Preventing Infection of Patients and Healthcare Workers Should Be the New Normal in the Era of Novel Coronavirus Epidemics

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As we write this editorial, the world is waiting anxiously to find out whether the current SARS-CoV-2 (etiologic agent of coronavirus disease 2019; COVID-19) epidemic will be contained or burgeon into a pandemic. By the time you read this editorial, perhaps the answer will be known. We would like to emphasize at the outset that this editorial represents the opinions of the authors at the time it was written when there is much still unknown about COVID-19. Readers are urged to utilize multiple sources of information including those offered by various professional organizations and government agencies, and to carefully consider differing opinions.

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Previous outbreaks of novel coronavirus infection (*i.e.,* SARS, MERS) spread less widely than COVID-19 but had a higher mortality rate. The current mortality rate of COVID-19 appears to be approximately 2 to 3%, while the mortality rate during the 2003 SARS epidemic was 10 to 15%.[1] While not wishing to minimize the importance of the risks posed by COVID-19, it is important to remember that the world is constantly awash in infectious diseases, some of which present ongoing significant threats to public health. For example, during 2018 to 2019 in the United States, influenza killed approximately 34,000 people, and during 2017 to 2018, 61,000 people.[2] Healthcare-associated infections in the United States are thought to affect approximately 1.7 million patients annually, resulting in approximately 99,000 deaths.[3]

Novel coronavirus outbreaks may be particularly hazardous to healthcare workers. An early report of 138 hospitalized patients with COVID-19 pneumonia from Wuhan, China, found that approximately 40% of cases were presumed hospital-related transmissions, including 40 healthcare workers and 17 patients originally hospitalized for other reasons.[4] A more recent publication from the Chinese Center for Disease Control and Prevention (Beijing, China) reported that as of February 11, 2020, there were 1,716 healthcare workers diagnosed with COVID-19 out of 44,672 confirmed cases, although most of the infected healthcare workers were confined to the initial epicenter of the outbreak (Hubei Province, China).[5] During the 2003 SARS outbreak in Ontario, Canada, 51% of cases were healthcare workers. Healthcare worker involvement with tracheal intubation conferred a 13-fold higher relative risk ratio for acquiring SARS infection when compared to healthcare workers not participating in tracheal intubation.[6]

Preventing transmission of infectious diseases to patients and protecting healthcare workers should be a top priority every day, especially but not exclusively during recurring viral epidemics. While anesthesia providers have not traditionally considered themselves to be on the front lines of infection prevention, we have learned in recent years that organisms acquired in the hospital setting can originate from the anesthesia workplace and from the hands of anesthesia providers.[7,8] In 2018, a writing group of the Society for Healthcare Epidemiology of America (Arlington, Virginia) published an expert guidance with recommendations for preventing transmission of pathogens in the anesthesia workplace.[9] The group recognized the difficulty of cleaning the anesthesia workplace, especially the anesthesia machine and the anesthesia cart, in the short time typically allowed for

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turnover of an operating room. However, included in the recommendations were a number of measures that are relatively easy to accomplish in the operating room.

1. Closed injection ports, covered with isopropyl alcohol caps, can reduce the likelihood that pathogens are injected into the patient's intravenous line.
2. Frequent hand hygiene with alcohol-containing gel can increase the rate of hand hygiene by anesthesia and critical care providers and has been shown to decrease hospital-acquired infection.[10,11]
3. Double gloving for airway management and discarding the outer glove immediately afterward has been shown to decrease environmental contamination.[12]
4. Single-use laryngoscopes can be a cost-effective method of avoiding reusable laryngoscopes that have not been effectively cleaned and can be a source of infection.[13]
5. Environmental disinfection should be performed between cases and at the end of the day.

The etiologic virus of COVID-19 is transmissible by respiratory droplet (greater than 5 μm), and from contaminated hands and surfaces. Even though it is unclear if COVID-19 is also transmitted by the airborne route (droplet nuclei 5 μm or less), the Centers for Disease Control and Prevention currently recommend the use of N95 respirators for healthcare workers exposed to COVID-19 patients. (N95 respirators are defined by the National Institute for Occupational Safety and Health [Cincinnati, Ohio] as having 95% efficiency for filtering particulates. In the European Union, the roughly equivalent CE-marked respirator is called an FFP2.[14]) Aerosols produced during airway management may be particularly hazardous to anesthesia providers.[15,16] Given that anesthesia providers frequently perform procedures that aerosolize particles, providers should renew their familiarity with airborne isolation procedures, which are seldom necessary in routine anesthesia practice. Anesthesia providers should be familiar with the proper use of N95 masks and powered air purifying respirators. Fit testing prior to the use of an N95 is required by the Occupational Safety and Health Administration of the United States Department of Labor (OSHA) as improper fitting can allow inadvertent exposure. (29 CFR 1910.134—The employer shall ensure that an employee using a tight-fitting facepiece respirator is fit tested prior to initial use of the respirator, whenever a different respirator facepiece [size, style, model or make] is used, and at least annually thereafter.)
Additionally, there is individual variability in N95 mask fit such that a particular size, design, or brand of N95 mask may be required, and those with facial hair such as beards may not effectively use an N95 mask. Powered air purifying respirators are reusable and may provide more reliable protection than N95 masks without the need for fit testing. However, training on the proper use of powered air purifying respirators is necessary, including techniques for removal without contamination and the need for meticulous cleaning after each use. Whether anesthesia providers performing high-risk procedures such as intubation on a patient with COVID-19 should always use powered air purifying respirators is unclear, but if they are available and the anesthesia provider is trained in their use, we would advise powered air purifying respirators to be employed during high-risk procedures such as airway management.[17] If powered air purifying respirators are used, consideration should be given to wearing an N95 mask inside the powered air purifying respirator for protection when the latter is removed. If powered air purifying respirators are not used, then an N95 should be used in combination with eye protection. Recent photos of healthcare workers in Asia frequently show very high-level personal protective equipment resembling that used during Ebola outbreaks. Whether very high-level contact isolation with "Ebola-wear" is truly necessary for protection from COVID-19, especially during intubation, is unknown.

Coronaviruses can survive on surfaces for up to 9 days[18]; however, the COVID-19 virus is susceptible to killing by 62 to 71% alcohol, 0.5% hydrogen peroxide, or 0.1% sodium hypochlorite.[18] Routine injection port care and hand hygiene with alcohol-based products should be effective. Hand hygiene is of fundamental importance. Hands should be cleaned frequently with soap and water, alcohol, or other materials that are known to inactivate the virus. Because COVID-19 can be spread by contact, environmental cleaning of the anesthesia workplace is particularly important. As previously noted, routinely cleaning the surfaces and interior storage areas of anesthesia machines and anesthesia carts is very challenging. We suggest that anesthesia providers consider having a dedicated anesthesia cart for high infection risk situations, and that the cart be thoroughly cleaned, inside and out, following use. Alternatively, anesthesia supplies could be provided in a dedicated "case pack" (similar to surgical supplies) rather than in a traditional cart. The anesthesia circuit should be fitted with a high-efficiency particulate air filter (commonly known as a HEPA filter), all exhaled gas should be filtered, and the anesthesia machine and patient monitor surfaces should be thoroughly cleaned following use. Plastic covers for the anesthesia machine, patient monitor, computer keyboard, mouse, and touch screens are commercially available and should be considered in order to reduce bioburden on these "high touch" surfaces (fig. 1). There is at least one study showing that anesthesia machine covers reduce the contamination of the anesthesia machine.[19] It should be noted that operating rooms are designed to have positive pressure airflow to protect the patient inside the room, while airborne isolation requires negative pressure airflow (air being pumped from the room to outside the facility) to protect those outside the room from the patient inside the room. Note that it is possible to convert operating rooms to negative pressure airflow,[20,21] and this option should be considered. Finally, single-use laryngoscopes, video laryngoscopes,

Fig. 1. An anesthesia machine is shown with a plastic cover. Photo courtesy of Murlikrishna Kannan, M.D., F.R.C.A. (Integrated Anesthesia Medical Group, Los Angeles, California, and AnesthesiaHygiene.com).

and bronchoscopes are commercially available and should be employed if possible. Reusable airway equipment, considered "semi-critical" equipment by the Centers for Disease Control and Prevention, should undergo high-level disinfection or sterilization following use.

Whether our hospitals are adequately prepared for a pandemic is open to question. Obtaining ample supplies such as N95 masks, powered air purifying respirators, and other protective equipment to contend with a significant outbreak of a communicable disease may be challenging. Hospitals often utilize "just in time" supply chain practices that are very susceptible to disruption, and shortages are common under ordinary circumstances, let alone during a pandemic. Guidance is available on how to optimize use of respirators among healthcare workers during national shortages.[22] Whether anesthesia providers and healthcare workers have sufficient training in the use of personal protective equipment, especially N95 and powered air purifying respirators, is also open to question. We believe that infection prevention is a critical function of our healthcare system. Hospitals and healthcare workers should always be practicing infection prevention in routine daily patient care and should be prepared and trained to negotiate epidemics that will certainly recur on a regular basis.

COVID-19 is only the most recent example of the need for constant vigilance.

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Competing Interests

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