Singapore's experience of SARS

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ABSTRACT – The coronavirus that causes severe acute respiratory syndrome (SARS) is transmitted mainly via respiratory droplets. Typical presenting symptoms are akin to those of ordinary pneumonia. Young patients start with fever, chills, malaise, headache, or myalgia; cough and dyspnoea follow. Older persons and those taking corticosteroids may have neither fever nor respiratory symptoms. Exceptional suspicion is needed to identify SARS early in the illness. During an outbreak, even patients with low suspicion of SARS should be promptly isolated, and all contacts quarantined. Health workers need training in the use of appropriate barriers against droplets and other body fluids. Any fever cluster in patients or carers requires immediate action: discharges, visits, and transfers between wards and hospitals should be stopped. Halting hospital admissions and ten-day quarantine of suspected cases create wide buffer zones. To counter a possible resurgence of SARS, a system of prepared isolation and quarantine facilities is important.

KEY WORDS: coronavirus, health workers, personal protective equipment, quarantine, severe acute respiratory syndrome (SARS), surveillance, visitors

The human coronavirus that causes severe acute respiratory syndrome (SARS) probably emerged in Guandong Province, China, in November 2002. Since then SARS has affected 8,462 persons in 32 countries and killed 804 of them.[1] In reliable reports from Hong Kong, Toronto, and Singapore, the case fatality rate averages 16%, much higher than the estimated rate, 3–4%, reported by the World Health Organization (WHO) in March 2003 when SARS first hit these cities.[2] We are fortunate that the SARS coronavirus is less transmissible than some other RNA viruses, and ordinary influenza strains.[3,4] The WHO has removed its last travel alerts, but SARS still threatens social and economic loss indefinitely.

We cannot yet eradicate SARS because we lack three crucial elements:

- a fast, accurate diagnostic test
- an effective vaccine to break disease transmission
- safe effective treatments to kill the coronavirus in both its human hosts and its likely reservoir of wild animals.[5]

The present anti-infection strategies, that is, isolation of suspect cases and quarantine of contacts, are pragmatic but unsustainable over time. We describe specific problems of early detection of SARS, derived from experience in the Singapore outbreak, and suggest measures that promote the early termination of human-to-human transmission in future epidemics.

Key Points

- **Typical presenting symptoms of severe acute respiratory syndrome (SARS) are non-specific, and, apart from diarrhoea, resemble those of ordinary pneumonia**
- **Older patients and those taking corticosteroids may have neither fever nor respiratory symptoms**
- **During an outbreak, even patients with low suspicion of SARS should be isolated, and contacts strictly quarantined**
- **Health workers require repeated training in the use of appropriate barriers against respiratory droplets and other body fluids**
- **Clusters of fever should trigger an immediate cessation of discharges and visits, and of transfers between wards, clinics, and hospitals**

Clinical report

Atypical presentations

The initial diagnosis of new cases of SARS can be straightforward, if patients who present with symptoms of fever and an evolving chest infection also give a clear history of contact, or of recent travel to a SARS-affected country.[6–10] However, the typical presenting symptoms of SARS are non-specific, resembling those caused by other, more common, pathogens of pneumonia.[11] Thus, the diagnosis cannot be made confidently in patients who deny or are unaware of exposure to SARS.

Diagnostic uncertainty is compounded if patients have neither fever nor respiratory symptoms. The initial diagnoses of patients with atypical presentations of SARS in Singapore included community-acquired pneumonia from usual pathogens, dengue fever, gastroenteritis, meningitis, congestive heart failure, fibrosing alveolitis, and pyogenic hospital-acquired pneumonia.[12]

During the first week of illness in young, previously healthy patients, constitutional symptoms such as fever, chills, malaise, headache and myalgia predominate.[7–10] Dry cough and breathlessness usually start later.[6,8,10] Blood counts are non-specific and may show lymphopenia with mild thrombocytopenia.[13] In South-East Asia SARS is often misdiagnosed as dengue fever, which has recently increased in incidence. In other communities, SARS might be mistaken for influenza. Up to 50% of patients have diarrhoea,[7,8] which may be diagnosed as gastroenteritis, or ascribed to antibacterial drugs empirically administered for fever.

Older patients with many comorbidities can show exacerbations of their underlying illnesses, such as congestive heart failure, chronic obstructive pulmonary disease or lung fibrosis.[12] The illness may therefore be attributed to many different causes. Patients receiving corticosteroid or immunosuppressive treatment may even be afebrile initially. Long-stay patients who acquire SARS in hospital are often mistakenly thought to have hospital-acquired bacterial pneumonia.

Early diagnosis and prompt isolation are the key public health measures to minimise transmission of the SARS coronavirus, but they are seriously undermined by atypical presentations which result in delayed or missed diagnosis. We recommend that, during an outbreak of SARS, even patients with low suspicion of SARS should be isolated until the diagnosis has been confirmed or denied.

Personal protective equipment for health workers

Health workers comprise nearly half the cases of SARS; this is a unique and distinguishing feature of SARS epidemics in hospitals (Table 1). An outbreak of fever and pneumonia among nurses is often the first sign that a new cluster of infection has emerged. Thus, the use by health workers of appropriate personal protective equipment (PPE) against respiratory droplet infection and exposure to other body fluids is a key infection control measure in hospitals.[14]

Seto *et al*[15] in Hong Kong showed, in a retrospective case-controlled study, that the use of face masks is associated with the lowest (but not zero) risk of infection among health workers. The experience in Singapore is broadly consistent with this finding. In the first week of the epidemic, the Tan Tock Seng Hospital (TTSH) had been designated to manage all patients with SARS in Singapore.[10] Isolation of patients with suspected SARS and the use of PPE for health workers started immediately. Before PPE institution several health workers acquired SARS, and a 29-year-old physician died from pulmonary embolism complicating SARS. From one week after the introduction of the PPE policy, no new cases of infection among health workers were reported there.

However, from the experience in three other general hospitals, including the National University Hospital (NUH), PPE alone may not protect all health workers against severe, even fatal, SARS infection.[16] A securely fitting N-95 mask, a high degree of personal caution, and diligence in infection-control procedures are all necessary to counter the zeal with which some physicians and nurses attend to ill patients who require urgent and intensive care. Proper mask-fitting tests according to the manufacturer's specifications, and systematic training, plus periodic reinforcement of compliance, are important infection-control procedures against the spread of SARS coronavirus in hospitals. Extraordinary precautions are needed in seriously ill patients with advanced SARS who require airway-related procedures, such as intubation and bronchscopy. Even close clinical examination and transportation of such patients is hazardous. We recommend the use of a powered air-purifying respirator on top of the usual PPE in these high-risk situations.

Patient transfers and discharges

During the first part of the SARS outbreak at TTSH, before the strict implementation of adequate infection control measures, the infection had spread rapidly to many health workers, other patients, and visitors.[10] The spread occurred unnoticed right across this large hospital of over 2,000 beds, from designated wards into apparently unrelated wards. The important factors which contribute to SARS transmission within a hospital are:

- lodging patients in large 'open' wards with shared facilities
- routine traffic of patients between wards and across different zones for procedures
- redeployment of health workers between different wards and disciplines in response to sharp reductions in manpower, as staff fall ill with SARS.

Many patients acquired the infection while recovering from the original illnesses which brought them into TTSH. They then left hospital during the incubation period (ie up to 10 days) of their SARS infection. Case history 1 illustrates the effect of discharging a patient who had just acquired SARS within TTSH.

Table 1. Characteristics of hospital patients with probable or clinically confirmed severe acute respiratory syndrome (SARS), according to the likely source or setting of infection.

	Number of patients	%
Imported cases	**8**	**3.9**
Community	**7**	**3.4**
Wholesale fruit and vegetable market	3	1.4
Taxicab driver	2	1.0
Cryptic or undefined	2	1.0
Probably nosocomial	**191**	**92.7**
Health worker	84**	40.8
Other inpatient	25	12.0
Visitors to hospital	19	9.2
Family member	49	23.8
Friend or social contact	14	6.8
Total	**206***	**100**

*Out of 206 patients, 32 died: a case fatality rate of 15.5%.
**Five health workers (6%) died.

CASE HISTORY 1

A 60-year-old man, TKC, was discharged from Tan Tock Seng Hospital three weeks after the first index case of SARS was admitted. He became ill four days later but was admitted to the Singapore General Hospital, because by then Tan Tock Seng Hospital had closed for general admissions. His initial diagnosis was gastrointestinal bleeding but he developed fever in the next 48 hours. The fever was attributed to nosocomial bacteraemic *Escherichia coli* urosepsis and he was not isolated. He became the index case for a cluster of 53 probable SARS cases in the Singapore General Hospital. This cluster included 23 health workers, 16 patients, and 14 visitors. Thirteen people (two health workers, eight patients, and three visitors) died.

Because of such cases we recommend that, in a hospital experiencing the ongoing transmission of SARS, all patients, even those apparently unexposed to infection, should be monitored carefully for fever and pertinent symptoms. All patients should also undergo home quarantine for 10 days when discharged from hospital. They should not be transferred or readmitted to another healthcare facility without similar precautions.

Visitors

After health workers, the next largest group of SARS patients consists of family members, friends, and other unrelated visitors to hospitals (Table 1). Case history 2 of one such visitor to TKC, the 60-year-old man who was the index case in Case history 1, shows the dire consequences of a visitor contracting the disease.

Case history 2 highlights the danger posed by a hospital visit, not just to the visitor but also to others. Most such visitor cases, like TSC himself, were friends and family of SARS cases, and for this reason should have been recognised as close contacts. However, one in 10 patients who acquired SARS in hospital (Table 1) were visitors quite unconnected with SARS patients. They were meeting other, non-SARS patients and were not initially considered close contacts and thus escaped contact listing and monitoring. We recommend that, once an outbreak of SARS is recognised, visiting rights should be suspended or severely restricted, and that all visitors should be placed under a contact surveillance system.

Conclusion

Singapore's clinical experience of SARS shows the consequences of a new and serious infectious disease affecting many health workers. We had to rapidly overcome the difficulties of limiting the dissemination of the coronavirus infection both within hospital and into the community. Routine fever surveillance must be stringent at all points of entry and exit in hospitals. Extraordinary vigilance is needed to detect early SARS, manifest as fever within 10 days after unprotected exposure to SARS. Health workers need training in the proper use of personal protective gear. Clusters of patients or health workers with undefined fever signal a breakdown in infection control (Box 1). The immediate response must be to stop discharges and visits, and transfers between wards, clinics, and hospitals. Halting hospital admissions and 10-day quarantine of suspected cases creates a buffer zone (Box 1).

CASE HISTORY 2

TSC, a man aged 64 years who worked at a wholesale fruit-and-vegetable market, visited his brother, TKC, in Singapore General Hospital. Five days later he attended the emergency department of National University Hospital with acute breathlessness. He had a past history of coronary artery disease, and prior episodes of congestive heart failure. He was critically ill on admission: hypothermic and hypotensive, with cardiomegaly and basal infiltrates on chest radiography consistent with pulmonary oedema (Fig 1). Neither he nor his brother was then on the nationwide list of patients or contacts for SARS. He was thus admitted to the general cardiology ward and treated for heart failure. He was only isolated eight hours later, after the respiratory consultant brought him to the intensive care unit for endotracheal intubation and ventilation. TSC died from SARS and transmitted it to 24 persons. This cluster included two taxicab drivers, 10 people linked to the market, three health workers (including the physician who made the initial diagnosis), two family members, and three visitors. The deaths in this cluster included TSC, one taxi driver, one market worker, two patients, and one visitor.

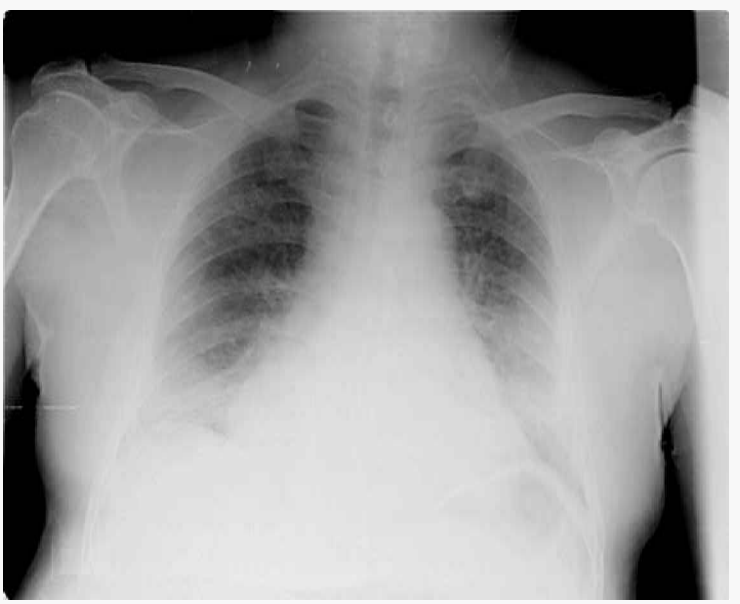

Fig 1. Chest radiograph of TSC, a man aged 64 with coronary heart disease, who had visited his SARS-infected brother at another public hospital. Enlarged cardiac shadow and basal lung infiltrates led to initial treatment for heart failure in a cardiology ward. Patient transmitted SARS to 24 people.

Box 1. Early indications of possible ongoing nosocomial transmission of SARS in hospital, and suggested responses.

1 HWs, patients, or visitors with fever, with or without pneumonia, < 10 days after unprotected exposure to a patient with SARS.
2 One or more HWs with fever, with or without pneumonia, < 10 days after managing a patient with similar but undefined illness.
3 Cluster or clusters of undefined fever, with or without pneumonia, in HW or patients detected during routine surveillance.
4 HWs, patients or visitors exposed to new cases of suspected or probable SARS anywhere in the hospital without adequate PPE.

After detection of the above conditions, consider taking the following steps:

1 Admit, isolate, and manage all febrile persons as for SARS cases.
2 Manage exposed persons as for contacts of probable SARS cases.
3 Stop the deployment of all categories of HWs to other unaffected wards/units/areas and hospitals.
4 Stop all admissions to affected hospital (preferably), or wards to produce a wide buffer zone.
5 Stop all discharges and transfers from affected hospital or wards, until patients have become afebrile for 10 days* after possible exposure.
6 Stop all visitors to affected hospital (preferably) or wards, including emergency rooms and waiting areas, to make a buffer zone.

HW = health worker; PPE = personal protective equipment.
**Some reports suggest that a few unusual patients might manifest SARS after up to 16 days' incubation; prudence might therefore suggest an 18-day period.*

It is difficult to strike a balance between strict control measures and sensitive practice in severely ill patients and mothers with their newborn babies. However, resistance to, or tardiness in, implementing stringent anti-infection measures will hinder the containment of any SARS outbreak.

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