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"I would have everie man write what he knowes and no more."—Montaigne

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Editorial I

Anaesthesia and SARS

The epicentre of the severe acute respiratory syndrome (SARS) outbreak in North America was Toronto in Canada. The outbreak brought the healthcare system of the city to a standstill for 4 weeks. Health authorities placed 8000 people in quarantine. Two hundred and sixty-seven people with suspected or probable SARS were admitted to 17 different hospitals. Twenty-one deaths have occurred at the time of writing. Over half of those infected have been frontline healthcare workers, including three anaesthetists and one intensivist.[1] As specialists in airway management, anaesthetists are routinely exposed to patients' respiratory secretions and are at high risk of contracting SARS from infected patients. This editorial provides suggestions on how to minimize this risk by improved infection control.

Infection control in anaesthesia

SARS is a highly infectious disease probably transmitted by a novel coronavirus via contact or droplet spread with substantial morbidity and mortality. It is an enveloped RNA virus and is therefore sensitive to disinfection measures. However, it can live in the environment for up to 24 h.[2] It can affect otherwise healthy people causing fever (in 100% of cases), malaise, myalgia, and respiratory symptoms ranging from a dry cough to respiratory failure requiring artificial ventilation.[3–5] Current guidelines address important issues pertinent to anaesthetic practice in the face of this highly infectious respiratory disease.[6 7] In order to suggest optimal methods of protection against known or suspected SARS patients, the details of current recommendations are scrutinized.

Hand washing

Routine hand washing between cases was routinely performed by only 50% of anaesthetists in UK and North American studies.[8 9] Hand-mediated transmission is the major contributing factor to cross infection.[10] Effective hand decontamination prior to every episode of patient contact will result in significant reduction in the carriage of potential pathogens and decrease the incidence of preventable infection.[11] Alcohol denatures proteins and has good activity against enveloped viruses such as coronaviruses. Alcohol-based hand rubs containing at least 60% ethyl alcohol have been widely endorsed as an effective and efficient method of hand hygiene practice.[12–14]

Frequent hand washing is the single most important hygiene measure in protection against cross infection and must be actively enforced. Alcohol-glycerol-based hand wash gels are now located on every anaesthetic machine in every operating room and on every work surface within the hospitals of the University Health Network in Toronto. It is essential to wash hands before touching your face or eyes, as this seems to have contributed significantly to the spread of SARS.

Gloves

A survey of UK consultant anaesthetists revealed only 14.5% of the respondents routinely wore gloves.[8] Ninety-eight per cent of anaesthetists' contact with patients' blood could be prevented by routine use of gloves.[15] Guidelines emphasize the requirement for routine glove wearing.[6 7] Blood contamination of surgeons' hands decreases from 13 to 2% with the use of double gloves.[16] A recent Cochrane Database Systematic Review advocates double gloving to reduce surgical cross infection.[17] Health Canada advises double gloving when attending a suspected SARS patient. Hands must be washed after degloving.

Face Masks

Only 35.2% of UK anaesthetists routinely wear facemasks compared with 75.3% of North American anesthesiologists.[8 9] Facemasks have two functions. The first is patient protection by reducing the risk of iatrogenic infection. Standard surgical facemasks do reduce the volume of bacterial organisms falling to a surgical site,[18 19] but the Cochrane Database review on disposable surgical facemasks in surgery remains equivocal.[20] The second is self-protection by reducing the risk of nosocomial infection. For this purpose, standard surgical masks are inadequate because they may have up to a 50% leak, and are not sufficiently tight fitting to prevent entraining of room air and

aerosols. Some of the anaesthetists who contracted SARS, early in the outbreak, were only wearing standard surgical facemasks when they intubated infected patients.

As a result of the transmission of SARS to healthcare workers, N95 (or equivalent) masks are currently mandatory in Toronto for all medical personnel. They fulfil the filtering efficiency criteria of the National Institute for Occupational Safety and Health (NIOSH) N95 standard by protecting against droplet and airborne transmission of 95% of particles greater than 0.3 microns in size.[21] These masks will offer a high degree of protection against the contact and droplet spread of the coronavirus. The N95 masks should be fit tested using an appropriate 'fit test kit' according to the manufacturer's instructions.[22] The PCM 2000 Tuberculosis masks meet the N95 filtration criteria and fit the majority of wearers adequately. They do not require routine fit testing. N95 masks can be worn continuously for 8 h whereas PCM 2000 masks can only be worn continuously for 4 h. All of these masks are uncomfortable and increase the work of breathing; staff compliance therefore requires motivation and encouragement. Masks must not be touched or taken down and then re-used as this greatly increases the risk of contamination.

Extra protection

Theatre caps may reduce the risk of staff potentially contaminating their hands by touching their hair. The nature of the novel coronavirus is such that mucous membrane and eye spread is likely and therefore disposable fluid-resistant long sleeved gowns, goggles and disposable full-face shields are recommended for frontline medical staff at risk of exposure to SARS. Hand washing is essential after touching or removing the above items.

The SARS patient

Early in the outbreak, three anaesthetists intubated patients with respiratory failure of unknown cause wearing traditional respiratory and contact precautions. They subsequently contracted SARS. With the benefit of hindsight we can conclude that standard surgical facemasks, gowns and gloves offer inadequate protection. One intensivist contracted SARS after a very prolonged and difficult intubation in a patient with florid pulmonary oedema, despite wearing an N95 mask and goggles. As a result of these disturbing events, we adopted additional precautionary measures from our experience of patients with tuberculosis.

Any known or suspected SARS patient must be regarded as ultra high risk and the attending anaesthetist should wear an N95 mask, goggles, face shield, double gown, double gloves, and protective overshoes. Removal and disposal of these items without contaminating oneself is critical. The use of a powered respirator by the anaesthetist and assistant is strongly advised for high-risk aerosol generating airway procedures in suspected SARS patients.

Powered respirator

We have several years experience of staff using the 3M AirMate™ (3M Occupational Health and Environmental Safety Division, 3M Center, Building 0235–02-W-70, St Paul, MN, 55144–1000, USA) powered air purifying respirator (PAPR) in the bronchoscopy suite when managing patients with suspected tuberculosis. The AirMate™ consists of a belt-mounted motor-driven fan, High Efficiency Particulate Air (HEPA) filter and a rechargeable battery pack. Room air is drawn into the filter and delivered under positive pressure to a 3M R-Series Tyvek® head cover via a snap-in hose connector that is sewn into the back of the hood. Decontaminated air is then circulated from the top of the head cover, down over the user's face and, together with exhaled air, exits through holes on the bottom of the faceseal. The AirMate™ provides 98–100% protection at 0.3–15 microns, and has a flow rate of 180 litres min^{-1}.[23] The major advantage offered by the AirMate™ is that it completely covers the head, thus eliminating the risk of respiratory, ocular or skin contamination. An N95 mask and goggles are worn underneath the respirator to provide maximal protection.

Intubating a SARS patient

This is an extremely high-risk procedure as it may result in significant exposure to a particularly high viral load. The following guidelines were developed in our institution to minimize the risk to the anaesthetist when intubating a suspected SARS patient. The guidelines should be followed if there is a high index of suspicion that a patient may have SARS.

1. Plan ahead. It takes 5 min to fully apply all barrier precautions.
2. Apply N95 mask, goggles, disposable protective footwear, gown and gloves. Put on the belt-mounted AirMate™ and attach the respirator tubing and Tyvek® head cover. Then apply extra gown and gloves. All staff assisting to follow same precautions. If a powered respirator is unavailable, then apply N95 mask, goggles, disposable theatre cap, and a disposable full-face shield.
3. Most experienced anaesthetist available to perform intubation.
4. Standard monitoring, i.v. access, instruments, drugs, ventilator and suction checked.
5. Avoid awake fibreoptic intubation unless specific indication. Atomized local anaesthetic will aerosolize the virus.
6. Plan for rapid sequence induction (RSI) and ensure skilled assistant able to perform cricoid pressure. RSI may need to be modified if patient has very high A–a gradient and is unable to tolerate 30 s of apnoea, or has a contraindication to succinylcholine. If manual ventilation is anticipated, small tidal volumes should be applied.

7. Five minutes of preoxygenation with oxygen 100% and RSI in order to avoid manual ventilation of patient's lungs and potential aerosolization of virus from airways. Ensure high efficiency hydrophobic filter interposed between facemask and breathing circuit or between facemask and Laerdal bag.

8. Intubate and confirm correct position of tracheal tube.

9. Institute mechanical ventilation and stabilize patient. All airway equipment to be sealed in double zip-locked plastic bag and removed for decontamination and disinfection.

10. Assistant should then wipe down the Tyvek® head cover with disinfectant (accelerated hydrogen peroxide is most effective) after exiting the negative-pressure atmosphere. The protective barrier clothing is then removed paying close attention to avoid self-contamination. The outer gloves are used to remove the outer gown and protective overshoes. The outer gloves are then discarded and the inner gloves remove the disinfected head cover and the inner gown. The inner gloves are then removed. The head cover is discarded, the AirMate™ tubing is pasteurized and the belt pack wiped down with disinfectant. The N95 mask and goggles are only removed after leaving the room.

11. After removing protective equipment, avoid touching hair or face before washing hands.

Operating rooms

A dedicated operating room is required for known or suspected SARS patients. Warning signs should be posted on the entrance to the operating room and only essential staff should be present. The door to the operating room should remain closed for the duration of the case to prevent potential contamination of the corridor. In a suspected SARS case, the breathing circuit and soda lime should all be disposable. A disposable high efficiency bacterial/viral hydrophobic filter must be placed on the expiratory circuit of the ventilator. The patient should be induced and recovered in the operating room itself. High-risk procedures or the use of power tools in an open procedure warrants the use of a powered respirator by all medical staff. Anaesthetists are instructed to wear barrier protection as described above.

Strong consideration should be given to the use of prophylactic antiemetics in SARS patients undergoing anaesthesia to reduce the risk of vomiting with subsequent contamination and viral spread. Care must be taken not to contaminate surfaces with the used oropharyngeal suction, which should be secured in its own holder on the drip stand.

Meticulous aseptic practice must be emphasized with attention paid to items such as stethoscopes and patients' charts. Single-use disposable pens are supplied separately for each case and must not be removed from the operating room. Telephones should be used in hands-free mode and cleaned after use. All airway adjuncts should be removed before transfer of the patient. They should be placed in a secure receptacle directly after use and be removed for decontamination. The anaesthetic machine is presumed infectious and must be decontaminated.

Most operating rooms are under positive pressure with up to 20 room air exchanges per hour. Any viral load should therefore decrease quickly. However, because the coronavirus can live outside the body on inanimate surfaces for up to 24 h, the entire operating room should be disinfected after a case involving a suspected SARS patient.

Intensive care

Attending a patient with suspected SARS requires full precautions. The patient should be in strict isolation in a negative-pressure room. If patients require supplemental oxygen, then nasal catheters should be applied and covered by a surgical facemask. Venturi-type masks should be avoided, as they will disseminate droplet spread if the patient coughs.[24] Continuous positive airway pressure (CPAP) and forms of non-invasive ventilation including Bi-level positive airway pressure (BiPAP) and high frequency ventilation must be similarly avoided as they increase the viral load in the room. Procedures in suspected SARS patients that induce coughing, such as nebulization of medications, chest physiotherapy, bronchoscopy, gastroscopy, and airway suctioning increase the risk of aerosolizing the virus.[22 25] Using spacer devices instead of nebulizers and closed suctioning systems help to reduce this risk. The ventilators of SARS patients must have high efficiency bacterial/viral hydrophobic filters placed on the expiratory circuit. Transportation of an intubated SARS patient with a tracheal tube and a Laerdal bag requires a similar filter between the tube and the bag to avoid contaminating the atmosphere. Strict adherence to the infection control precautions detailed above should prevent further transmission of SARS to anaesthetists and other medical staff.

Conclusions

The Toronto SARS outbreak has emphasized that we cannot be complacent about infection control. Our current infection control practices may have been adequate in the past, but they have been exposed as entirely inadequate in the presence of the highly infectious SARS virus. Anaesthetists must be rigorous about the application of standard precautions in every day practice. In the presence of a known or suspected SARS patient, full droplet and contact precautions must be applied. For additional safety, until the exact nature of transmission of the coronavirus is elucidated, airborne precautions should be taken with high-risk procedures.

SARS should serve as a new red flag, marking our need to change the way we practice infection control

and ultimately directing us toward the evolution of a 'new normal'.

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Appendix

Protective equipment

N95 particulate respirator. For suppliers see www.google.com
3M AirMate™ and Tyvek® head cover. 3M. St Paul, Minnesota, USA. www.3M.com

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