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Theoretical and evidence-based infection control during general anesthesia in the COVID-19 pandemic

Osamu Nagata*, Koshi Hattori, Yasuhiro Maehara

Department of Anesthesiology, Center Hospital of the National Center for Global Health and Medicine, Tokyo, Japan.

Abstract: With the outbreak of COVID-19, attention has focused on measures to prevent droplet infection. Operating rooms, where we anesthesiologists mainly work, are equipped with various theories and techniques for performing surgical procedures and general anesthesia on patients with various infectious diseases, whether airborne, droplet, or contact infection, and are an environment where surgical procedures and general anesthesia can be safely performed on patients with compromised immune functions. Here, we describe the anesthesia management standards assuming COVID-19 from the viewpoint of medical safety, as well as the structure for supplying clean air in the operating room and the structure of a negative-pressure operating room.

***Keywords*:** COVID-19, general anesthesia, operating room

The COVID-19 pandemic has drawn attention to droplet infection control measures. Various methods have been devised to protect against droplet infection, including not only surgical masks but also acrylic plates and film sheets, and detection of poorly ventilated areas by measuring CO_2 concentrations, but their effectiveness remains unclear. In addition, although a simulation of droplet dispersion using the Japan's supercomputer Fugaku has attracted much attention, we cannot verify whether the various preconditions are general or not, and it is very doubtful whether we can really apply them to our living and working environments.

In the operating room environment where we anesthesiologists mainly work, we have established an environment in which surgical procedures and general anesthesia can be safely performed on surgical patients with impaired immune functions through many years of research and efforts to improve the environment. In addition, various theories and techniques for performing surgical procedures and general anesthesia on patients with various infectious diseases, whether airborne, droplet, or contact infection, have been developed, and evidence has already been established on how to deal with them. Therefore, if these theories and techniques are properly applied, general anesthesia can be administered with ease even to patients with SARS-CoV-2 infection and other unknown infectious diseases.

Environmental features of operating room

In the operating room for surgery, clean air is supplied from the ceiling, and air contaminated by the patient is collected from the air intake under the feet. In general operating rooms in Japan (air clean level 2), clean air is supplied at a rate at which the air in the operating room is replaced in about 4 minutes (*1*). But in reality, the air is not actually supplied at a uniform rate due to the installation of the ceiling light, some devices in the operating room, operating tables, and so on. Therefore, it is important to identify and remove obstacles so that medical personnel can avoid the risk of inhaling contaminated air emitted from patients by using test smokes used in the occupational safety domain (Figure 1). The effectiveness of acrylic panels in preventing the spread of droplets from the patient should also be evaluated for actual airflow. Unfortunately, the measurement of CO_2 concentration used in some situations can only predict air stagnation by measuring the CO_2 contained in exhaled air, but cannot evaluate air movement. Unfortunately, it is not possible to assess the movement of air. To begin with, a situation in which air is stagnant is out of the question from the perspective of ventilation or airflow management, and a more appropriate environment should be created.

To ensure the airflow created in the operating room, it is essential to minimize the number of people in the operating room as well as entering and leaving the operating room. For this reason, even if COVID-19 is not in its infestation period, strict control is required to limit the entry of visitors and minimize the opening and closing of the doors of each operating room. In particular, bio-clean rooms (air clean level 1) are equipped with a front chamber, and a system is used to prevent the simultaneous opening of doors on the operating room

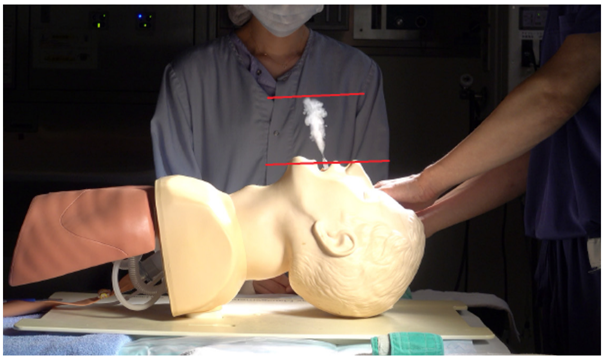

Figure 1. Image of Airflow with test smokes. The airflow in the operating room can be evaluated under various conditions using a test smoke that simulates the patient's exhalation.

side and the corridor side.

Use of negative-pressure operating rooms to reduce leakage of contaminated air

As in patients with common infectious complications, invasive procedures are known to worsen the prognosis in patients with SARS-CoV-2 infection. As a rule, invasive procedures should be performed only after the infectious disease is cured. On the other hand, invasive procedures are exceptionally performed under general anesthesia in life-threatening emergent surgeries. In such situations, a negative-pressure operating room is used to prevent contaminated air generated by the infectious patient from leaking out of the operating room. In a normal operating room, clean air is supplied from the ceiling, so the air pressure is higher than that in the corridor. In a negative-pressure operating room, however, air is collected from the air intake under the feet so that the air pressure in the operating room is lower (*i.e.* negative pressure) than that in the corridor to prevent contaminated air from leaking into the corridor side. It should be understood that a negative-pressure operating room draws air from the corridor, which has the lowest level of air cleanliness in a medical facility. Since surgery is performed in an unclean environment, the use of negative-pressure operating rooms should be limited to unavoidable cases, and patients will be at a great disadvantage if they are used easily because they are suspected of having an infectious disease.

Standards of anesthesia management to prioritize protection of the surgical patient

In patients with SARS-CoV-2 infection, risk of perioperative mortality increased throughout 6 weeks of infection (*2*), and patients should avoid elective surgery within 7 weeks after the presence of infection, even if asymptomatic. In addition, the anesthesiologist should determine the waiting period from the viewpoint of recovery of the respiratory and other systemic conditions in patients with moderate disease whose general condition has not yet recovered, and in patients on ECMO or ventilatory management (*3*). It is important that this does not mean that the risk of infection to the surrounding population, including health care workers, continues until 7 weeks later. From an infectious point of view, elective surgery should not take place within 10 days of diagnosis (*3*). In patients with recent or preoperative infection with SARS-CoV-2, surgery under local anesthesia should be considered, avoiding general anesthesia.

If a patient scheduled for surgery shows signs of infection, such as fever, before surgery, surgery should generally be postponed. This is because fever itself is a risk for perioperative complications, not the presence or absence of SARS-CoV-2 infection, which determines whether general anesthesia can be performed or not. From the viewpoint of medical safety, it is fundamentally wrong to think that surgery can be performed because the PCR test is negative.

Causes of unfortunate events

This article has focused on the structure of the operating room, the negative pressure operating room, and the latest perioperative management guidelines, but faithful adherence to the items described here will help control risk and achieve stable perioperative management. However, as we have seen in various media reports, lack of basic medical knowledge, human error, local rules at each facility that pervert the evidence, and irrational and emotional on-site judgment have caused confusion in clinical practice. The job of anesthesiologists is expressed to be crisis management. In order to respond appropriately not only to COVID-19 but also to newly emerging infectious diseases, it is essential to follow the basic procedure of crisis management, which is to take the maximum possible measures at first, and then to accumulate the necessary measures while reducing excessive measures based on the knowledge obtained later.

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**Address correspondence to*:
Osamu Nagata, Department of Anesthesiology, Center Hospital of the National Center for Global Health and Medicine, 1-21-1 Toyama, Shinjuku-ku, Tokyo 162-8655 Japan.
E-mail: onagata@hosp.ncgm.go.jp