An Outbreak of Severe Acute Respiratory Syndrome among Hospital Workers in a Community Hospital in Hong Kong

Alice S. Ho, MB, FRCP; Joseph J.Y. Sung, MB, PhD, FRCP; and Moira Chan-Yeung, MB, FRCP, FRCPC

Background: **During outbreaks, hospital workers are at high risk for nosocomial infection with severe acute respiratory syndrome (SARS)–associated coronavirus.**

Objective: **To examine how hospital workers became infected and whether they transmit the virus to their families.**

Design: **Retrospective descriptive study.**

Setting: **529-bed community hospital in Hong Kong.**

Patients: **40 hospital workers infected with SARS-associated coronavirus over a 6-week period (25 March through 5 May 2003).**

Measurements: **Percentage of infected hospital workers according to job category.**

Results: **The cumulative incidence was highest among health care assistants, followed by physicians and nurses (8%, 5%, and 4%, respectively). Most hospital workers were infected from direct contact with patients with SARS, who primarily were in general wards and had unsuspected infection. At the time of contact, all hospital workers had used masks but not necessarily other protective devices. Affected hospital workers did not infect their families.**

Conclusion: **Before isolation of all patients with clinically confirmed or suspected SARS, routine use of several protective devices, and training of staff in infection control, many health care workers were infected with SARS from patients with unsuspected cases.**

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For author affiliations, see end of text.

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Severe acute respiratory syndrome (SARS) due to coronavirus infection is a new disease that quickly spread globally from southern China (1, 2). Much information has been learned about the clinical features of the disease (3–5), the causative virus (1, 6, 7), and the complete genome of the virus (8–10).

The outbreak in Hong Kong started in late February 2003 when a physician arrived from Guangzhou, China, to attend a wedding. He stayed briefly in a hotel and infected 12 guests, who brought the virus with them as they returned home to their respective countries (3). In Hong Kong, the disease initially involved hospital workers before spreading to the community. Hospital workers were at a high risk for developing SARS (11, 12) and accounted for about one quarter of the cases in Hong Kong and 65% of the cases in Canada (12).

We report an outbreak of SARS among workers at a community hospital in Hong Kong. We examined how hospital workers became infected and whether they transmitted the virus to their family members.

METHODS

This retrospective study was conducted among all workers at a 529-bed community hospital who developed SARS. This hospital served the Tai Po District in the New Territories. The hospital staff consisted of 1312 persons: 138 physicians, 500 nurses, 144 allied health workers, 126 health care assistants, 131 administrative and clerical workers, and 273 support staff (for example, catering staff and guards). In addition, 93 full-time and 65 part-time employees of a private company were contracted for cleaning the hospital. During the epidemic, the hospital admitted patients directly from the emergency department and from other hospitals of the same regional cluster.

We reviewed the records of 40 workers of this hospital who met the Hong Kong Hospital Authority's case definition of probable SARS from 25 March to 5 May 2003. The definition consisted of 1) body temperature greater than 38 °C; 2) infiltrate on chest radiograph; 3) at least 2 of the following: chills in the last 2 days, new or increased cough, and general malaise; and 4) a history of contact with a patient with known SARS or a history of travel to southern China, where the epidemic originated. The following information was obtained: demographic data, job category, date of contact with patient with SARS, date of symptom onset, use of precautionary measures, and whether family members or close friends developed the disease.

We tested acute and convalescent serum samples for IgG antibodies to SARS-associated coronavirus using an indirect immunofluorescent method, as described previously (13). In some patients, nasopharyngeal aspirate and stool samples were sent for SARS-associated coronavirus RNA testing using reverse-transcriptase polymerase chain reaction (13).

Ethics committee approval was unnecessary because this study was retrospective and descriptive.

RESULTS

The crude attack rates in hospital workers for each of the successive 6 weeks from 25 March were 6.1, 10.2, 8.8, 2.0, 0, and 0/1000 persons. No infected hospital worker was reported after the week of 22 April. **Table 1** shows the cumulative incidence of infection over 6 weeks by job category. The incidence was highest in health care assistants (8%), followed by physicians (5%) and nurses (4%).

Characteristics of Affected Hospital Workers

The mean age of affected hospital workers was 36 years; most affected workers were female (**Table 2**). All

workers were positive for IgG antibodies to the SARS-associated coronavirus.

All hospital workers developed SARS from exposure at work. Thirty-two had direct contact with patients with SARS, 2 had contact with coworkers who subsequently developed SARS, and 3 had contact with both patients and coworkers with SARS. Three workers were cleaners who had no direct patient contact but had worked in a pneumonia triage ward. Of the 32 hospital workers infected as a result of contact with patients, 11 were exposed to patients with suspected SARS and 21 were exposed to infected patients in whom SARS was unsuspected.

None of the hospital workers infected their immediate family members or close friends. Many hospital workers isolated themselves by residing at the hospital when they were assigned to the isolation wards. The average time between symptom onset and hospitalization was 2.7 days.

Location of Infected Hospital Workers and Patients

The outbreak centered on 4 wards (wards A through D). On 23 March 2003, 2 patients with fever and an infiltrate on chest radiograph were admitted to ward A. Both patients reported no history of contact with persons with SARS or travel to southern China. The patients infected 9 health care workers before being transferred to an infectious disease hospital.

Ward B received a patient with diarrhea and abdominal pain from another hospital where a SARS outbreak had started in early March. Three days later, he developed fever and an infiltrate on chest radiograph; he was then transferred to ward C. Sixteen affected hospital workers (4 in ward B and 12 in ward C) and 8 patients in ward C were linked to this patient.

When ward A was closed for disinfection, ward D housed the ward A patients who had had contact with patients with suspected SARS. Seven health care workers developed disease while working in ward D between 7 April and 13 April.

Eight hospital workers were exposed to patients with SARS in other parts of the hospital, but none was infected as a result of working in SARS isolation wards.

Infection-Control Measures

At the end of March, hospital areas were classified according to risk for exposure to patients with SARS. Ultra-high-risk areas (isolation rooms in medical wards and the intensive care unit) were provided with N95 masks, gowns, gloves, and eye shields. Workers were instructed to dispose these materials after one-time use. High-risk areas (medical and pediatric wards) were given the same materials, with instructions to use them for 1 work-shift and then dispose them. Thus, protective devices were reused at least once in high-risk areas. In low-risk areas (the rest of the hospital), workers were given only surgical masks. All hospital workers, regardless of job title, were given the same protective materials according to where they worked.

At the time of SARS contact, all infected workers had used surgical or N95 masks. Some had used gowns (55%) and gloves (58%). Only 28% of infected workers had used eye shields (available on 7 April) because of limited supply, and 73% regularly washed their hands (**Table 2**). Protective device did not differ between job categories.

All hospital workers were trained in infection-control measures by the beginning of April. Two isolation wards were established for patients with SARS on 14 April. No new infection of hospital staff occurred after 22 April.

Context

During outbreaks, health care workers may be at high risk for contracting severe acute respiratory syndrome (SARS).

Contribution

This retrospective study from a community hospital in Hong Kong describes 40 health care workers who contracted SARS from infected patients or coworkers. During early weeks of the outbreak, about 8% of the health care assistants, 5% of the doctors, and 4% of the nurses developed SARS. All reportedly had used surgical masks.

Implications

Simply wearing surgical masks doesn't protect health care workers from SARS. More elaborate measures are needed.

–The Editors

DISCUSSION

During an outbreak, hospital workers are at high risk for developing SARS from nosocomial infection (1, 8–10). In this outbreak in a community hospital in Hong Kong, most infected staff (35 of 40) were infected from direct patient contact and 2 were infected from contact with coworkers. Only 3 (who were cleaners) had no direct patient contact. The outbreak was contained after isolation of patients with clinically confirmed and suspected SARS, use of several protective devices, frequent hand washing, and training in infection-control measures. Our findings were similar to those reported locally (14) and in Canada (15).

Table 1. **Estimated Cumulative Incidence of Severe Acute Respiratory Distress Syndrome over a 6-Week Period in Health Care Workers by Job Category***

Job Category	Health Care Workers	Health Care Workers with SARS	Estimated Cumulative Incidence	Proportion of all SARS Cases in Hospital
	n		%	
Physicians	138	7	5	18
Nurses	500	19	4	48
Health care assistants	126	10	8	25
Cleaners	158	3	2	7
Clerical staff	131	1	8	2

* SARS = severe acute respiratory syndrome.

Table 2. **Characteristics of Hospital Workers with Severe Acute Respiratory Distress Syndrome***

Worker	Sex	Age, *y*	Job Title	Symptom Onset Date	Hospitalization Date	Symptoms	Exposure Location
1	M	35	Nurse	3/25/03	3/28/03	Fever, myalgia, malaise	Ward A
2	F	28	Nurse	3/28/03	3/31/03	Fever, chills, myalgia, malaise	Ward A
3	M	25	Physician	3/29/03	3/31/03	Fever, chills, myalgia, malaise, headache, rigor	Ward B
4	F	24	Nurse	3/29/03	4/4/03	Fever, sore throat, sputum, dizziness	Ward C
5	F	38	HCA	3/29/03	4/7/03	Fever, chills, myalgia, headache, cough, dyspnea, dizziness	Ward A
6	M	36	Nurse	3/30/03	4/4/03	Fever	Ward B
7	F	40	HCA	3/30/03	4/5/03	Fever, chills, myalgia	Ward B
8	F	33	Nurse	3/31/03	3/31/03	Fever, chills, malaise, sore throat, cough	Ward A
9	F	27	Nurse	3/31/03	3/31/03	Fever, chills, sore throat, chest pain	Ward A
10	F	50	Cleaner	4/1/03	4/3/03	Fever, chills, rigor	Ward A
11	F	37	HCA	4/1/03	4/6/03	Fever, chills, myalgia, headache	ICU
12	F	29	Nurse	4/1/03	4/7/03	Fever	Ward C
13	M	30	Nurse	4/2/03	4/4/03	Fever, runny nose	Ward C
14	F	36	Physician	4/3/03	4/3/03	Fever, chills, myalgia, sore throat	Emergency department
15	F	40	Clerical	4/3/03	4/7/03	Fever, chills, myalgia	Ward C
16	F	30	Physician	4/4/03	4/5/03	Fever, chills, myalgia	Ward F5
17	M	29	Physician	4/5/03	4/7/03	Fever, myalgia, malaise	Ward A
18	F	42	HCA	4/5/03	4/10/03	Fever, chills, myalgia, headache	Ward C
19	F	35	Nurse	4/5/03	4/14/03	Fever, chills, night sweats	Ward C
20	F	26	Nurse	4/5/03	4/6/03	Fever, chills, myalgia	Ward C
21	F	29	Nurse	4/6/03	4/9/03	Fever, chills	Ward C
22	F	30	Nurse	4/7/03	4/7/03	Fever, chills, myalgia	Ward C
23	F	31	Physician	4/7/03	4/9/03	Fever, myalgia, dyspnea	Ward D3/Ward B
24	F	54	HCA	4/7/03	4/12/03	Fever, chills, myalgia, cough, sputum, dyspnea	Ward D
25	F	25	Nurse	4/8/03	4/9/03	Fever, chills	Ward C
26	F	37	Nurse	4/9/03	4/11/03	Fever, chills, myalgia, chest pain	Ward B
27	M	25	Physician	4/9/03	4/11/03	Fever, chills	Ward F1
28	F	40	Nurse	4/10/03	4/14/03	Fever, chills	D6 Renal unit
29	M	39	Nurse	4/10/03	4/15/03	Fever, rigor	Ward F5
30	F	50	Cleaner	4/11/03	4/11/03	Fever, chills, myalgia, headache	Ward A
31	F	42	HCA	4/11/03	4/12/03	Fever, chills, myalgia	Ward D
32	F	24	HCA	4/11/03	4/12/03	Fever, chills, headache	Ward D
33	M	34	Nurse	4/11/03	4/14/03	Chills, myalgia, sore throat, cough, sputum, diarrhea, runny nose	Ward C
34	F	49	HCA	4/12/03	4/14/03	Fever, chills, myalgia, cough	Ward D
35	F	41	HCA	4/12/03	4/14/03	Fever, headache	Ward F1
36	M	48	Cleaner	4/12/03	4/14/03	Fever, chills, rigor	All medical wards
37	F	41	Nurse	4/14/03	4/15/03	Fever	Ward D/Ward F1
38	F	37	Nurse	4/16/03	4/17/03	Fever, cough	Ward C
39	F	32	Physician	4/17/03	4/18/03	Fever	All medical wards
40	F	32	HCA	4/21/03	4/22/03	Fever, myalgia, headache, cough	Ward A

* F = female; HCA = health care assistant; ICU = intensive care unit; M = male.
† Eye shield supply started on 7 April 2003.

Hospital wards in Hong Kong were categorized into ultra-high-risk, high-risk, and low-risk areas according to whether the ward had patients with SARS. The types of protective devices that were dispensed depended on the risk category. The outbreak resulted from staff exposure to patients with unsuspected SARS in low-risk general wards. These findings indicate that during an outbreak, physicians must have a very high index of suspicion for SARS in patients presenting with fever and a lung infiltrate. Unless hospitals use meticulous screening to exclude patients with suspected SARS from admission to general wards, hospital workers should regard every patient area as high-risk and be assiduous in their infection-control measures. Moreover, none of the hospital workers was infected from working in the ultra-high-risk SARS isolation wards, where infection-control measures were strictly enforced.

Health care assistants had the highest crude attack rate of SARS, perhaps because of their close contact with patients. The 3 cleaners, who developed SARS from cleaning an isolation room, had no direct patient contact. They were probably infected as a result of fomite transmission.

The SARS-associated coronavirus is primarily transmitted by droplets and by direct contact (16). In our retrospective study, all infected hospital workers claimed that they had used masks during contact. This conflicts with the findings of Seto and colleagues, who reported a 13-fold increased risk for infection when workers did not use masks, either surgical or N95 (16). In our community hospital, workers were not fit-tested for N95 masks, which were available toward the end of March. The use of surgical masks alone may be inadequate protection.

Hospital workers in this study did not infect any of

Table 2—**Continued**

Protection Measures					IgG Antibody Titer in Convalescent Serum
Mask	Gown	Gloves	Eye Shields†	Handwashing	
Yes	No	No	No	No	320
Yes	No	No	No	No	320
Yes	No	No	No	No	50
Yes	No	Yes	No	Yes	320
Yes	No	No	No	Yes	320
Yes	No	No	No	Yes	320
Yes	No	Yes	No	Yes	640
Yes	No	No	No	No	320
Yes	No	No	No	No	160
Yes	Yes	No	No	No	400
Yes	Yes	Yes	No	Yes	640
Yes	No	No	No	Yes	640
Yes	No	No	No	No	160
Yes	Yes	Yes	No	No	320
Yes	No	No	No	No	320
Yes	No	No	No	Yes	160
Yes	Yes	No	No	Yes	320
Yes	Yes	Yes	No	Yes	320
Yes	Yes	Yes	No	Yes	160
Yes	No	No	No	No	320
Yes	Yes	Yes	No	Yes	40
Yes	No	No	No	Yes	40
Yes	No	Yes	No	Yes	640
Yes	Yes	Yes	No	Yes	320
Yes	Yes	Yes	No	Yes	320
Yes	No	No	No	Yes	>640
Yes	Yes	Yes	No	No	320
Yes	Yes	Yes	No	Yes	640
Yes	Yes	Yes	Yes	Yes	320
Yes	Yes	Yes	Yes	Yes	>640
Yes	Yes	Yes	Yes	Yes	80
Yes	Yes	Yes	Yes	Yes	320
Yes	Yes	Yes	Yes	Yes	320
Yes	Yes	Yes	Yes	Yes	320
Yes	No	No	Yes	Yes	80
Yes	Yes	Yes	Yes	Yes	640
Yes	Yes	Yes	Yes	Yes	640
Yes	Yes	Yes	Yes	Yes	640
Yes	Yes	Yes	No	Yes	320
Yes	Yes	Yes	Yes	Yes	160

their family members or close friends. The workers were aware of the infectious nature of SARS, and many isolated themselves from their families and friends when they were assigned to the isolation wards. In addition, they presented themselves early for hospitalization and treatment. The average time between symptom onset and hospitalization was 2.7 days, compared with 5 days for community cases (3–5).

In summary, this retrospective case series suggests that strict isolation, infection-control measures, and adherence to protective device use may be important in preventing nosocomial SARS. During outbreaks, a high index of suspicion for SARS is needed to avoid admitting patients with unsuspected SARS to general wards, where protection may be inadequate and infection-control awareness low.

From Alice Ho Miu Ling Nethersole Hospital, The Chinese University of Hong Kong, and The University of Hong Kong, Hong Kong, China.

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Requests for Single Reprints: Moira Chan-Yeung, MB, FRCP, FRCPC, University Department of Medicine, 4/F Professorial Block, Queen Mary Hospital, Hong Kong; e-mail, mmwchan@hkucc.hku.hk.

Current author addresses and author contributions are available at www.annals.org.

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