

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

Note: This article is being made available on the Web prior to publication in the *Canada Communicable Disease Report* (CCDR). It will be published in an upcoming issue of the CCDR.

Infections among healthcare 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 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 with oral medications. During 1-2 April, 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 4 April, 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 8 April, 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.

Over the next several days the patient remained febrile with increasing cough, although his diarrhea resolved. On 12 April, the patient's temperature reached 40.4 °C (104.7 °F), 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 12 April, he had a nearly constant cough and was assessed for transfer to the intensive care unit (ICU). On 13 April, the patient was transported to the ICU in a wheelchair on 100% oxygen through nonrebreather facemask.

Soon after his arrival in the ICU, his measured oxygen saturation decreased to 60%, and he was placed on positive pressure ventilation through facemask (BiPAP). Because of severe cough and agitation, he removed the mask repeatedly despite administration of intravenous (IV) sedation. After an approximately 2-hour attempt to provide oxygen through BiPAP, the patient was intubated. During intubation, he had 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 14 May, the patient remained in critical condition. Both a sputum sample collected from the patient on 13 April and a stool sample collected on 5 May were positive for the SARS-associated coronavirus (SARS-CoV) by polymerase chain reaction.

Between 15 and 21 April, nine HCWs who had cared for this patient around the time he was intubated developed illnesses consistent with the World Health Organization case definitions for suspect or probable SARS⁽³⁾; another two HCWs had symptoms that were not consistent 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 (PPE) each time they entered the patient's room, including gown, gloves, PCM2000™ duckbill masks (Kimberly Clark Health Care, Roswell, GA), 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 PPE took place in a staged manner both inside and outside the room, with the door kept closed between each entry and exit. Understanding the correct order to remove 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™ and a surgical mask with face shield, he could sometimes feel air entering around the sides of his mask.

Table. Characteristics of 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, 15-21 April, 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	Provided care before, during, and after

			to another patient	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 13 April
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 13 April
9	April 18	Suspect	Radiology technician	Performed chest radiograph of patient on ward during early morning of 13 April
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

Source: M Ofner, Division of Blood Safety, Nosocomial and Occupational Infections, Health Canada; M Lem and S Sarwal, Field Epidemiology Training Program, Health Canada; M Vearncombe and A Simor, Sunnybrook and Women's College Health Sciences Centre, Toronto, Ontario, Canada, SARS Investigative Team, CDC.

Editorial note

Transmission of SARS appears to result primarily from direct patient contact or contact with large respiratory droplets within 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⁾.

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 but has been mandated in the United States since 1972.

Endotracheal intubation might cause an awake or a semiconscious 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 facemask 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 28 March⁽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. 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. Infection control precautions for SARS are available on the Health Canada SARS Website at http://www.hc-sc.gc.ca/pphb-dgsp/sars-sras/prof_e.html#control or <http://www.SARS.gc.ca> and click on Health Professionals and then Infection Control.

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