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Cluster of Severe Acute Respiratory Syndrome Cases Among Protected Health-Care Workers — Toronto, Canada, April 2003

Infections among health-care workers (HCWs) have been a common feature of severe acute respiratory syndrome (SARS) since its emergence. The majority of these infections have occurred in locations where infection-control precautions either had not been instituted or had been instituted but were not followed. Recommended infection-control precautions include the use of negative-pressure isolation rooms where available; N95 or higher level of respiratory protection; gloves, gowns, and eye protection; and careful hand hygiene. This report summarizes a cluster of SARS cases among HCWs in a hospital that occurred despite apparent compliance with recommended infection-control precautions (*1*).

The index patient was a Canadian family physician aged 54 years with a history of hyperlipidemia, hypertension, and noninsulin-dependent diabetes controlled on oral medications. During April 1–2, 2003, he examined three patients who were family members involved in a community cluster of SARS in Toronto, Ontario (*2*). No infection-control precautions were used. On April 4, he had fever, myalgia, headache, mild diarrhea, and a dry cough; on medical evaluation, he had a clear chest radiograph, but he continued to feel ill during home isolation. On April 8, he was reevaluated and found to have a left upper-lobe infiltrate on a repeat chest radiograph; he was admitted to the SARS ward of hospital A. During the next several days, he remained febrile with increasing cough, although his diarrhea resolved. On April 12, the patient's temperature was 104.7° F (40.4° C), his chest radiograph showed worsening pneumonia, and he required supplemental oxygen for hypoxia. He was treated with ipratropium bromide and albuterol sulfate by metered dose inhaler, intravenous (IV) ribavirin, and steroids. On April 12, he had a nearly constant cough and was assessed for transfer to the intensive care unit (ICU). On April 13, the patient was transported to the ICU in a wheelchair on 100% oxygen through nonrebreather face mask. Soon after his arrival in the ICU, his measured oxygen saturation decreased to 60%, and he was placed on positive pressure ventilation through face mask (BiPAP). Because of severe cough and agitation, he removed the mask repeatedly despite administration of IV sedation. After an approximately 2-hour attempt to provide oxygen through BiPAP, the patient was intubated. During intubation, he had copious frothy secretions that later obstructed the ventilator tubing, requiring disconnection and drainage. Once supported with mechanical ventilation, the patient was sedated further by using IV midazolam/morphine sulfate.

Later that evening, the patient was switched from assist-control ventilation to high-frequency oscillatory ventilation (HFOV) because of continued inadequate oxygenation. At this point, the patient's condition stabilized, and he was maintained on HFOV for 7 days, after which he was switched back to assist-control mode. As of May 14, the patient remained in critical condition. Both a sputum sample collected from the patient on April 13 and a stool sample collected on May 5 were positive for the SARS-associated coronavirus (SARS-CoV) by polymerase chain reaction.

INSIDE

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During April 15–21, nine HCWs who had cared for this patient around the time he was intubated had illnesses consistent with the World Health Organization case definition for suspect or probable SARS (*3*); another two HCWs had symptoms that were not consisent with the case definition (Table). Six of these 11 HCWs had been present during the intubation procedure. Interviews with affected HCWs indicated that they all had worn the recommended personal protective equipment each time they entered the patient's room, including gown, gloves, PCM2000™ duckbill masks (Kimberly Clark Health Care, Roswell, Georgia), and goggles with or without an overlying face shield.

The room in which the intubation took place was at negative pressure to the hallway, and all air was vented to the outside after high-efficiency particulate air filtration; however, no anteroom was available, and removal of personal protective equipment took place in a staged manner both inside and outside the room, with the door kept closed between each entry and exit. Understanding of the correct order to remove personal protective equipment (PPE) (i.e., gloves first followed by mask and goggles) varied among HCWs.

Masks worn by HCWs inside ICU rooms and halls were changed on leaving each patient's room; however, no formal respiratory protection program existed at the hospital, and individual workers had not been fit tested. In addition, the primary nurse for the patient had a small beard and reported that his mask did not fit well. Although he wore both a PCM2000™ duckbill mask and a surgical mask with face shield, he sometimes could feel air entering around the sides of his mask.

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Editorial Note: Transmission of SARS appears to result primarily from direct patient contact or contact with large respiratory droplets in the close vicinity of an infected person. Despite apparent limited modes of transmission, SARS has been known to spread extensively among HCWs in various settings. For example, among 138 cases of secondary and tertiary spread in Hong Kong, 85 (62%) occurred among HCWs (*4*); among 144 cases in Toronto, 73 (51%) were HCWs (*5*). SARS infection of HCWs might be related to increased contact with respiratory secretions, contact with patients during a more contagious phase of critical illness, contact with particular patients at increased likelihood of spreading SARS (i.e., super spreaders), or exposure to aerosol-generating patient-care procedures (*6*).

TABLE. Characteristics of 11 health-care workers who had symptoms of severe acute respiratory syndrome (SARS) following exposure to the index patient during the time of his intubation — Toronto, Canada, April 15–21, 2003

Health-care worker	Symptom onset date	Suspect or probable SARS case	Occupation	Exposure
1	April 15	Suspect	Respiratory therapist	Provided care before, during, and after intubation in ICU*
2	April 16	Suspect	ICU nurse assigned primarily to another patient	Provided care before, during, and after intubation in ICU
3	April 16	Suspect	ICU primary nurse	Provided care before, during, and after intubation in ICU
4	April 16	Suspect	Respiratory therapist	Provided care before, during, and after intubation in ICU
5	April 16	Probable	Ward physician	Examined patient on ward during morning of April 13
6	April 17	Probable	ICU physician	Provided care before, during, and after intubation in ICU
7	April 17	Suspect	ICU charge nurse	Provided care before, during, and after intubation in ICU
8	April 18	Suspect	ICU physician	Examined patient on ward during early morning of April 13
9	April 18	Suspect	Radiology technician	Performed chest radiograph of patient on ward during early morning of April 13
10	April 18	Not a case†	ICU nurse assigned primarily to another patient	Provided care after intubation in ICU
11	April 21	Not a case§	ICU physician	Provided care before intubation in ICU

* Intensive care unit.
† Illness marked by headache, cough, and diarrhea but without fever.
§ Illness marked by cough and infiltrate on chest radiograph but without fever.

Health Canada and CDC are aware of several unpublished reports of SARS clusters among unprotected HCWs involved with intubation, both in Canada and outside North America. The cluster described in this report might be unique, as HCWs appear to have followed infection-control precautions recommended by Health Canada. The Health Canada recommendations, although similar to those of CDC, differ from CDC guidelines with respect to respiratory protection. CDC guidelines specify use of respirators approved by the National Institute for Occupational Safety and Health (NIOSH) rated at an N95 level of protection or greater (*7*). Health Canada recommends use of "N95 equivalent" respirators (*8*). The respirators used in hospital A, although compliant with Canadian public health recommendations, were not NIOSH-approved. In addition, at the time these exposures occurred, fit testing was not recommended by Canadian public health authorities; such testing has been mandated in the United States since 1972.

Endotracheal intubation might cause an awake or a semiconcious patient to cough and often necessitates open suctioning of respiratory secretions. In addition, other potentially aerosol-generating procedures were performed on this patient, including BiPAP, during which air might be forced out around the face mask and thereby aerosolize secretions, and HFOV, during which exhaust from the ventilator tubing is more likely to escape without passing through an antibacterial/antiviral filter. The patient also was in his second week of illness with clinical deterioration and severe cough, possibly explaining why HCWs who were exposed to the patient only before his transfer to the ICU became infected, as the viral loads of patients at this stage of illness appear high (*9*).

Direct contact with the patient or contact with an environment contaminated by large respiratory droplets might have led to HCWs infecting themselves as they removed their PPE. For example, HCWs have been known to spread other nosocomial pathogens from patient to patient despite the use of barrier precautions; even in the best of circumstances, correct use of PPE might be suboptimal. If contact or droplet spread alone were responsible for this cluster, a lapse in technique would be required on the part of each infected HCW. Many HCWs apparently lacked a clear understanding of how best to remove PPE without contaminating themselves. Alternatively, aerosolizing procedures or the patient's own cough might have led to airborne spread, and either the level of respiratory protection used or the manner in which it was used did not prevent transmission.

This cluster is part of a larger number of cases in HCWs in hospitals in the greater Toronto area who have become infected while caring for SARS patients since directives for contact, droplet, and airborne precautions were instituted at the provincial level on March 28 (*1*). Further investigation is necessary to determine factors associated with transmission despite the apparent use of recommended infection-control precautions.

HCWs caring for SARS patients should be properly trained in the correct use and removal of PPE and reminded of the importance of hand hygiene. Patients who are experiencing rapid clinical progression with severe cough during their second week of illness should be considered particularly infectious. Procedures that might generate aerosols (e.g., nebulized medications, BiPAP, or HFOV) should be avoided if possible.

When intubation is necessary, measures should be taken to reduce unnecessary exposure to HCWs, including reducing the number of HCWs present and adequately sedating or paralyzing the patient to reduce cough. Updated interim infection control precautions for aerosol-generating procedures on patients who have SARS are under development and will be available from CDC at http://www.cdc.gov/ncidod/sars/ic.htm.

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Update: Severe Acute Respiratory Syndrome — United States, May 14, 2003

CDC continues to work with state and local health departments, the World Health Organization (WHO), and other partners to investigate cases of severe acute respiratory syndrome (SARS). This report provides an update on reported SARS cases worldwide and in the United States.

During November 1, 2002–May 14, 2003, a total of 7,628 SARS cases were reported to WHO from 29 countries, including the United States; 587 deaths (case-fatality proportion: 7.7%) have been reported (*1*). The 345 SARS cases identified in the United States have been reported from 38 states, with 281 (81%) cases classified as suspect SARS and 64 (19%) classified as probable SARS (more severe illnesses characterized by the presence of pneumonia or acute respiratory distress syndrome) (Figure,Table) (*2*).

Of the 64 probable SARS patients, 44 (69%) were hospitalized, and three (5%) required mechanical ventilation. No SARS-related deaths have been reported in the United States. Of the 64 cases, 62 (97%) were attributed to international travel to areas with documented or suspected community transmission of SARS during the 10 days before illness onset; the remaining two (3%) probable cases occurred in a health-care worker who provided care to a SARS patient and a household contact of a SARS patient. Among the 62 probable SARS cases attributed to travel, 35 (56%) patients reported travel to mainland China; 18 (29%) to Hong Kong Special Administrative Region, China; six (10%) to Singapore; three (5%) to Hanoi, Vietnam; and eight (13%) to Toronto, Canada. Seven (11%) of these 62 probable patients had visited more than one area with SARS during the 10 days before illness onset.

Laboratory testing to evaluate infection with the SARS-associated coronavirus (SARS-CoV) has been completed for 96 cases (23 probable and 73 suspect). Of 20 probable SARS patients with complete test results, six with laboratory-confirmed infection with SARS-CoV have been identified (*3,4*); this number remains unchanged since the last update (*5*). None of the 73 suspect SARS patients evaluated has had laboratory-confirmed infection with SARS-CoV. Negative findings (i.e., the absence of antibody to SARS-CoV in convalescent serum obtained >21 days after symptom onset) have been documented for 90 cases (73 suspect and 17 probable).

Since the previous update (*5*), the epidemiology of SARS in the United States has not changed markedly; secondary spread to contacts such as family members and health-care workers is limited, and most cases continue to be associated with international travel to areas where SARS is being transmitted in the community. CDC has developed interim recommendations for businesses and other organizations with employees returning from areas with community transmission of SARS and for other organizations and institutions (e.g., schools) hosting persons arriving in the United States from such areas (*6,7*). CDC does not recommend quarantine of persons traveling to the United States from areas with SARS nor the cancellation or postponement of classes, meetings, or other gatherings that would include travelers from areas with SARS. Activities to prevent importation and spread of SARS from inbound travelers (*6*) include 1) pre-embarkation screening of persons traveling from areas with SARS, 2) assessment by health authorities of ill persons aboard flights arriving from areas with SARS to ensure that ill passengers are isolated and