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Open tracheostomy in a suspect severe acute respiratory syndrome (SARS) patient: brief technical communication

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Patient management in the setting of severe acute respiratory syndrome (SARS) is complicated by the controversies about transmissibility, a reliable diagnostic tool and a clinically proven cure.[1–4] High-risk procedures are particularly problematic. Directives for high-risk procedures were published by Ontario's Ministry of Health and Long-Term Care in June 2003.[5]

Herein we describe the salient technical and essential infection-control principles[6] (S. Abrahamson, unpublished data) learned from our experience with open tracheostomy in a SARS patient. We could find only 1 other report[7] of tracheostomy in patients with or suspected of having SARS.

High-risk procedures such as intubation, bronchoscopy and tracheostomy should be done in a negative-pressure isolation environment. However, the Canadian Standards Association requires that operating rooms (ORs) operate at positive pressure. At present, there are no negative-pressure isolation rooms in Toronto. A patient's clinical status or anatomy may warrant the greater anesthetic and surgical safety provided by ORs. If the patient's clinical status is expected to improve, it is prudent to wait; but difficult surgical anatomy is a more daunting problem, and should be given due consideration.

The possibility of contamination in the OR of health care workers and other patients should be balanced against the potential for surgical mishap in the intensive care unit (ICU). If OR personnel are educated in and equipped with personal protective systems, and the procedure planned in advance in consultation with the hospital's infection prevention and control service, the risk to health care workers is likely to be small.

Case

While driving, a 73-year-old man with ankylosing spondolyitis was struck from behind by another vehicle. He was brought to hospital 7 days after this motor-vehicle accident (MVA) with right torticollis and progressive numbness and weakness. A fracture/dislocation through C7–T1 was diagnosed, and he was transferred to St. Michael's Hospital for definitive management. Physical examination revealed profound quadriparesis, worse in the lower extremities and on the right. He experienced no bowel or bladder incontinence. Computed tomography confirmed angulation at C7/T1 with narrowing of his spinal canal; magnetic resonance imaging showed spinal-cord compromise.

The patient was managed with skeletal and halo traction, with only minimal improvement. On day 16 post-MVA, he underwent a posterior decompression, instrumentation and fusion from C3 to T3. The procedure was uncomplicated, and he was transferred to the trauma and neurosurgery ICU in stable condition.

His postoperative course was com-

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plicated by pneumonia caused by a ciprofloxacin-resistant strain of *Pseudomonas aeurginosa* and *Enterococcal bacteremia*. He was treated with ceftazidime, gentamicin and ampicillin. The referring hospital, North York General Hospital, was an epicentre for the resurgence of SARS in Toronto that year. On day 25 post-MVA he was deemed a "suspect SARS patient" based on fever, respiratory symptoms and an epidemiologic link. He was placed in a negative-pressure isolation room with SARS precautions to reduce droplet and ærosol transmission of the presumed infection.

His strength gradually improved, and he was weaned to a pressure support of 8 cm H_2O and a positive end-expiratory pressure of 5 cm H_20 and an inspired-oxygen fraction of 40%. Copious secretions persisted, however, with an inadequate cough. The treating team was reluctant to proceed to extubation, given the likelihood of re-intubation. The decision to proceed with a tracheostomy was reached on day 50. We decided against a percutaneous tracheostomy because of the presence of halo traction in an anatomically difficult neck.

Methods and materials

The operative and anesthetic considerations in this case involved conflicting goals of patient care and safety balanced with the requirement to minimize potential risk to health care personnel. Although the OR is usually considered to be the ideal setting for a technically difficult tracheostomy, this would have incurred the risk of transporting a ventilated SARS patient through the hospital to the OR, exposure of additional personnel (transport, OR) and loss of the advantage of working in a negative-pressure environment. After consultation within the departments of anesthesia, critical care, surgery, infection prevention and control, and infectious diseases, a decision was reached to perform an open, bedside tracheostomy in this patient.

The procedure was planned the day before and done early on day 52, a Monday, to ensure access to additional personnel and equipment. It was performed in a negative-pressure isolation room in our medical–surgical ICU.

The staff anesthesiologist, respiratory technician (RT), staff surgeon, senior surgical assistant and OR nurse who were present wore an N95 mask, goggles and personal protective equipment (T4 Personal Protective Systems, Stryker Instruments, Kalamazoo, Mich.). The personal protective equipment and the gowning and de-gowning procedures outlined in Box 1 and Box 2 (S. Abrahamson, unpublished data) are described in greater detail elsewhere.[6] Every health care provider involved was educated beforehand about the personal protective equipment and the safe technique for gowning and de-gowning.

Equipment assembled before the procedure included a "difficult intubation" cart including all airway adjuncts and a fibre-optic bronchoscope with videocamera and screen. A tracheostomy set, cautery machine, suction, sutures and ties were brought from the ORs. All anesthetic and resuscitation drugs as well as infusion pumps were made available in the room. The patient was monitored with an arterial and central venous line; adequate intravenous access was secured as well.

Personnel available immediately outside the negative-pressure room included a nurse in the antechamber, 3 additional circulating or ICU nurses, an additional RT, a second anesthesiologist and the ICU attending physician. Our negative-pressure isolation rooms are equipped with hands-free telephone service, to ensure rapid communication with personnel outside the room.

The number of persons in the room was designed to provide optimal efficiency of all procedures, optimize patient safety and minimize health care persons at risk. An OR nurse and ICU nurse entered the room first to set up the instruments, open and test the tracheostomy appliance (6- and 8-cuffed Shilley [Tyco Healthcare, UK]). The anesthetist and RT entered next, to draw up medications and ready the patient. The surgeon and assistant entered last.

Total anesthesia was planned, with midazolam 0.1 mg, sufentanil 0.4 µg and propofol 150 µg per kilogram of body weight administered intravenously per minute, with a phenylephrine infusion to maintain an adequate mean arterial pressure near 80 mm Hg. Intravenous glycopyrrolate (0.4 mg) was given preoperatively to the patient as an anti-sialogogue. Pancuronium (0.2 mg/kg) was administered to prevent the patient from coughing. Inspired oxygen was maintained at 100%; to minimize the risk of airway fire, the surgeon used a scalpel to incise the trachea. To minimize aerosolization of tracheal secretions, the ventilator was turned off just before tracheal incision.

The patient was placed on a rigid spine board to counteract the lack of resistance offered by the pneumatic bed (KCI, Mississauga, Ont.). The front plate of the Halo device was removed. The patient's neck was prepped and draped. A horizontal incision was made in his skin and carried down through subcutaneous

Box 1. Gowning protocol before a high-risk procedure* in a suspect or probable† SARS patient

1. Remove jewellery, pager and stethoscope, and tie hair in pony-tail if necessary.
2. Rinse hands with a 70% ethyl alcohol solution.
3. Don a fit-tested, previously unused N95 respirator [mask].
4. Don goggles with side shields and elastic headstrap.
5. Don operating room (OR) cap.
6. Tuck OR greens into socks.
7. Don OR shoe covers and plastic bag atop, and a second pair of shoe covers.
8. Don T4 Stryker Helmet.
9. Put on battery pack — clip to OR scrubs.
10. Connect helmet to battery pack.
11. Don isolation gown.
12. Don 1st pair of gloves.
13. Don toga.
14. Don 2nd pair of surgical gloves.

*High-risk procedures include intubation, brochoscopy and/or tracheostomy.
†As defined by the infection control and public health teams.

tissues. The strap muscles were divided in the midline and the trachea bared. At this point, the ventilator was turned off. Stay sutures were placed on either side of the midline around the second tracheal ring. The trachea was incised and dilated. The tracheostomy appliance, which had been checked and assembled previously, was introduced into the trachea. The ventilator was reattached and resumed function. The tracheostomy cuff was inflated and the presence of expired end-tidal CO_2 was confirmed. The tracheostomy was secured in place and trach ties were used to further stabilize the appliance.

Personnel exited the patient's room one by one, with the assistance of a nurse educated in the proper de-gowning procedure. After the patient's hemodynamic stability, end-tidal CO_2 and arterial oxygenation were confirmed, his care was handed over to the ICU attending physician. The procedure, from gowning to de-gowning, took 1.5 hours.

Discussion

High-risk procedures in patients with known or suspected infectious agents must be performed in a manner that minimizes risk to health care personnel and optimizes patient care. In recent history, this precarious balance has been experienced during polio, tuberculosis and influenza epidemics. Fortunately, mass quarantines of patients suffering from airborne infections have not occurred since the influenza epidemic of the 1920s.

In the early 1980s, the medical community faced the new challenges of patient care and control of infectious risk posed by the HIV virus. Health care workers continue to struggle with containment of resistant strains of tuberculosis. However, neither of these conditions poses the same degree of risk of transmissibility as SARS.

SARS is the latest in a series of new pathogens.[2] The mode of spread of this organism is primarily droplet. However, there is evidence from super-spreading events that the virus may be airborne during certain high-risk procedures.[8] Of concern is the fact that of the first 144 SARS patients in Toronto, half were health care workers. N95 masks are clearly protective; however, there have been reports[9] of N95 masks being removed from health care workers by agitated patients. Recent studies[10] have shown that the greatest reductions in particle count (0.02–1 μm) are achieved with the Stryker T4 system. N95 respirators provide significantly better filtration than the Styker T4 alone.[10,11] The Styker T4 protective system, however, provides the best protection against droplet spread. In addition, it prevents against the N95 respirator being inadvertently removed, either by the health care provider or by a distressed patient.

With all this in mind, we chose the T4 Styker system worn over an N95 mask and eye goggles. We increased our protection with foot and lower-leg coverings. In our experience, this system provided a high level of protection, was relatively practical to use, and was perhaps slightly less cumbersome than other means when putting on and taking off the device.

There are technical challenges to bedside tracheostomy in a SARS-infected patient. Patient positioning on a pneumatic ICU bed is difficult, because the patient's anatomy sinks away from the surgeon with any manipulation. ICU beds are wider than the usual OR tables, making it difficult to reach the patient.

Additional limitations are imposed by personal protective systems. A fan intrinsic to the system is designed to provide relief from body heat, but condensation on the surgeon's goggles and the visor limits visibility. The equipment and headgear are one-size-fits-all, and necessarily shifts as the wearer moves about the room. The fan and the helmet make it very difficult to hear and communicate with the other members of the operative team. The lighting in the ICU was inadequate and the helmet had no provision for the surgeon to wear a headlight; we utilized a bright overhead lamp. As always, detail-oriented planning of the anesthetic and surgical aspects of a complicated case such as this minimizes opportunities for mishap.

About 40% of ICU tracheostomies at St. Michael's Hospital are performed percutaneously with fibre-optic bronchoscopic guidance, yielding a low complication rate. General anesthesia is induced, and a short-acting paralytic agent used. Patient selection is important; in general we adhere to the following criteria. First, the patient must have favourable anatomy: the surgeon should be able to palpate the airway and landmark through the skin

Box 2. De-gowning protocol after a high-risk procedure

1. While still in the patient's room, disconnect battery pack through the toga.
2. Remove the first pair of gloves.
3. A nurse trained in the de-gowning procedure is to untie and unzip the toga of the surgeon or assistant.
4. Remove the toga, taking care not to contaminate self or assistant.
5. Remove foot-covers and step onto the bleach mat in the anteroom.
6. Remove the second layer of foot protection.
7. Remove goggles and discard in biohazard bags.
8. Close the anteroom door.

In the anteroom

9. Rinse hands with a 70% ethyl alcohol solution.
10. Remove gown.
11. Remove goggles.
12. Rinse hands with a 70% ethyl alcohol solution.
13. Remove helmet and discard the inside Velcro straps.
14. Remove the power pack; place helmet and power pack in a plastic bag for further decontamination.
15. Remove head cover.
16. Remove gloves and rinse hands.
17. Remove mask.
18. Rinse hands.
19. Leave anteroom.
20. Wash hands thoroughly with antibacterial soap.

and subcutaneous tissue. Second, there should be no limitation to extension of the patient's neck (e.g., cervical spine injury in trauma patients). Finally, the patient's ventilatory requirements should be minimal, so an inadvertent airway loss of short duration will be tolerated.

We have summarized the challenges of performing a high-risk procedure in the setting of a new pathogen. These challenges are greater when there is a paucity of scientific evidence or clinical method.

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Elective and emergency surgery in patients with severe acute respiratory syndrome (SARS)

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On Mar. 12, 2003, the World Health Organization issued a global health alert for severe acute respiratory syndrome (SARS), a new illness that originated in Guangdong Province, China. It is known to be caused by a coronavirus. Its spread to Toronto, Canada, occurred in late February 2003. The spectrum of illness ranges from fever, muscle aches and mild respiratory symptoms to severe respiratory distress requiring mechanical ventilation.

The SARS epidemic introduced essential infection control considerations. SARS' respiratory-droplet route of transmission and the organism's potential to remain infectious on surfaces for long periods mandate extraordinary precautions. For this reason, the Centers for Disease Control and Prevention (CDC) have published recommendations for the personal protective equipment (PPE) appropriate as precautions, both standard and against contact and airborne infection.[1] These recommendations included the use of caps, goggles, N95 masks, gowns and gloves (Fig. 1), hereinafter referred to as standard PPE.

We found only 2 reports in the literature on the conduct of operations upon patients known to have SARS, which describe 1 emergency and 3 elective tracheostomies.[2,3] The staff involved used essentially the standard PPE recommended by the CDC; 2 weeks after the operations, they remained healthy.

In our institution 9 health care workers, after being involved with a difficult airway situation in a patient with SARS, were infected despite wearing standard PPE.[4] As a result, the Ontario Ministry of Health and Long-Term Care published a

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