

CHAPTER 10

THE USE OF PERSONAL PROTECTIVE EQUIPMENT IN ANESTHESIA OF PATIENTS WITH COVID-19

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INTRODUCTION

While healthcare workers are providing healthcare services for diagnosis and treatment purposes, they expose to many risks such as infections, radiation, physical, chemical, etc. in their areas of work. Therefore, healthcare workers are required to wear protective clothing and equipment to reduce aforementioned risks. Protective clothing and equipment should comply with the standards and be used properly. The new Coronavirus disease (Covid-19), which emerged in China in December 2019, was classified and announced as a pandemic by the World Health Organization in January 2020. Covid-19 virus is transmitted between people through close contact and droplets. The patient's respiratory activity and medical interventions can generate aerosols. These aerosols contain particles that can stay longer in the air. The risk of contact

with these aerosols is higher during airway maneuvers, especially during tracheal intubation. It has been shown that those who perform tracheal intubation during the severe acute respiratory failure syndrome (SARS) epidemic have a higher risk of infection. Anesthesiologists are in one of the most risky groups among healthcare professionals, as they are in the group performing high-risk aerosol-forming medical interventions in intensive care and operating rooms. Personal protective equipment is an important factor in minimizing the risk of infection to healthcare workers. The World Health Organization (WHO) and other international public health authorities recommend applying safety protocols for healthcare workers. The use of appropriate personal protective equipment takes a special place among the precautions to be applied by healthcare professionals who care for Covid-19 patients. Personal protective equipment includes gloves, medical masks, goggles or a face shield and gowns, as well as respirator masks (N95, FFP3 or FFP2) and hospital gowns during specialized procedures.

Anesthesiologists may encounter potential Covid or Covid-positive patients in both intensive care and emergency or elective surgeries. Full personal protection including a liquid-proof long sleeve gown, pair of gloves, eye protection, full face protection, headgear, suitability tested respirator mask or air-purifying respirators is recommended for anesthesiologists in case of confirmed or possible Covid-19 patients.

Procedures such as balloon mask ventilation, tracheal intubation, and tracheostomy are considered as high-risk aerosol-forming medical interventions.

The proper use of personal protective equipment is important in terms of both protecting the healthcare workers and preventing the spread of the disease.

Table 1. Recommended Infection Prevention Precautions

Suggested Practice	Comments
Respirator mask during anesthetic care	Such as N-95 or FFP-2. Assumes abundant supply of masks. Conservation efforts should be implemented if in short supply.
Ordinary surgical masks in public areas of the health care	Recommended by CDC. Assumes abundant supply of masks. Reusable cloth masks could be used if surgical masks are not available in sufficient quantities.
Hand gel close to provider or personal, wearable gel dispenser	Frequent hand hygiene is essential for personal protection and protects patients from hospital-acquired infection.

Eye protection at all times during anesthesia care	Required by US Department of Labor, Occupational Safety and Health Administration Standard 1910.1030.
HEPA filter (or similar) on exhalation side of anesthesia circuit (at least) and/or between the airway and the Y of the circuit (to filter gas in both directions)	HEPA filter (or similar) effectively filters small particles including viruses.
Reusable standard and videolaryngoscopes should undergo high-level decontamination or sterilization	Recommended by CDC. Consider single-use standard and videolaryngoscopes if available and cost-effective. Be aware that some videolaryngoscopes cannot undergo high-level decontamination or sterilization (Supplemental Digital Content, Table 1, http://links.lww.com/AA/D186).
Avoid entering anesthesia cart without performing hand hygiene first	Contents of anesthesia cart are easily contaminated during use.
Single-use plastic covers for parts or all of anesthesia machine and anesthesia computers, keyboards, and touchscreens	Covers can reduce bioburden on contaminated, difficult to clean surfaces.
Wipe anesthesia machine high touch areas with hospital antiseptic wipes (if not covered with plastic covers)	High touch areas of anesthesia machine have been shown to be frequently contaminated.
Double glove for airway management	Discard the outer glove immediately following airway management to limit surface contamination.
Enclose cell phones and other personal communications devices in plastic bags or wipe with antiseptic wipes compatible with electronic devices	Cell phones have been shown to be contaminated with antibiotic-resistant pathogens during use in the hospital.
Manage endotracheal tubes to minimize aerosolization following placement	HEPA filter (or similar) on open lumen of double-lumen tube during single lung ventilation.
Consider gowns for airway management	Gowns could be used during airway management to protect providers' skin and clothing from contamination. Be aware of variable permeability of gowns depending on rating.
Consider airway management adjuncts such as covers and boxes	Effectiveness has not been well studied and may interfere with airway management.
Consider surgical smoke evacuation	Risk of infection of providers by surgical smoke is unknown, but surgical smoke evacuation was a recommended practice before the SARS-CoV-2 pandemic.
Consider how to protect the surgical team	The surgical team should consider whether to utilize N-95 masks and whether to vacate the operating room during airway management.
Consider discussing infection prevention measures during the "time out" (safety checklist)	Be aware that not all providers can be fit for N-95 masks.

Key recommendations are in boldface.

Abbreviations: CDC, Centers for Disease Control and Prevention; HEPA, high-efficiency particulate air; SARS-CoV-2, severe acute respiratory syndrome coronavirus

RESPIRATORY MASKS

Respiratory masks such as the N-95 mask (**Figure 1**) (or equivalent FFP-2) appear to provide reasonable protection against the spread of viruses both by droplets and the air. Respiratory masks differ from ordinary surgical masks since they fit tightly to the area of the face while filtering very small particles, limiting the penetration of airborne particles. The definition of N-95 means that at least 95% of 0.3 μm particles are filtered by the mask. The N-95 mask is approximately 10 times more effective in filtering small particles than surgical masks. Although it is still unclear whether this means better infection prevention is feasible through the N-95 masks. As a result of a meta-analysis, it has been put forward that N-95 masks have a greater effect than surgical masks in preventing transmission of the SARS-CoV-2 virus.

It can be suggested that the N-95 mask probably provides more protection than an ordinary surgical mask. Routine use of an N-95 mask or similar respiratory masks in the operating room during the SARS-CoV-2 pandemic has been recommended by the American Society of Anesthesiologists (ASA).



Figure 1: Different types of N 95 Masks

Although the use of N-95 and similar respirators is recommended for the protection from the respiratory viruses, these masks have serious limitations. A 'fit-test' should be performed to users to ensure that there is sufficient fit between mask and face. Facial hair typically causes air to leak from the sides of the mask. For this reason, users must wear a specific brand and model of masks. If a specific mask is not available, a fit test for a different mask should be performed. N-95 masks are only for single use, but reuse could be considered in such cases where respiratory masks are insufficient.

Wearing a standard face mask over the N-95 mask allows reuse of the N-95 by preventing further contamination, but this may increase the work of breathing. Many users report that the N-95 mask causes breathing difficulties because of its greater airflow resistance compared to surgical masks. Some users report nasal congestion and skin deterioration due to prolonged use of N-95 masks.

Elastomeric respirators are reusable masks with a replaceable filter, made of rubber or synthetic material, and fit tightly. As with the N-95 mask, fit testing is required.

RESPIRATORY MASKS FOR THE SURGICAL TEAM

Anesthesia-related airway management is one of the procedures with the highest risk of aerosolization and transmission from patients with suspected SARS-CoV-2 infection, with the exception of surgical cases involving the direct airway. Therefore, N-95 masks or similar masks should be used by the entire operating room team; however, if the number of N-95 masks is insufficient, the surgical team, including nurses and surgeons, may evacuate the operating room during airway management, including anesthesia induction and extubation. Operating rooms normally have a slightly positive pressure and higher air exchange. The time required to remove foreign particles from the air from an operating room can be estimated if the number of hourly air changes is known; generally, approximately 7 air changes in total are required to reduce foreign particles by 99%. An operating room with 15 air changes per hour requires approximately 30 minutes to reduce foreign particles by 99.9%. It may not be practical to adhere to such waiting times, but even shorter waiting times can reduce the risk. Cautery or laser used during surgery may cause aerosolized particles, but if not performed in the respiratory tract, dispersal of infective SARS-CoV-2 viral particles may not be possible. However

the use of N-95 masks by surgeons and surgical smoke evacuation systems are recommended.

EYE PROTECTION

The conjunctiva is a possible site of infection by respiratory viruses. Therefore, eye protection is generally recommended during exposure to droplets or aerosols containing respiratory pathogens. For this purpose, it is thought that glasses with side shields can provide more effective protection.

PROTECTIVE CLOTHES

In the care of patients with known or suspected SARS-CoV-2 infection, gowns that cover a part of the body or medical overalls covering the whole body are widely used.

Gowns are graded on the basis of their permeability; 4 levels have been defined for gown standards, ranging from minimum (level 1) to high risk (level 4). Repeated washing of reusable gowns can make gowns more permeable. There is no specific recommendation regarding the types of gowns to be used for protection from respiratory tract viruses. It is assumed that the infection does not occur directly through contact between the virus and the skin. However, virus particles on the skin or clothing can pass into the respiratory tract with fingers. Therefore, it appears to be a reasonable precaution to routinely wear a gown during airway management or other aerosol procedure. (Figure 2)



Figure 2: Protective clothing

ROUTINE USE OF SURGICAL MASKS IN THE HOSPITAL AND OPERATING ROOM

During the SARS-CoV-2 pandemic, healthcare professionals, patients, and visitors were recommended to wear surgical masks when they are inside the healthcare facility. Standard surgical masks should be worn within the operating room complex, including waiting rooms, corridors, patient retention and recovery areas, break rooms and other areas where staff can meet. Anesthesiology staff should be aware that they or their colleagues may have an undiagnosed SARS-CoV-2 infection.

HAND HYGIENE AND SURFACE CLEANING

Cleaning the anesthesia area of work is very crucial, as the SARS-CoV-2 virus can be transmitted through contact with contaminated surfaces (from surfaces to fingers and respiratory tract). SARS-CoV-2 is easily inactivated with sodium hypochlorite, alcohol or hydrogen peroxide, and some other hospital-approved disinfectants. Hand hygiene is critical in protecting hospital staff and patients; hand disinfectants should be placed near to the anesthesia and surgical team. People with dermatitis due to frequent hand hygiene may consider applying disinfectant to examination gloves.

Cleaning the anesthesia machine and supply cart is difficult, especially in a busy operating room, due to the limited time between cases. Plastic cloths covering all or a part of the anesthesia machine have been suggested in operating rooms exposed to SARS-CoV-2. It should be taken care to cover the computer keyboard, mouse and computer touch screens with disposable plastic covers. Another alternative consists of an anesthesia machine sleeve built for the purpose including a special storage pocket for airway aspiration (**Figures 3-4**). Contaminated covers should be discarded carefully to avoid cross contamination.

A partial view of the anesthesia machine cover with a pocket for Yankauer aspiration is shown. (Photo courtesy of Murlikrishna Kannan, MD, FRCA.) (Integrated Anesthesia Medical Group, Los Angeles, CA and AnesthesiaHygiene.com.)

In such situations where the anesthesia machine is not covered with a plastic cover, hospital antiseptics can be used to clean contact areas. Personal items such as mobile phones can be wiped with 100 antiseptic wipes or covered with plastic bags.



Figure 3: A partial view of the anesthesia machine cover with a pocket for Yankauer aspiration is shown. (Photo published with consent of Murlikrishna Kannan, MD, FRCA.) (Integrated Anesthesia Medical Group, Los Angeles, CA and AnesthesiaHygiene.com.)



Figure 4: Another view of the anesthesia machine cover is shown. (AnesthesiaHygiene.com, Los Angeles, CA).

Ultraviolet light is used in the decontamination of operating rooms. Ultraviolet light can also be used to neutralize airborne pathogens. Some ultraviolet light wavelengths can be harmful to human skin and eyes; however, this problem can be managed by controlling the wavelength of light and the intensity of exposure. A recent study has shown that ultraviolet light at 222 nm wavelength inactivates airborne coronaviruses.

AIRWAY MANAGEMENT

During airway management, respiratory viruses can become aerosol and cause the spread of infection in the anesthesia team. Airway management can also spread pathogens to the surfaces of the anesthesia area of work and airway equipment. It is said that wearing double gloves for airway management and immediately discarding the outer glove can reduce surface contamination of the anesthesia area of work. Laryngoscopes are classified as “semi-critical” (in contact with mucous membranes) devices that require a high level of decontamination or sterilization. However, some video laryngoscope handles cannot be subjected to high levels of decontamination or sterilization, for this reason, conventional and disposable laryngoscopes or videolaryngoscopes may offer a more cost-effective alternative.

It is recommended to place a HEPA filter or similar filter on the exhalation side of the breathing circuit, or to place a filter in the «Y» part (protecting both the breathing and exhalation sides of the circuit) to protect the anesthesia machine from contamination with aerosolized airway secretions.

In addition, opening the lumen of any endotracheal tube or supraglottic airway device to the operating room atmosphere should be minimized as much as possible. It makes sense to place an anesthetic circuit filter in the lumen of the endotracheal tube for this.

Several methods such as covering the patient’s head with plastic covers or plastic boxes have been proposed, in order to prevent the spread of aerosolized airway secretions during airway management. However, the effectiveness and impact of such practices on airway management are unknown. Plastic materials that got contaminated during airway management should be disposed of or the decontamination of reusable materials should be done carefully. The results of a simulation study performed on plastic intubation boxes has revealed that this way intubation takes longer, first attempts are less successful, and when the boxes are used, the gowns of the anesthetist are frequently opened, which raises safety problems.

Various recommendations including the use of rapid sequential induction, avoidance of balloon and mask ventilation, and the use of videolaryngoscopy over standard laryngoscopy have been made for airway management in patients with known or suspected SARS-CoV-2 infection. While these recommendations are reasonable, there is little evidence for the reduction of infection transmission.

TEST AND STANDARD MEASURES APPROACH

A range of respiratory precautions has been recommended for all patients. As mentioned earlier, this is similar to “standard” measures for bloodborne pathogens (such as HIV or hepatitis C viruses), which assume all patients are potentially infected. PCR testing is recommended to identify infected patients. However, this test has some handicaps. Firstly, PCR testing for SARS-CoV-2 may give a false negative result. Secondly, testing takes time. Tests are usually done about 2 or 3 days in advance. Hypothetically, patients may be infected after testing and before anesthesia. Third, this approach is not suitable for emergency procedures because the test takes time to perform. For this reason, it is recommended to apply respiratory precautions to all patients. More detailed measures could be required in patients with known or suspected SARS-CoV-2 infection.

CONCLUSIONS

Fundamentally, it is recommended that anesthesiologists wear a surgical mask at all times in the hospital and routinely wear breathing masks when providing anesthetic care. Eye protection should also be worn and hand hygiene should be done frequently. The surfaces of the anesthesia workplace should be kept as clean as possible. Healthcare facilities and government agencies should prioritize the production and distribution of needed personal protective equipment, especially high-quality respiratory masks. It is essential to continue research to better understand the SARS-CoV-2 virus and that will help us improve our approach to protect ourselves and our patients. The SARS-CoV-2 pandemic is not the first respiratory virus pandemic of the 21st century, and will probably not be the last one. Anesthetic care for patients diagnosed with definite or suspected SARS-CoV-2 infection requires more detailed measures.

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