

Severe Acute Respiratory Syndrome (SARS) and Healthcare Workers

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The recent outbreak of severe acute respiratory syndrome (SARS) was spread by international air travel, a direct result of globalization. The disease is caused by a novel coronavirus, transmitted from human to human by droplets or by direct contact. Healthcare workers (HCWs) were at high risk and accounted for a fifth of all cases globally. Risk factors for infection in HCWs included lack of awareness and preparedness when the disease first struck, poor institutional infection control measures, lack of training in infection control procedures, poor compliance with the use of personal protection equipment (PPE), exposure to high-risk procedures such as intubation and nebulization, and exposure to unsuspected SARS patients. Measures to prevent nosocomial infection included establishing isolation wards for triage, SARS patients, and step-down; training and monitoring hospital staff in infection-control procedures; active and passive screening of HCWs; enforcement of droplet and contact precautions; and compliance with the use of PPE. *Key words:* severe acute respiratory syndrome; healthcare workers; risk factors; nosocomial infection; infection-control measures; prevention.

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The multi-country outbreak of severe acute respiratory syndrome (SARS) was a direct result of globalization. The disease originated in November 2002 from Guangdong, a province in southern China, arriving in Hong Kong in late February 2003. Once it reached Hong Kong, it spread within a week to 11 countries in three continents, a rapid transmission made possible by a highly mobile closely interconnected world.¹ The incubation period of ten days allowed asymptomatic infected travelers to transport

the disease around the world with ease.² Healthcare workers accounted for 21% of the global cumulative total cases at the end of the outbreak.³

This article reviews how healthcare workers became infected in Hong Kong, the epicenter of the outbreak, the infection-control measures put in place, and the psychological effects of SARS on healthcare workers during the outbreak.

HISTORY OF THE OUTBREAK IN HONG KONG, THE EPICENTER

The outbreak in Hong Kong started when a professor of nephrology arrived from Guangzhou, China, on February 21 to attend a wedding. He had felt unwell for a few days before the trip. He spent part of his first day in Hong Kong sightseeing and shopping with his brother-in-law, before being admitted to a local hospital as an emergency case, with respiratory failure and acute respiratory distress syndrome.² He died of respiratory failure in the hospital. His brother-in-law was also admitted to the same hospital several days later, and died there. The nephrologist had infected at least 12 guests or visitors who were staying on the same floor of his hotel before his death. These hotel guests in turn carried the disease around the world as they returned to their respective countries or other destinations.⁴⁻⁶

One of the visitors to the hotel, a 26-year-old airport worker, was admitted into a general medical ward in a local regional hospital (Hospital X) on March 4, 2003, with a high temperature, muscle pain, and cough. His chest X-ray showed a small shadow in the right upper lung. He was treated with antibiotics for community-acquired pneumonia but also received a bronchodilator through a jet nebulizer at a flow rate of 6 liters/min, four times daily for seven days.⁷ Two days after his admission, doctors and nurses who had helped in his care, and medical students who had examined him, fell ill one after another. By March 10, 11 healthcare workers had reported fever, cough, and difficulty in breathing. The number of staff who became sick had increased to 50 by March 12.⁸

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Table 1 Numbers of Probable Cases of SARS, Deaths, and Healthcare Workers Infected in Selected Countries and Globally

| | Cumulative No. of Cases | Deaths No. (%) | Workers Infected No. (%) |
|-------------|-------------------------------|-------------------|--------------------------------|
| Canada | 251 | 41 (17) | 108 (43) |
| China | 5,327 | 349 (7) | 1,002 (19) |
| Hong Kong | 1,755 | 299 (17) | 386 (22) |
| Taiwan | 346 | 37 (11) | 68 (20) |
| Philippines | 14 | 2 | 4 (29) |
| Singapore | 238 | 33 | 97 (41) |
| Thailand | 9 | 2 | 1 (11) |
| Vietnam | 63 | 5 | 36 (57) |
| Global | 8,098 | 774 | 1,707 (21) |

THE DISEASE

The incubation period of SARS is generally two to ten days, although it has been estimated to average 6.4 days. The time from onset of clinical symptoms to hospital admission was three to five days. The major clinical features on presentation include persistent fever, chills/rigor, myalgia, dry cough, headache, and dizziness. Less common symptoms include sputum production, sore throat, coryza, nausea, vomiting, and diarrhea.^{2,7,9,10} These clinical symptoms are rather nonspecific and may mimic influenza or atypical pneumonia due to other agents such as mycoplasma, chlamydia, and legionella. Older subjects may present with decrease in general well-being, poor feeding, falls, and in some cases, delirium, without the typical febrile response.^{11,12} Physical examination of patients with SARS may show fever, tachycardia, tachypnea, and inspiratory crackles at the lung bases in some cases.^{2,7,9,10} The most consistent laboratory finding is lymphopenia.

There is no difference between the clinical presentation of healthcare worker with SARS and that of patients infected from the community. In general, the outcomes of healthcare workers were better, as they tended to be younger and had less co-morbid illnesses. They presented themselves for treatment and isolation sooner than did patients from the community and, as a result, they seldom infected their family members except in the early stages of the epidemic, when they were not aware of the disease.¹³

It is now established that the disease is caused by a new coronavirus.¹⁴⁻¹⁶ The entire genome of the virus was sequenced, confirming that it is a novel coronavirus.¹⁷⁻²⁰ Transmission is by way of droplets or by direct inoculation, although in some situations, airborne transmission cannot be excluded.²¹

EPIDEMIOLOGY

In mid-July, when the World Health Organization (WHO) declared that no local transmission has been

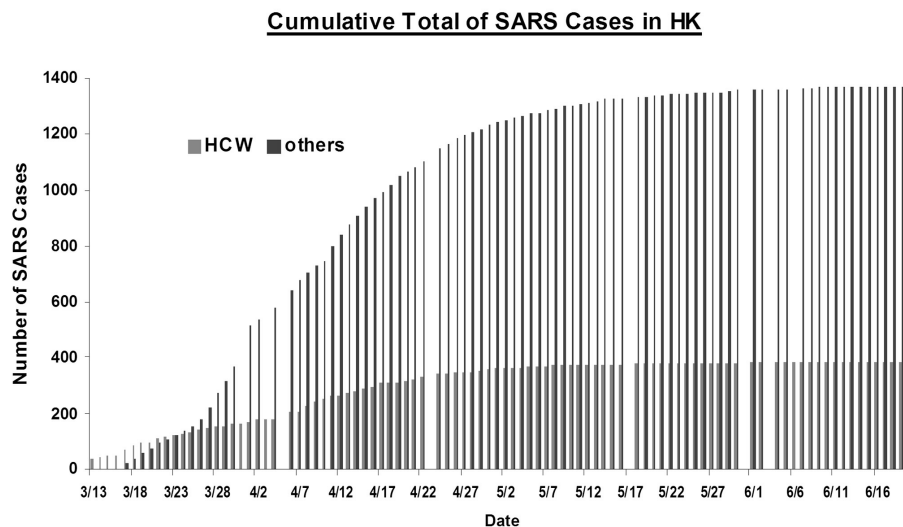
reported for over 20 days in all parts of the world, the global cumulative total was 8,098, with 774 deaths, a case fatality ratio of 9.6%.³ Health care workers were at the highest risk of having the disease, accounting for one fifth of the global total. Table 1 shows the total numbers of cases of SARS, the numbers of deaths, and the numbers and percentages of healthcare workers affected in selected countries.³ In Hong Kong, 22% of the cases of SARS were healthcare workers. In Canada and Singapore, the proportions were higher (43% and 41%, respectively), as they had fewer SARS cases in the community than Hong Kong. The cumulative number of new cases of probable SARS and the number of healthcare workers during the epidemic in Hong Kong are shown in Figure 1.²² It can be seen that the disease occurred only among healthcare workers initially but spread rapidly to the community. It is critical to understand how healthcare workers contracted the disease and how to prevent their infection.

WHY HEALTHCARE WORKERS CAME DOWN WITH SARS IN HONG KONG HOSPITALS

Several studies have been carried out on healthcare workers in Hong Kong attempting to understand why and how these workers became infected.^{13,23-25} The first study traced what happened to the healthcare workers in each of the four regional hospitals in Hong Kong after the admission of the first index cases that were epidemiologically linked.²³ This took place at the onset of the epidemic, when the disease was unknown and hospital staff were caught unaware and unprepared. In two of the four hospitals, the first unsuspected index case was transferred within a very short period of time after admission to the intensive care unit with isolation; only one hospital staff member was infected in one of these two hospitals. The third hospital, a designated infectious disease hospital, did not have any infected staff resulting from the admission of the first SARS patient; however, staff infection occurred in April after the hospital had admitted more than 400 suspected cases of SARS during the course of one week. The large workload overwhelmed the capacity of the staff of this hospital to deal with these patients, who need a great deal of care. The fourth hospital was Hospital X.

One hundred and twenty healthcare workers in Hospital X were infected between the onset of the epidemic and the middle of May 2003. A careful analysis was carried out as to why the healthcare workers in this hospital came down with the disease, and the results are summarized in Table 2.²⁴ Of these 120 healthcare workers, 26 (22%) were doctors, 66 (55%) nurses, and 28 healthcare assistants and allied health workers. The proportion of doctors affected decreased with time, while the proportion of nurses increased and remained

Figure 1—Cumulative number of cases of SARS and number of healthcare workers with SARS in Hong Kong during the epidemic.



high, as the nature of their job required more close and prolonged contact with patients.

The outbreak in the hospital could be divided into six phases, and the reasons for staff infection during the individual phases were different. During the first phase, when SARS first struck, healthcare workers in that hospital did not know what they were dealing with. They did not have any personal protective equipment. The use of jet nebulizers also helped to disseminate infected aerosol widely to a large number of patients and staff on the ward.

During the second phase, when the workers realized that they were dealing with an infectious disease, they started to wear personal protective equipment, but there was an inadequate supply in the beginning. Moreover, there was a general lack of familiarity and training regarding infection-control measures among the hospital staff. The general medical ward was not set up adequately as an isolation ward, and visitors were still allowed even though they were told to use masks.

The reasons identified for the later phases of the outbreak were different, because by then all staff had adequate training. Those infected during this phase were the non-regular ones who did not have experience in dealing with SARS patients. There were also elderly patients who presented atypically; the diagnosis remained unsuspected for a few days, and they required extensive nursing care. High-risk procedures such as intubation were found to be responsible for some infections of staff during this phase.

High risk Procedures

Certain types of procedures have been shown to be high-risk because they can lead to extensive spreading of droplets from the patient—for example, the use of the jet nebulizer and intubation⁷ and assisted ventilation. A retrospective case-control study was carried to identify factors associated with SARS transmission in

healthcare workers who participated in intubation of SARS patients.²⁵ There were 91 intubation procedures identified in four major hospitals during the period of the study; eight resulted in infection at least one healthcare worker, while 83 did not. The investigators found that procedures resulting in transmission of disease were usually associated with difficult intubation, extensive bagging, and extensive droplet contamination. Intubation in a general ward environment rather than in the intensive care unit was also a high risk factor.

Noncompliance with Use of Personal Protective Equipment and Infection-control Precautions

The effectiveness of protective measures of using masks, gloves, gowns, and hand-washing, recommended under “droplet precautions” when caring for SARS patients, was investigated in a retrospective study of 241 non-infected and 13 infected hospital staff after documented exposures in the course of care of SARS patients admitted to their hospitals.²⁰ The investigators found that all staff fully practicing the four protective measures did not contract the infection, while all infected staff had omitted at least one of the measures. In this study, the use of the mask was the only measure that provided significant protection. Thus, the factors contributing to high infection rate among healthcare workers in Hong Kong can be grouped into three categories, processes, environmental problems, and problems associated with patients.

Processes. Processes included the degree of awareness among healthcare workers, how they handled patient admissions and transfers, and how high-risk procedures were applied. Others included hospital management, such as ensuring no rapid influx of patients into one hospital to avoid excessive workload, training of staff in infection-control procedures, enforcing staff compliance with use of personal protective equipment, and ensuring a good supply of personal protective equipment.

TABLE 2 Staff Infections in Hospital X during Different Phases of the Epidemic and Reasons Identified

| | No. | Staff Category | | | Reasons Identified |
|---------------------------|-----|--------------------|-------------------|--------------------|---|
| | | Doctors No. (%) | Nurses No. (%) | Others† No. (%) | |
| Phase 1: March 4–16 | 72* | 23 (42) | 19 (35) | 13 (24) | Unexpected No protection Use of nebulizer |
| Phase 2: March 17–28 | 40 | 1 (3) | 33 (78) | 8 (21) | Use of nebulizer Unprepared Inadequate setup on the ward Inadequate supply of PPE† Staff issues—inadequate training, poor compliance with PPE Patient issues—poor compliance with use of masks |
| Phase 3: March 29–April 7 | 0 | | | | |
| Phase 4: April 8–20 | 16 | 1 (6) | 19 (63) | 5 (31) | Elderly patients requiring extensive nursing A super-spreader in one of the wards |
| Phase 5: April 21–29 | 0 | | | | |
| Phase 6: April 30–May 16 | 9 | 1 (11) | 6 (67) | 2 (22) | Close and prolong contact High risk procedure Non-regular staff |

*17 were medical students.

†Health care assistants, allied health workers, administrators.

‡Personal protective equipment.

Source: Chan-Yeung et al.²³

Environmental problems. In many public hospitals in Hong Kong, beds in general wards are only about three feet apart. It was easy for the disease to spread from patient to patient. Inadequate ventilation may also have been a contributing factor. Low air exchange may not have been sufficient to clear a high viral load. In addition, many public hospitals do not have sufficient facilities to enable staff to wash their hands frequently—let alone a place for them to shower after removing used protective gear.

Problems associated with patients. Patients can also be uncooperative and refuse to wear a face mask and maintain good personal hygiene when they are in the hospital. Extensive nursing and prolonged contact were required for elderly sick patients.

INFECTION CONTROL MEASURES IN HONG KONG HOSPITALS DURING THE EPIDEMIC

Contact and droplet precautions were recommended and enforced in all clinical areas in hospitals in Hong Kong. Where medically feasible, all admitted patients were instructed to wear surgical masks. Thorough daily and terminal disinfection were carried out, with careful washing and disinfection of the bed, handrails, bedside tables, floor, and equipment with hypochlorite solution.

Admission, Triage, and Disposal of Patients

Early identification and isolation of patients with probable or suspected SARS are important to prevent nosocomial spread of the disease. Front-line clinicians often found it difficult to make an accurate diagnosis at the time of patient presentation, as a rapid and accurate diagnostic test for SARS is still lacking. In most hospitals, there are only a few private rooms for isolation of patients with communicable diseases. At the onset of the epidemic, some hospitals in Hong Kong evacuated one patient floor and designated it for triage, SARS, and step-down isolation wards. To minimize the risk of cross transmission in the triage ward, the number of beds was reduced to allow a minimum bed-to-bed distance of 2 meters. A dedicated team of physicians and nurses was formed to provide care to all patients admitted to the designated areas.

At the emergency department, all new cases and transfers from other hospitals were systematically evaluated and admitted to the triage ward when patients presented with fever and an infiltrate on chest x-ray. In the triage ward, patients underwent the necessary evaluation for SARS. All patients with a clinical diagnosis of community-acquired pneumonia were treated with antibiotics in accordance with recommended guidelines.²⁶ Patients were promptly moved to the SARS ward when their conditions deteriorated despite antibiotics,

or to the step-down ward if their conditions improved and the diagnosis of SARS was deemed not likely.

Active surveillance was implemented in the general wards to identify and promptly isolate any previously unrecognized cases of SARS.

Reconfiguration of Other Parts of the Hospital

To reduce nosocomial transmission, investigations and procedures for SARS patients were carried out in areas separated from other patients. Imaging examinations were performed outside the radiology department as often as possible, using portable x-ray units for inpatients as well as in the emergency department. Imaging units such as ultrasound and CT equipment were dedicated to SARS patients when feasible. The management and reconfiguration of a radiology department in Singapore to deal with the SARS epidemic are described by Tsou and colleagues.²⁷

Personal Protective Equipment

In high-risk areas, personal protective equipment, including surgical or N-95 masks, gloves, gowns, goggles, and caps, were worn and discarded carefully after use. Gloves should not be washed and reused between patients. Hand-washing after glove removal is important, as washing gloved hands is not effective for decontamination. A review of SARS cases in Toronto found that some healthcare workers who acquired SARS were not fit-tested and had not been trained to use personal protective equipment; but the study did not distinguish whether it was the fact that fit testing was not done or the lack of training that accounted for these healthcare workers' getting infected.²⁸

High-risk Procedures

High-risk procedures such as the use of jet nebulizers, bronchoscopy, noninvasive positive-pressure ventilation and intubation²⁵ were avoided unless absolutely indicated. When indicated, they were carried out in a room with negative pressure ventilation and healthcare workers were fully protected by using personal protective devices.

To avoid the need for cardiopulmonary resuscitation, early recognition of a sick patient followed by close monitoring and early involvement of the intensive care unit team and/or anesthesia team were important. Endotracheal intubation might cause the patient to cough and often necessitates open suctioning of respiratory secretions. A closed suction system for ventilated patients decreased air leak and reduced the risk of disease transmission. Intubation done by these experts and done with patients adequately sedated reduced contamination by infectious secretions and the risk of transmission of disease to hospital staff.

Training and Monitoring of Hospital Staff

Very clear guidelines for infection control were developed for hospital staff, and all staff attending the isolation wards were trained in infection-control measures and how to put on and remove personal protective equipment. Direct contact with the patient or contact with an environment contaminated by respiratory droplets might lead to healthcare workers' infecting themselves as they removed their personal protective gear. Many healthcare workers apparently lacked a clear understanding of how best to remove personal protection gear without contaminating themselves.²⁹

Surveillance of Healthcare Workers

Active and/or passive surveillance for fever and respiratory symptoms among healthcare workers were practiced in healthcare facilities in Hong Kong and other affected areas. In one institution in Toronto,³⁰ all hospital staff and visitors were required to complete a SARS screening questionnaire before being permitted to enter the building after one unsuspected patient was diagnosed with SARS in the intensive care unit. Individuals who did not pass the screening questionnaire or temperature check were referred either to the hospital's emergency department or to the occupational health department.³⁰ During the surveillance period, 15 individuals were identified as meeting the case definition of probable SRS in this institution. No additional cases were identified after infection-control precautions were instituted and following the implementation of aggressive surveillance procedures.

Designating Dedicated SARS Hospitals

In China, a new hospital outside Beijing, dedicated to SARS patients, was erected within one week. In Taiwan, hospitals throughout the island were designated dedicated to SARS patients to reduce transmission.³¹ In Hong Kong, one general hospital was designated initially, but the influx of patients (400 to 500 suspected cases) in the course of one week overwhelmed the capacity of the hospital to deal with such infectious and sick patients, who required a great deal of care, and led to infection of hospital staff stemming from the excessive workload.²³

It is not known at present which elements of SARS isolation are effective, as they have not been subjected to evidence-based evaluation. Consequently, infection-control practices at the moment are simply a matter of opinion.

PSYCHOLOGICAL EFFECTS OF THE SARS OUTBREAK ON HEALTHCARE WORKERS

Healthcare workers, especially those in hospitals, are at high risk for contracting SARS. At the onset of the epi-

demically, they were caught unaware and were not prepared. There were many reasons for the anxiety and fear. The causative agent was unknown at first. When it became known, no specific agent was available for treatment. The perception of personal danger was heightened by the fact that the disease is relatively infectious, is associated with high morbidity (20–30% of cases requiring intensive care), and can be lethal (case fatality rates varied between 5% and 27%).²² In the beginning, the workers were not familiar with infection-control measures, and these measures were modified day by day and sometimes hour by hour, thus increasing the uncertainty. Moreover, in Hong Kong, in some hospitals there was a shortage of supplies in the beginning, when there was a great influx of suspected SARS patients.

During the epidemic, all hospital workers felt lonely and isolated from the outside world. All gatherings were discouraged; teaching and meetings were discontinued. Staff members were discouraged from interacting with the outside world. Eating and drinking, which required removal of the mask, were done alone in the hospital. E-mails were used extensively for communication rather than face-to-face encounters. In Hong Kong, many hospital workers were afraid that they might infect their family members and stayed in hospital facilities instead of going home. Some hospital workers even sent their children to stay with relatives during the epidemic.

Maunder et al.³² described in detail the immediate psychological and occupational impact of the outbreak in a teaching hospital in Toronto. In some hospitals, employees who had potentially contacted patients with SRS entered voluntary ten-day quarantine. Quarantined staff worried about their personal safety, about stigmatization, and about interpersonal isolation. Staff members who were not directly involved in patient care were deemed nonessential and were asked to stay home. Those who were working were concerned about understaffing, while those who were not working felt ineffective in contributing meaningfully to the crisis. On medical wards that treated patients with SARS, some staff reported anxiety about infection and resentment about being chosen for the task. Heightened anxiety occurred in association with special events such as a change in isolation precaution procedures, when staff entered quarantine or treatment, when healthcare workers were admitted with unclear sources of infection, and when one of the SARS-units' staff developed a fever. Caring for colleagues with SARS increased the anxiety. Many reported fatigue, insomnia, irritability, and decreased appetite.

Measures described by Maunder et al.³¹ to deal with the psychological stress of hospital staff included clear communication of directives and disease information from the hospital, a high degree of collaboration between disciplines, and the provision of support services that were flexible, collegial, and unintrusive. A

drop-in support center, a confidential telephone support line staffed by psychiatric nurses, and an informal network of mutual telephone contacts and support were some of the measures that proved to be useful.

CONCLUSION

Extensive transmission of SARS in hospital settings during the epidemic was largely the result of lack of knowledge and awareness of the disease among the healthcare profession at the onset of the epidemic and laxity of institutional infection-control practices. Now that the epidemic appears to have subsided, it is advisable for all hospitals and institutions to evaluate and improve their infection-control practices to limit possible future outbreaks of SARS (as well as other nosocomial outbreaks). The teaching and training of the medical profession in infectious diseases and the capacity of the public health sector to deal with these diseases must be strengthened. The World Health Organization has recommended that even without a resurgence of new cases, there should be at least a full year of surveillance to determine whether the disease has established itself as an endemic disease. All healthcare workers in previously affected areas should remain vigilant.

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