March 2003                    | 18 March 2003                    | Y                          | Y                          | 24 March 2003               |
| Collective quarantine in groups/Institutions                               |  | Y   | Y                | Y                           | Y                           | Y                                | Y                                | Y                                | Y                                | Y                          | Y                          | N                           |
| Isolation of probable SARS cases   |  | Y   | Y                | 11 March 2003               | 6 March 2003                | 15 March 2003                    | 15 March 2003                    | 15 March 2003                    | 15 March 2003                    | 5 March 2003               | 5 March 2003               | 13 March 2003               |
| Isolation of suspect cases   |  | Y   | Y                | Y                           | Y                           | Y                                | Y                                | Y                                | Y                                | Y                          | Y                          | Y                           |
| Designated SARS hospitals  |  | Y   | Y                | Y                           | Y                           | Y                                | Y                                | Y                                | Y                                | Y                          | Y                          | Y                           |
| Infection control guidelines for hospitals & HCWs                          |  | Y   | Y                | Y                           | Y                           | Y                                | Y                                | Y                                | Y                                | Y                          | Y                          | Y                           |
| Triage facilities/fever clinics  |  | Y   | Y                | Y                           | Y                           | Y                                | Y                                | Y                                | Y                                | Y                          | Y                          | Y                           |
| Travel advice and exit screening   |  | Y   | Y                | Y                           | Y                           | Y                                | Y                                | Y                                | Y                                | Y                          | Y                          | Y                           |
| Official public information on SARS & prevention                           |  | Y   | Y                | Y                           | Y                           | Y                                | Y                                | Y                                | Y                                | Y                          | Y                          | Y                           |

Y, yes; N, no; blank, information was not available; NA, not applicable.

\*Data from SARS (2003), Tsang and Lam (2003), Whaley and Mansoor (2006).

†Data from Tan (2005, 2006), Goh *et al.* (2006).‡Data from CDC Taiwan (2003), Maloney *et al.* (2006).

§Data from Thuong (2003), Pascale and Cheng (2006).

¶Data from Health Canada (2003b), Varia *et al.* (2003), Svoboda *et al.* (2004).\*\*Data from Pang *et al.* (2003), Liang *et al.* (2004), Balasegaram and Schnur (2006).††Data from Xu *et al.* (2004).

†††Data from WHO (2003b).

§§Data from WHO (2003d) (Country was removed from WHO list 20 days after the last reported case was isolated or died).

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(Xu *et al.* 2004). Hong Kong had initiated contact tracing activities in late February for cases of atypical pneumonia (SARS 2003), followed by Singapore, Taiwan, Vietnam and Canada in March. Singapore for example made intensive efforts to locate contacts within 24 h of case notification, set up a contact tracing centre with up to 140 employees, involved the armed forces in contact tracing and set up a contact database accessible to all hospitals (Tan 2006). In Beijing, the district CDC staff started interviewing cases from 9 April about potential close contacts during the 2 weeks prior to symptom onset. This data was collected in a district close contact databases (Pang *et al.* 2003).

### Quarantine

Mandatory quarantine of close contacts was instituted in all reviewed countries experiencing local SARS transmission, only the extent differed. Generally, a 10- to 14-day home quarantine of close contacts of probable and suspect SARS cases was instituted. While Singapore placed contacts of SARS cases under home quarantine from the start (24 March) (James *et al.* 2006), Hong Kong initially placed contacts under medical surveillance asking them to visit a designated medical centre for 10 days (Tsang & Lam 2003). China quarantined close contacts from 21 April. Of the 30 000 contacts quarantined in Beijing, 60% were quarantined individually (Pang *et al.* 2003). In addition to home quarantine, people in Taiwan, Vietnam, Hong Kong (SAR) and China were also quarantined in groups, e.g. in hospitals, government housing, hotels, holiday camps, etc. Beijing among others within the provisions of the 'Treatment and Prevention Law' instituted collective quarantine for 12 000 people by completely sealing off hospitals, construction sites, residential buildings and universities. In some rural areas in China, entire villages were cordoned off, e.g. in Hebei Province (Rothstein *et al.* 2003; Balasegaram & Schnur 2006).

### Travel-related measures

A large variety of travel-related measures were introduced by the affected countries themselves and also in response to WHO recommendations to detect SARS cases among domestic and international travellers and hence prevent them from travelling within or leaving the country or isolate them immediately on entry. Fear of getting infected also led to a substantial reduction in travel volume.

Health alert notices informing about the signs and symptoms of SARS, and where to seek help were provided to travellers by all reviewed countries (Bell and WHO Working Group on Prevention of International and Com-

munity Transmission of SARS 2004). From 27 March, WHO recommended countries experiencing local SARS transmission to screen departing passengers, which included asking them questions and checking their temperature. All reviewed countries required arriving and departing passengers to submit health declaration cards certifying that they were free of SARS symptoms and had no contact to SARS cases (Bell and WHO Working Group on Prevention of International and Community Transmission of SARS 2004). Millions of domestic and international travellers entering or leaving affected areas via different routes were subjected to thermal scanning using infrared scanners. Beijing for instance from late April onwards screened people travelling within the country by air, rail, bus, ferry, etc., and also set up checkpoints at all 71 roads connecting Beijing to other areas (Pang *et al.* 2003; Balasegaram & Schnur 2006). Travel was also restricted to and from quarantined villages in China (Rothstein *et al.* 2003).

### Hospital containment measures

Hospitals acted as major sites for transmission and multiplication of SARS cases. In Singapore and Canada, more than two thirds of cases were hospital acquired (Svoboda *et al.* 2004; Tan 2006).

All countries isolated probable and suspect SARS cases, either in a designated hospitals, as was the case in Singapore (Goh *et al.* 2006) and Vietnam (Brudon & Cheng 2006) or as in China, Taiwan and Hong Kong who initially designated hospital units and later entire hospitals for isolation of SARS cases. Canada initially required all hospitals to be prepared for isolating and treating SARS cases, yet in the later phase four hospitals in Toronto were designated for SARS cases. (Health Canada 2003b). Guangdong began isolating cases from the beginning of February 2003 (Xu *et al.* 2004). Beijing started isolating cases in late April and from 8 May admitted suspect and probable cases in separate hospitals (Pang *et al.* 2003).

Countries with local transmission generally established separate triage facilities, for example, at hospitals to screen and separate symptomatic patients at the first point of presentation. Patients identified through triage were isolated or placed under observation. Taiwan (CDC Taiwan 2003) and Beijing had set up more than 100 fever clinics yet Beijing had to close many on account of SARS amplification at these facilities (Pang *et al.* 2003).

All reviewed countries developed detailed infection control guidelines both for the hospital setup and for health care workers (HCWs) and conducted special infection control training courses for their HCWs. Singapore, Taiwan, Vietnam and Canada had hospital infection

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control teams, which monitored the infection control practice in hospitals and the proper use of personal protective equipment (PPE) by HCWs. Many countries faced acute shortage of masks and other protective equipment, even in Singapore PPE resources became stretched (Tan 2005).

Toronto experienced a resurgence of the SARS outbreak in May after downgrading barrier precautions and relaxing visiting restrictions, which resulted in unrecognised nosocomial transmission. Reinstating infection control, contact tracing and active surveillance in hospitals controlled the second outbreak (Loutfy *et al.* 2004; Svoboda *et al.* 2004).

Additional measures to prevent the transmission of SARS outside hospitals included the restriction of HCWs to work at one health care institution only and stay under work or home quarantine. Visiting SARS patients in hospitals was restricted in all studied countries. Singapore, Taiwan and Canada had hospital discharge guidelines requiring convalescent patients to observe home quarantine. In Hong Kong, elderly home residents had been infected with SARS (Tsang 2005); hence some countries issued special guidelines for this vulnerable group. HCWs were also asked to employ a high index of suspicion when dealing with immuno-compromised or chronic patients because of their often atypical presentations.

**Community containment measures**

Community containment measures aimed at limiting social interaction and movement of people. China, Hong Kong and Singapore closed schools for a couple of weeks, even in Toronto-Canada some schools were closed and students placed under home quarantine. Beijing from 26 April closed >3500 public places such as libraries, cinemas, bars, indoor sports complexes, etc. By late April, China made a unique move, to mobilise its rural and urban population in a 'People's War' against SARS and developed a people's surveillance system where family members, neighbours, etc., monitored each other to ensure that SARS cases were identified quickly (Balasegaram & Schnur 2006). Additional measures to enhance early detection of cases in the community and to reassure the public included public temperature screening, for example, before entering schools, public buildings, offices, hospitals, etc. In Taiwan, people were asked to wear masks in closed public places (Maloney *et al.* 2006).

**Guidance and information to the public**

Affected countries held official press conferences and issued press releases to inform their public and different stake-

holders about SARS, the status of the outbreak within and outside the country, about the risk factors and preventive measures and about government actions to counter the epidemic. Some countries did so as soon as information became available while others like China (Balasegaram & Schur 2006) or Taiwan (Maloney *et al.* 2006) initially tried to restrict the flow of information to the public.

Various means of communication including electronic media, print media, the internet, telephone hotlines, advertisements, roving exhibitions, etc., were used. All reviewed countries broadcasted special educational programmes on television; Singapore dedicated a TV channel solely for informing about SARS.

The ministries of health of most countries set up telephone hotlines for public enquiry. In addition, Hong Kong authorities held roving exhibitions at shopping malls, railway stations and health centres, arranged health talks at schools and conducted mass public health education campaigns using posters, pamphlets, exhibition boards, etc., to inform the public (SARS 2003).

In China, with the listing of SARS as a notifiable disease on 8 April, openly communicating and informing the public was officially authorised (Rothstein *et al.* 2003). After mid-April, once China officially declared a 'People's War' against SARS, a huge propaganda machinery was activated to inform the public. Daily press conferences by the government, SARS educational programmes, folk songs, banners, advertisements on buses, etc., were some of the means used to inform and motivate the people to protect themselves and fight against SARS (Balasegaram & Schnur 2006).

Table 2 summarises the date of SARS onset and the main control measures implemented by the reviewed countries. It shows that while the measures applied in mainland China were generally similar to those applied in the other countries yet they were initiated at a later stage. The table also shows that Guangdong province, which was the first affected region in the world in contrast to the rest of China, reacted earlier.

**Discussion**

The 21st century science and communication systems helped in rapidly identifying the SARS virus and providing continuously updated information, yet it was the 19th century public health tools of case detection and isolation, contact tracing, quarantine and infection control which resulted in the successful containment of SARS. The control measures implemented by the countries closely resembled each other and were generally in line with the WHO recommendations. However, differences among the countries were seen in the timeliness of implementation

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and in the mode and extent to which individual countries went to apply or enforce control measures.

When comparing China's response to that of other SARS affected regions, it should be kept in mind that China is a huge and densely populated country. It was the first country to be affected, and hence could not build its response on past experiences. In addition, China's political and legal structure and the division of authority within this structure are very different from the other countries. China's outbreak management strategy had some notable features which distinguished it from the other affected countries: (i) time chosen to publicise the outbreak; (ii) collaboration with WHO and other nations; (iii) vigour with which control measures were implemented and (iv) public participation in containment.

Severe acute respiratory syndrome became a notifiable disease in all reviewed countries by the end of March except for China (Table 2). This has to be understood in the light of their complex political decision making structure and disjointed bureaucracy at the lower level (Huang 2004). China had a decentralised system of disease surveillance and cases were reported to higher authorities only after full investigation of the source by the local health authorities (Balasegaram & Schnur 2006). In addition, lower-level government officials feared reprimand or being bypassed for promotion, on account of inefficiency and hence also hampered or distorted the upward flow of information. An additional communication gap arose because of the large number of cases, which were received by the Beijing military hospitals and initially not reported to the state medical system (Huang 2004). This resulted in a delayed and limited flow of information to the provincial and central level health authorities giving rise to a distorted picture consequentially delaying policy decisions.

China has an oligarchic political structure with authority distributed among four institutions. According to the 1996 Implementing Regulations on the State Secrets Law, the decision of publicly announcing an infectious disease outbreak lies within the authority of the Chinese MOH and is not to be openly disclosed until that time. Therefore, anyone who reports about such an occurrence without prior permission is liable to persecution, which partially explains why Guangdong could not share their information with other provincial health authorities (Huang 2004). The MOH's decision to finally list SARS as an infectious disease on 8 April opened the way for implementing the provisions provided in the 'Law on Prevention and Treatment of Infectious Diseases' at all levels and hence marked the turnaround in China's SARS control policy. This included instituting measures such as accurate case reporting, imposing sanctions for non-reporting, institution of quarantine and isolation, initiating open communication at all

levels, etc. (Rothstein *et al.* 2003). Establishing a system where the central and local authorities are well connected and each level has its predefined responsibilities could avert such delays. The Chinese public health emergency regulations now require the immediate setting up of an emergency task force after a health crisis is identified, in addition cases can be reported directly to China CDC and MOH by the local level through internet based reporting (Huang 2004).

The WHO along with its 'Global Outbreak Alert and Response Network' played a major role in coordinating the global response to SARS and assisting affected and at risk countries. (WHO 2003c). All affected countries collaborated with and regularly updated the WHO on the SARS situation after they became aware of the atypical pneumonia cases or latest after WHO issued its global alert (Table 2), with the exception of China, which started regular case reporting in late April. The WHO's request for sending an expert team to China for investigation, after the Guangdong outbreak in February, was approved with delay on 2 April (Balasegaram & Schnur 2006). The treatment and control guidelines developed and implemented by the Guangdong authorities in January 2003 were commended by the WHO as a 'model for the rest of China or maybe for the rest of the world' but, on account of different legal and political constraints mentioned earlier, this information was not shared with other Chinese provinces and the rest of the world until early April 2003. This facilitated national and international spread and forced affected regions and countries to learn from their own experiences and develop their own measures (Abraham 2004).

Quarantine of contacts was applied in all reviewed countries, yet China in its decision to apply quarantine on a wide scale by declaring epidemic zones and placing people under collective quarantine in villages or institutions outdid the other countries. Shanghai for instance placed people from Beijing under quarantine even in the absence of symptoms (Huang 2004). Such a large scale quarantine might have been effective for China because of its unique situation as many of the initial SARS cases in Guangdong were food handlers or sold wild animals (Xu *et al.* 2004) along with the fact that more than 65% of cases in Beijing did not have a contact history during the later phase of the epidemic (Wu *et al.* 2004) but generally its effectiveness for containing SARS was questioned as only a very small percentage of quarantined individuals developed SARS (Bell and WHO working group on prevention of international and community transmission of SARS 2004; Day *et al.* 2006). In Hong Kong 2.7% (Tsang 2005) and in Taiwan only 0.22% (Bell and WHO working group on prevention of international and community transmission of SARS 2004) of quarantined individuals developed SARS. Monitoring con-

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tacts and placing them under isolation if symptoms develop would have been less distressing and impinging on individual freedom. Yet, SARS could be effectively controlled in the absence of quarantine only if the isolation measures in place are very effective and strict (Day *et al.* 2006).

The resurgence of the Toronto outbreak highlights the importance of strict infection control precautions in hospitals, the vulnerability of transmission to HCWs, in-hospital patients and visitors and the difficulty of identifying such cases among hospitalised patients with multiple conditions and often atypical symptoms and no clear epidemiologic link (Public Health Agency Canada 2003; Loutfy *et al.* 2004). This underlines the importance of continuing active and passive surveillance specially among high-risk groups including HCWs and patients and in high-risk settings like hospitals, rehabilitation centres or even senior citizens homes. The example of Hong Kong where 72 elderly home residents had developed SARS reinforces the significance of these measures (Tsang 2005).

China's community containment efforts, which materialised in a short time, were impressive and unlike those implemented in the other affected regions. By late April, China made intensive efforts to mobilise its rural and urban population. China's president Hu Jintao declared a 'People's War' against SARS and a people's surveillance was developed encouraging people to monitor themselves for fever and to ensure that SARS cases were identified quickly (Balasegaram & Schnur 2006). The time between symptom onset and hospitalisation in Beijing reduced significantly from initially 5–6 days before the outbreak was made public to 2 days after widespread information became available (Pang *et al.* 2003). Although control measures were introduced later in the epidemic in Beijing, the enormous participation of the public played an important role in the successful containment of SARS.

This article only compares the major control measures implemented by the national authorities of the reviewed countries, the large variety of diverse control measures implemented during all the different phases of the epidemic could not be taken into account here. As the SARS epidemic was also a politically charged issue, with a lot of international pressure, some of the reviewed information might depict the ideal situation as laid down in the guidelines and to a lesser extent the real situation. In addition, it might have resulted in a publication bias with over projection of effective control measures while leaving out negative aspects. Because of language constraints articles and books published in Chinese, Malaysian, Vietnamese and French languages could not be reviewed, i.e. only literature published or translated in English language was used, which might have limited the diversity of opinion and information to some extent. Yet, all efforts

were made to find multiple literature sources and to view the literature in a scientific and objective manner.

Severe acute respiratory syndrome challenged the political and public health systems of all affected countries and a new event would do so again. It demanded rapid and decisive action to be taken, yet the comparison shows how difficult this was for an unknown new disease. The comparison shows that the reviewed countries reacted rapidly after WHO's global alert and dealt openly with the situation, Guangdong also reacted rapidly but this pace was not continued by China for sometime which facilitated national and international spread. Yet, criticising retrospectively is always easy. The dilemma of trying to maintain economic and social stability while at the same time protecting public health would challenge any nation. The SARS outbreak which fortunately was only moderately transmissible, indicates how dire the consequences of a highly infectious disease outbreak could be. The significance of timely information was perhaps the main lesson that the SARS epidemic taught. The key is to be prepared for such events as far as possible by establishing sensitive surveillance systems, clear reporting pathways, open communication structures, co-operation among nations and well planned and tested pandemic plans.

### Acknowledgements

The authors specially thank Sake de Vlas for the support he extended to get information regarding China and for his important and useful suggestions to improve the article. Special thanks also go to Nolene Sheppard and Tahera Ahmad for their helpful comments and for textual review of the article and to Roberta Andraghetti from WHO-EURO for her assistance in finding important literature sources. The authors are grateful to Jan Hendrik Richardus for the overall co-ordination of this project. In the end, the authors would like to acknowledge all the valuable discussions and information exchanges with the other SARSControl project partners.

This work was conducted as part of 'SARSControl: Effective and Acceptable strategies for the control of SARS and new emerging infections in China and Europe', a European Commission project funded within the Sixth Framework Programme. Amena Ahmad received additional funding for parts of this work from WHO-EURO.

### Conflicts of interest

The authors have declared that they have no conflicts of interest.



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