

Control of Severe Acute Respiratory Syndrome in Singapore

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Abstract

A Severe Acute Respiratory Syndrome (SARS) outbreak occurred in Singapore from February to May 2003. A high vigilance for the disease, frequent and regular temperature monitoring, early case identification and isolation of patients, as well as tracing and home quarantine of contacts, played major roles in controlling the outbreak. Hospitals were dedicated to the screening and treatment of SARS patients. Within and between hospitals, movement by healthcare workers, patients and visitors were restricted, as was the number of hospital visitors. Staff education and audits of infection control practices also featured prominently.

To prevent cross-border transmission, incoming travellers from SARS affected areas had to complete health declaration cards. They, as well as all outgoing travellers from Singapore, were monitored for fever. In the meantime, the public was urged to refrain from travelling to SARS affected regions.

Containment elements targeting the community included school closure, public education on good hygiene and readily accessible public information.

In response to a laboratory acquired SARS infection, laboratories were audited, and directives issued on the mandatory use of biosafety level 3 laboratories for SARS virus culture, and compliance of laboratory workers to biosafety guidelines.

Key words: outbreak control, SARS, patient isolation, quarantine, contact tracing

Introduction

The Severe Acute Respiratory Syndrome (SARS) outbreak in Singapore began in late February 2003 with the return of a traveller from Hong Kong. Her stay at a hotel there had coincided with that of a SARS-infected medical doctor from Guangdong, China (1). On 31 May 2003, Singapore was removed from the World Health Organisation (WHO) list of countries with local transmission of SARS. This paper describes the measures taken to control the epidemic. An outline of the outbreak is given here to lend perspective to these measures.

Summary of outbreak

During the outbreak, 238 people were infected, of whom 33 (13.9%) died (2). The disease was primarily transmitted in

hospitals; in a report on 206 probable SARS cases, 40.8% were health care workers (HCWs), 39.8% were family members, friends or visitors to hospitals, and 12.2% were hospital in-patients (3). As shown in Fig. 1, most of the infections occurred in 3 hospitals, fanned by 5 “super spreaders” who are defined as patients who infected 10 or more other people (1).

The first super spreader was the 22 year-old returned traveller from Hong Kong who was admitted to Tan Tock Seng Hospital (TTSH), where she infected 24 persons (1, 3). Among these was a 27 year-old nurse who had attended her. Before being isolated, the nurse was admitted to an open ward for 3 days, infecting 25 persons. One of these was a 53 year-old patient with diabetes and ischaemic heart disease, in whom SARS was not suspected because of her many medical complications (3). Consequently, N95 masks were not used by her health caregivers and 27 SARS-infected persons were eventually traced to her. Another patient with diabetes and chronic renal disease, on discharge from TTSH, was admitted to an open ward in Singapore General Hospital (SGH) on March 24 for gastrointestinal bleeding and urinary tract infection. Like the 53 year-old patient in TTSH, his medical problems resulted in atypical SARS symptoms. His SARS infection was unrecognised in spite of his caregivers’ deliberating on his possibly

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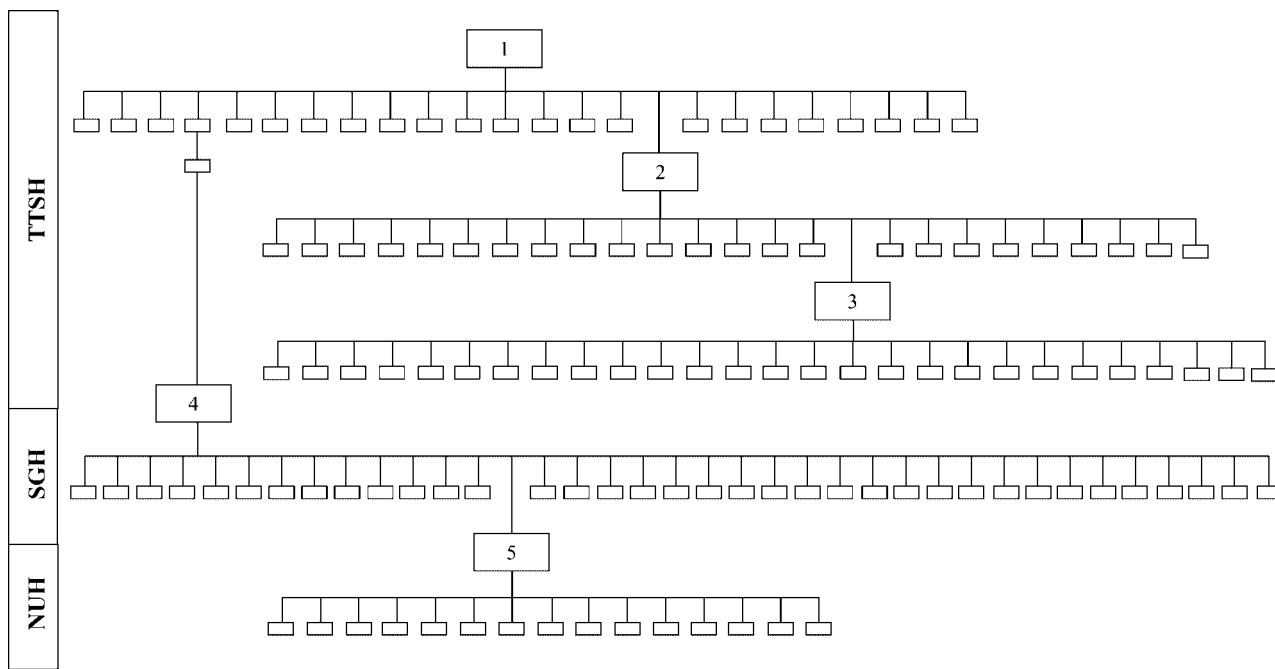


Fig. 1 Transmission of SARS infection by 5 super spreaders in 3 major hospitals.

- 1 Super spreader 1, a 22 year-old traveller, was admitted to TTSH.
 - 2 Super spreader 2, a 27 year-old nurse, was infected by super spreader 1.
 - 3 Super spreader 3, a 53 year-old patient, was infected by super spreader 2.
 - 4 Super spreader 4 was infected during hospitalisation in TTSH for chronic medical problems. He was not recognised as a SARS case and after discharge, was admitted to another hospital, SGH, where he started an outbreak.
 - 5 Super spreader 5 visited his brother, super spreader 4, in SGH and was subsequently admitted to NUH where he started a cluster of SARS cases.
- , Infected case; TTSH, Tan Tock Seng Hospital; SGH, Singapore General Hospital; NUH, National University Hospital.

Table 1 Measures taken to control SARS in Singapore

Health Institutions	Checkpoints	Community
1. Dissemination of information	1. Early detection of imported cases	1. Public education
2. Early case identification	2. Prevention of exportation of cases	2. Issuance of thermometers to households
3. Notification of SARS	3. Completion of declaration forms	3. Dedicated SARS ambulances
4. Contact tracing	4. Issuance of health advisory cards	4. Contract tracing
5. Isolation of patients	5. Temperature check	5. Home quarantine
6. Dedicated SARS hospital	6. Referral to dedicated SARS hospital	6. Closure of schools and child centres
7. Restricted people movement	7. Travel advisory	7. Suspension of sports activities and competitions
8. Restricted no. of visitors		8. Temperature check in schools and at place of work
9. Infection control		9. Public recognition for good hygienic practices in public buildings
10. Temperature check		
11. Home quarantine		
12. Modified hospital processes		

having SARS. He spread the infection to 37 HCWs, patients and visitors. This started an outbreak in SGH that resulted in 60 cases.

His brother who had visited him in SGH was subsequently admitted on 8 April to an open ward of National University Hospital (NUH) for suspected cardiac failure from acute myocardial infarction. He was there for less than a day before being transferred to the intensive care unit. He was then moved to TTSH when his SARS contact history became known, by which time he had started a cluster of 15 cases in NUH.

Control Measures

The control measures taken to contain SARS in Singapore can be broadly grouped into those in health institutions, at checkpoints, and in the community. A summary of these measures is listed in Table 1. Due to the health care associated nature of the disease, the majority of control measures applied to the health sector. These were implemented and modified progressively as the outbreak unfolded.

a. Containing spread in health institutions

i. Dissemination of information

As the number of atypical pneumonia cases increased in Singapore, and as similar cases in China, Hong Kong and Vietnam were reported, the Ministry of Health (MOH) began issuing medical alerts and updated information to all medical practitioners through email and short messaging services, urging vigilance for the disease. This mode of disseminating information was maintained throughout the outbreak and the medical community was kept abreast of cases, and policies and guidelines on patient management.

ii. Early case identification

One of the pillars of control was early identification of cases, and the SARS case definitions from WHO were used. Besides medical practitioners being alert for cases, the public was also urged to seek immediate medical attention if symptoms compatible with SARS developed, if symptoms onset within 2 weeks of history of travel to SARS afflicted areas, or if there was close contact with persons with SARS.

Rapid laboratory confirmation of infection was a priority to differentiate SARS from non-SARS patients for isolation, contact tracing and epidemiological investigations. Personnel from diagnostic and research laboratories met regularly to pool knowledge and resources in an effort to cope with the escalated demands for laboratory testing for a novel virus.

iii. Mandatory notification of SARS

In mid-March, immediate notification of suspected and probable SARS to MOH was made mandatory under the Infectious Disease Act for tracing contacts and ring-fencing the source of infection.

iv. Contact tracing

Contact tracing was a crucial factor in the containment strategy. It limited the spread of infection through identifying exposed individuals. Those who were ill were referred immediately for medical assessment, while those who were asymptomatic were monitored and quarantined. Speed in tracing contacts of SARS patients was of the essence and this was effected through teams set up at MOH and hospitals.

v. Isolation of suspected infectious patients

Besides contact tracing, another crucial component was patient isolation. All patients were screened at triage points that were specially set up at hospitals and clinics to separate febrile from afebrile patients. Where existing facilities did not permit such segregation, improvisations were made. Tents, for example, that were fully equipped with laboratories, X-ray facilities and pharmacies, were established outside polyclinics (4). Patients fitting the SARS case definition were given masks to wear and were isolated immediately, in a separate room if available, from other patients. They were then transported to TTSH, using a 24-hour dedicated ambulance service specifically set up for this purpose.

In all hospitals, suspected and probable SARS patients were nursed in isolation rooms. Later, other febrile patients

were also kept isolated until a diagnosis was made. In mid-April, after the SGH cluster of SARS cases was triggered by the patient with atypical presentation, existing inpatients in SGH who developed fever or respiratory symptoms, as well as those on steroids and other immunosuppressive therapy, were isolated as well. As a precautionary measure, patients from SGH were discharged only 3 days after the subsidence of fever.

vi. Dedicated SARS hospital

To confine SARS to one hospital and prevent spread to and in others, TTSH was designated a SARS hospital. Besides direct admissions of suspected cases, it also received HCWs and patients from other hospitals who became infected with SARS.

Resources were freed up in TTSH for treating probable and suspected SARS patients by scaling down specialist outpatient clinic activities, cancelling elective surgery, and diverting new non-SARS patients to other health institutions.

A dedicated team of HCWs, who would not perform outpatient or non-SARS inpatient tasks, was assigned to manage SARS patients. To further minimise exposure of other hospital staff to SARS, areas in TTSH where SARS patients were managed were cordoned off.

vii. Restriction of movement

Movement of HCWs and patients within and between hospitals was restricted and movement logs of these people and visitors were maintained to facilitate contact tracing should the need arise.

viii. Restriction of number of visitors

As it became clear that SARS was mainly linked to hospitals, the number of visitors was limited to 2 per patient. Visitors were screened for fever and their contact particulars, recent travel history and relationship to the patients recorded for potential contact and epidemiological tracing. They were provided with surgical masks to wear and advised to avoid contact with other patients and their belongings. With the recognition of a SARS cluster in SGH, the hospital further restricted visitors to 1 per patient per day from 18 April. By 29 April, when data showed that about 38% of SARS cases were visitors to hospitals, all public hospitals implemented a "no visitor rule" for patients (5). The exception to this was departments treating children or providing obstetric care where 1 visitor per patient was permitted. The rule was also relaxed on a case by case basis for seriously ill patients.

ix. Infection Control

Strict infection control measures were implemented to reduce risk of transmission to health care staff in all areas where there was a possibility of exposure to patients with SARS. Staff workers were required to wear personal protective equipment which included N95 masks (i.e. masks that are 95% efficient in filtering particles of 0.3 μm size and above), gloves and gowns. Hand washing or decontamination with alcohol-based hand rubs after each patient contact was emphasized.

Staff education was another element of control. It was compulsory for HCWs to attend teaching sessions on infection

control for SARS (6). MOH staff conducted audits of hospitals, and of general practitioner and traditional Chinese medicine clinics for compliance with infection control measures.

x. Temperature monitoring

At the same time, the health status of all HCWs was actively monitored through temperature checks, initially twice, then thrice daily with the first check before starting work for early detection and isolation of affected staff. Staff workers with fever were not allowed to work but were kept under surveillance either as hospital inpatients or at home via telephone communication.

xi. Home quarantine

From 17 April, patients with chronic conditions such as diabetes, chronic lung disease, or cardiac, renal or hepatic failure, were quarantined at home for 10 days after hospital discharge. They were required to monitor their temperature twice a day and daily telephone surveillance of their well-being was maintained. If unwell, they were recalled to the hospital for evaluation (7). A 10-day home quarantine was similarly imposed on HCWs, patients and visitors exposed to SARS patients (6).

xii. Modification of hospital work processes

SGH adopted a modular team system of doctors and nurses so that a reserve team of HCWs would be available should the active team be exposed to SARS. Another measure adopted was the suspension of elective services to reduce non-critical attendance at the hospital (6).

b. Preventing importation and exportation

The focus at land, sea and air checkpoints was early detection of imported cases. Incoming travellers from SARS-affected areas, and later, on all incoming flights, were required to complete health declaration forms. They were given health advisory cards bearing a hotline number to call should SARS symptoms develop. Their temperature was screened and nurses stationed at the checkpoints would refer febrile and visibly unwell passengers to TTSH for assessment (8). All outgoing travellers from Singapore were similarly monitored for fever to prevent exportation of SARS.

Meanwhile, the public was urged to heed the travel advisory from WHO and refrain from travelling to SARS affected areas.

c. Minimising community spread

i. Early detection

Early detection of cases was facilitated through educating the public and general practitioners on SARS via the mass media and government websites. Each family was issued with a thermometer for monitoring body temperature twice daily and urged to seek immediate medical attention if unwell.

ii. Dedicated SARS transport

SARS patients and those suspected to have SARS were conveyed to TTSH in dedicated ambulances, which were available by calling a hotline number. Other means of public and

private transportation were not allowed.

iii. Contact tracing

Contacts of cases were actively sought. Those who were sick were referred to TTSH while all other contacts exposed to SARS patients were quarantined.

iv. Home quarantine

Additional powers were invoked under the Infectious Disease Act to quarantine all asymptomatic contacts at home for 10 days to minimise their interaction with other people. Those quarantined were checked daily by telephone and would be referred immediately to TTSH if symptoms of SARS appeared. Logistical problems, such as the provision of food and other necessities, had to be overcome. As a deterrent to defying the quarantine order, quarantine breakers, if caught, were liable to fines or imprisonment or both.

v. Measures in schools

All schools from play groups to junior colleges, childcare centers, as well as tuition and recreational classes were closed from 27 March for 3 weeks. In addition, sports activities and competitions were suspended or cancelled, to prevent the congregation of big groups of children. During the closure, schools were cleaned and ventilated. When schools re-opened, pupils and visitors had to declare if they had visited other SARS affected regions.

The Ministry of Education prepared and distributed information packages to students to encourage the practice of good personal hygiene. A thermometer was issued to each pupil for daily temperature monitoring and parents were tasked with the responsibility of not sending their sick children to school.

vi. Other environmental measures

Markets and food centres were cleaned and temperature checks of stallholders and assistants were imposed. Recognition, in the form of certificates, was given to shopping centers and hotels that practised good hygiene. Public education messages were carried by the mass media to promote the practice of respiratory etiquette and frequent hand washing, and to discourage spitting in common areas.

Laboratory acquired SARS

As country after country was pronounced SARS-free by WHO, there was concern that SARS might re-emerge from a laboratory accident and it did in Singapore. On 3 September 2003, a graduate student, who had been working in a research laboratory where work on SARS-associated coronavirus (SARS-CoV) was conducted, was admitted to SGH for a febrile illness. SARS was suspected and later confirmed by the Virology Laboratory (9). This incident did not result in secondary transmission and another outbreak, but deserves mention for the additional control measures instituted in the laboratories.

Investigations revealed that the student was infected while working with a West Nile virus sample that had been contaminated with SARS-CoV. There were deficiencies in the practice of biosafety in the laboratory and lapses in containing SARS.

The incident triggered audits of other laboratories handling SARS-CoV. Ensuing recommendations included mandatory use of biosafety level 3 laboratories for SARS virus isolation, compliance of laboratory workers to biosafety guidelines, restriction of diagnostic testing and research on SARS to designated laboratories, the maintenance of an inventory of SARS samples and viral strains by these laboratories, and immediate reporting of laboratory incidents. National control of the importation of any SARS material will be instituted.

Areas for improvement

Could the outbreak have been managed better? Gaps existed. One of these was the sub-optimal use of information technology to manage the vast quantity of data generated in the course of contact tracing, laboratory investigations, quarantining exercise and epidemiological tracking. There was also a failure to efficiently transmit instructions for timely and coordinated action among and within hospitals.

In the initial phase of the outbreak in TTSH, the lack of visitor records was an impediment to identification of all contacts (3). This was later rectified in all health facilities. The

SGH experience has shown that in an outbreak situation where the causative agent is new and little is known about the disease, a fever cluster, albeit linked to an index patient with atypical presentation, should be treated as a manifestation of the outbreak until proven otherwise, and all contacts quarantined immediately (4). In both TTSH and SGH, had all exposed persons been identified and quarantined quickly, the outbreak might have been contained sooner.

Conclusion

Controlling the SARS outbreak was a profound learning experience for Singapore. Dealing with a new virus and disease, we were dependent on the collective information and experience of other countries that were similarly afflicted. We had to respond rapidly to new and unexpected developments, sometimes with improvised methods.

The outbreak in Singapore was controlled with the concerted effort of everyone in the country. The darkness is put behind us, perhaps only for a while. We have to remain vigilant for the disease and we hope that the lessons learnt at such cost will prepare us in the event of a re-emergence.

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