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The Initial Response to a Pandemic: Anesthesiology Experiences from China at the Onset of COVID-19

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KEYWORDS

• Anesthesia • Perioperative management • COVID-19 • Infection control

KEY POINTS

- Education, training, and constant update of coronavirus disease 2019 (COVID-19)-related knowledge and skills are vital during the pandemic.
- A well-designed and effective response system during the outbreak of COVID-19 is crucial for the safety of both patients and health care providers.
- In extreme situations such as the COVID-19 pandemic, anesthesiologists may transform into internists, while continuing to use their specialty skills in airway management and mechanical ventilation.
- During the pandemic, anesthesiologists acquired skills in personal protective equipment, infectious disease, and management of patients outside of the operating rooms.

INTRODUCTION

Since December 2019, a total of 41 cases of pneumonia of unknown cause, which were later identified from a novel virus named SARS-CoV-2 (severe acute respiratory syndrome coronavirus 2), have been confirmed in Wuhan city, Hubei Province, China.^{1,2} The disease was officially named coronavirus disease 2019 (COVID-19) by the World Health Organization (WHO). On January 30, the WHO Emergency Committee declared the 2019 novel coronavirus outbreak a public health emergency of international concern (PHEIC).³ With a population of more than 12 million people,

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Wuhan was the first city, and also the hardest-hit city, in China forced to deal with the outbreak of COVID-19. Since February 11, 2020, after being assigned as the designated hospital, Union Hospital, one of the biggest general hospitals in Wuhan, had reconstructed 3 districts specifically for treating a total of 5200 patients with COVID-19, mainly patients with severe or critical disease. At the same time, the hospital also managed 2 temporary COVID-19 specialty hospitals (named Fangchang Hospitals), providing treatment of more than 200,00 asymptomatic or mildly symptomatic patients with COVID-19.

The limited information about the virus increased the difficulty of predicting the required medical resources, and challenged almost all subspecialties of medicine. Anesthesiologists are not traditionally infection control professionals. Because of strict rules of aseptic technique in the operating room (OR), anesthesiologists are traditionally good at prevention and control of nosocomial infection during the perioperative period, resulting in a more positive attitude to fight against the epidemic. Meanwhile, expertise in resuscitation and basic life support makes anesthesiologists more active in participating in the treatment of severe and critical patients with COVID-19 in the multidisciplinary intensive care setting.

This article documents experiences of frontline anesthesia providers in Wuhan, mainly from the anesthesiologists in Union Hospital, Tongji Medical College, Huazhong University of Science and Technology, Wuhan, Hubei, China. It is hoped that these experiences can document valuable processes used to optimize the emergency response system, the arrangement of medical resources and emergency allocation, as well as provide insight into anesthesiologists' roles in expanding their practices and driving innovation to improve patient care.

TIME PERIODS CLASSIFIED BY KEY EVENTS AND INTERVENTION

Key events and interventions are helpful to understand the dynamics of the COVID-19 outbreak in Wuhan. One key event is Chunyun (massive human movement because of the Chinese New Year festival) from January 10 to 22. The other key event is large-scale city lockdowns in China, including Wuhan, from January 23 to March 8. A report about the COVID-19 outbreak in Wuhan classified the epidemiology of this epidemic into 5 periods: December 8 to January 9 (no intervention), January 10 to 22 (Chunyun), January 23 to February 1 (cordons sanitaire, traffic restriction, and home quarantine), February 2 to 16 (centralized quarantine and treatment), and February 17 to March 8 (universal symptom survey).⁴ In addition to these key events and associated epidemiologic features, several suspected cases at the early stage, and related nosocomial transmission, also had an impact on medical responses to the pandemic. Accordingly, the initial response can also be classified into 2 time periods: an early-warning period from January 10 to 18, and a full-scale-launch period in the whole hospital after January 19.

Early Warnings

Our early warning came from a specific patient treated in our hospital during the perioperative period before the outbreak of COVID-19. This patient is a milestone in the recognition of human-to-human transmission, before clinicians really paid attention to this pneumonia of unknown cause. A 70-year-old male patient was admitted in late December, 2019, and was scheduled for intranasal endoscopic surgery. Because of his past medical history of hypertension, diabetes, and heart attack, preoperative consultation and anesthesia evaluation were performed twice, on December 31, 2019 and January 3, 2020. The surgery was performed under total intravenous

anesthesia in a regular OR on January 6, 2020. After a 2-hour operation, he was transferred to the postanesthesia care unit and was extubated peacefully. He was transferred to the neurosurgery ward 30 minutes later. The patient developed a fever 3 days after surgery and was diagnosed with pneumonia of unknown cause. On January 18, 12 days after his operation, his oral swab tested positive for SARS-CoV-2. He was immediately transferred to an isolation ward for 1 week before being transferred to one of the first-batch designated hospitals in Wuhan. He died of respiratory failure 4 weeks after surgery.

Because the patient had no epidemiologic history and clinical manifestations related to COVID-19 before surgery, no COVID-19 investigation was performed then, and the medical staff only used standard protection during the perioperative diagnosis and treatment periods. Four nurses in the neurosurgery ward, who had direct contact with him before quarantine without protective equipment, were infected, and 10 more staff in the ward who did not contact him directly later tested positive.⁵ None of the anesthesia providers tested positive.

After January 10, when the patient was diagnosed with pneumonia of unknown cause, terminal disinfection of the anesthesia machine was immediately performed, and the follow-up patients in the same OR were traced. None of the patients developed a related infection. Later, the terminal disinfection of the anesthesia machine expanded to all of the neurosurgery ORs. Meanwhile, personal protective equipment (PPE) was increased throughout perioperative neuroanesthesia care, by wearing double gloves, double surgical masks, and disposable operating clothes as outer layers. At the same time, the hospital started an early detection and reporting system of suspected cases. Since then, our department has started to use PPE in every emergency surgery unit.

Full-Scale Launch

On January 18, an emergency meeting was held to review the epidemic situation of COVID-19 and emphasize that infection control was the top priority. Temporary notices and training rules regarding infection prevention and control were released throughout the hospital, including different levels of recommended protection based on risk, and paying special attention to the potential for virus transmission via the aerosolized route.

On January 19 and 20, information focusing on perioperative infection control was released to the department staff, referencing WHO and Centers for Disease Control and Prevention (CDC) guidelines. It included precautions for infection control in the perioperative setting, personnel emergency allocation workflow, and tracking and management of medical staff after suspected and confirmed exposures to patients with COVID-19.

SYSTEM: ANESTHESIA AND INFECTION CONTROL MANAGEMENT

Based within the division of the Anesthesia Quality Control Team in the Department of Anesthesiology, an emergency infection control team was established. A total of 12 members were assigned to different divisions, including infection control training and supervision, education and training, daily routine disinfection processes, and resource and PPE management.

Workflow of Perioperative Infection Control

The emergency infection control team formulated the following workflow covering perioperative infection control in and out of the OR, to ensure the quality and

safety of clinical anesthesia providers and patients, and prevent nosocomial infection:

1. Triage of suspected or confirmed cases of novel coronavirus pneumonia before entering the OR
2. Anesthetic checklist for suspected or confirmed cases of novel coronavirus pneumonia in the OR
3. Checklist of monitoring anesthesia care outside the OR during the outbreak of COVID-19, including sedation and anesthesia for gastrointestinal endoscopic and fiberoptic bronchoscopic procedures
4. Requirements for disinfection and sterilization of the environment, surfaces, instruments, and equipment in the OR during the outbreak of COVID-19
5. Personal protection requirements for medical staff in the OR
6. Personal protection requirements for anesthesiologists when performing emergency endotracheal intubation in the fever clinic or isolation ward
7. Infection control anesthetic requirements for anesthetic evaluation in the Preoperative Evaluation Center

Infection control precautions in the perioperative setting involve at least 3 stages: preoperative triage, infection control management intraoperatively, and infection control during postoperative patient transport. There was a high degree of familiarity with procedures in the OR setting already, so greater attention was paid to infection control management outside the OR at the early stage of the outbreak, such as in outpatient services, emergency endotracheal intubation in the fever clinic or isolation ward, and preanesthetic evaluation area. In general, it was easier to maintain high vigilance and strictly follow the safety protocols in clinical workplaces; however, non-work-related contact between medical staff generated a higher exposure risk, such as when dining together, because all medical staff may have been infected. Therefore, posting the key points of infection control in both the clinical and nonclinical settings, and maintaining a high level of vigilance and sterility, was important toward mitigating disease transmission.

Education, Training, and Updating

Education, training, and constant updates of COVID-19-related knowledge and skills are vital during the pandemic. Maintaining appropriate education includes the review of guidelines issued by the National Health Commission in China and the WHO, and protocols developed by the hospital. In order to avoid staff gathering, face-to-face and simulation instruction were replaced by online learning, including text materials and PowerPoint presentations, and instructional videos. Video conference also played an important role, allowing real-time discussion and feedback. During the training, it is particularly important to practice the standard process of donning and doffing of PPE. Formal information-sharing channels for medical staff should be encouraged through professional networks and diversified social media. Since June 2020, the National Conference on Medical Education has offered nationwide educational opportunities discussing various aspects of COVID-19, such as training on nucleic acid testing and epidemiologic investigation, which are mandatory requirements for all medical staff in China, and these are free for 1 year (<http://www.ncme.org.cn>).

STAFF: NEW WORK MODEL AND ALLOCATION OF ANESTHESIOLOGISTS

The COVID-19 pandemic challenged health systems and providers, and disrupted medical care. As the epidemic progressed, the work of our anesthesiologists progressed out

of the OR setting and into a more multidisciplinary team model of epidemic prevention and control, requiring anesthesiologists to work in a variety of locations. Anesthesiologists were not unique in the expansion of their clinical roles, because physicians from other medical specialties also returned to general medical practice. The balance of allocation of anesthesiologists between clinical anesthesia and COVID-19-related care needed continuous adjustments throughout the pandemic.

Clinical Work

Before experiencing an unprecedented surge of COVID-19 cases, clinical anesthesia was still our routine work mode. As indicated in Fig. 1, the number of monthly anesthesia cases in Union Hospital decreased from 8194 in December, 2019, to 5277 in January, 2020, in which emergency anesthesia comprised 1151 and 632 respectively.

Because epidemic control was considered the top priority, prompt risk assessment and strict measures to limit infection spread within the hospital, and to health care workers, were strictly enforced. The concept of flattening the curve by delaying the peak of the epidemic, aimed to put less strain on health care capacity and reduce the medical burden on hospitals. As a result, most elective operations were canceled or postponed, so the number of monthly anesthesia cases decreased dramatically to 155 and 332 in February and April 2020, respectively. Concurrently, almost all clinical doctors from various specialties converted to infectious diseases doctors, or critical care physicians.

Epidemic Prevention and Control

On January 19, an emergency personnel staffing model for PHEIC was established on a voluntary basis, and included 2 anesthesiologists on standby (24 h/d) in case of public emergency. It was touching that the 28-doctor roster was soon filled by our courageous colleagues, covering the following 2 weeks, including Spring Festival. Since January 23, anesthesiologists were included in the hospital multidisciplinary medical team, including the fever clinic, observation room of the emergency department, and isolation wards in Union Hospital, as well as other designated hospitals in Wuhan. From January to April, a total of 48 anesthesiologists and 27 anesthesia nurses were allocated to the frontline, including 5 professors or associate professors, 14 attending doctors, 21 residents, and 8 interns.

Daily Reports and Tracking Possible Infections

Core principles of epidemic control, including early detection, early reporting, early isolation, early diagnosis, early treatment, and early control, were identified when

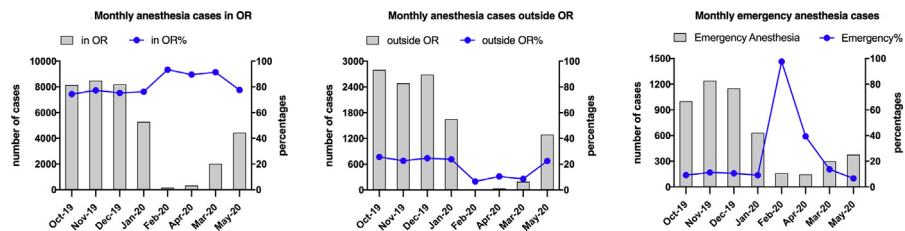


Fig. 1. Monthly anesthesia cases in the OR and outside the OR, and monthly emergency anesthesia cases. (A) Monthly anesthesia cases in OR: in OR% = (anesthesia cases in OR/total anesthesia cases) \times 100%. (B) Monthly anesthesia cases outside OR: outside OR% = (anesthesia cases outside OR/total anesthesia cases) \times 100%. (C) Monthly emergency anesthesia cases: emergency% = (emergency anesthesia cases/total anesthesia cases) \times 100%. (Data from Union Hospital from October 2019 to May 2020.)

the epidemic began. A daily reporting system for all medical staff was initiated in February, 2020. All medical staff working in the hospital completed personal reporting every day via the hospital Web site, or mobile app (Wechat Official Account). Departmental reporting was important for tracking and management of medical staff who had potential or confirmed exposures. In the event of a medical staff (or cohabitating family) potential exposure, they were advised to quarantine for at least 2 weeks. For potential exposures, staff were evaluated to meet the following criteria:

1. An exposure history 2 weeks before onset: a history of direct or indirect contact to Wuhan-related seafood markets, or exposure to suspected or confirmed patients with COVID-19
2. Clinical manifestations: fever, cough, soreness, imaging features of viral pneumonia, normal or decreased leukocyte count, no significant improvement or progressive worsening after at least 3 days of regular antibiotic treatment

Because all staff worked in Wuhan, the epicenter of the pandemic, they were considered high risk for COVID-19 as long as they showed any related clinical manifestations. During the 2 -week observation, the body temperature and respiratory status were monitored every day and recorded. One member of our emergency infection control team closely tracked and conducted follow-up by daily telephone communication, or instant messaging. Further evaluations, such as nasopharyngeal swab examination for nucleic acid, blood test, C-reactive protein, and pulmonary imaging, were considered depending on the severity and progress of the patient's clinical symptoms. Our department had 4 anesthesiologists who contracted COVID-19; 3 of them were admitted and 1 received home quarantine before all of them fully recovered and returned to work.

RESOURCE MANAGEMENT

Epidemic Prevention Materials and Personal Protective Equipment Management

Resource management should be established as fast as possible because of the ongoing imbalance between supply and clinical demands. Because of the extended closure of factories, city lockdown, and the 14-day-long vacation of Chinese New Year, the supply of disposable items faced a state of persistent shortage at the early stage of the pandemic. It was a relief that almost all of the elective surgery was canceled or delayed, and the stock of supplies at last could support the requirements of emergent surgery. However, PPE had been badly needed since the beginning of the outbreak, so it was strictly managed and used according to different levels of precaution requirement. PPE, including disposable protective clothing, goggles, face screens, and N95 masks, was classified, counted, and checked by special personnel every day to ensure adequate supply for clinical service. In addition, unprecedented social measures, such as lockdowns, transport restrictions, and even food provision, came as new challenges to health providers. The hospital arranged accommodation and commuting for the frontline staff, as well as basic food provision for the staff working in the hospital. In addition, the department arranged for the nonfrontline clinical staff to provide services for care not related to COVID-19; in particular, emergency surgery.

Instruments and Equipment

Routine maintenance, cleaning, and disinfection of instruments and equipment was performed by special personnel. The authors noted that the malfunction rate of the anesthesia machine increased significantly after undergoing the frequent disinfection processes, thereby making the preoperative machine check particularly important. In the case of an unexpected machine failure, there should always be at least 1 additional

anesthesia machine immediately available. In non-patient-care settings, ultraviolet lamp irradiation, plasma air disinfectant, and chlorine-based disinfectant were used on a regular basis.

EXPERIENCE AND ACHIEVEMENTS

What Can Anesthesiologists Do on the Front Lines?

Considering the high risk of potential exposure to respiratory droplets or aerosol from patients' airways, the frontline anesthesiologists set up a 16-member team in charge of out-of-OR airway management throughout the hospital. The team was on call for 24 hours, and later expanded to provide sedation and analgesia, invasive respiratory and circulatory monitoring (eg, central venous catheterization, artery cannulation, and blood gas analysis), and cardiopulmonary ultrasonography examination for patients in isolation wards.

Because of changing clinical needs during the pandemic, the doctors in the isolation ward or intensive care unit (ICU) were composed of intensive care doctors and other specialists functioning as multidisciplinary teams. The setting up of an emergency team was a successful and rewarding experience, allowing anesthesiologists to focus on airway management and basic life support, areas in which they are experts. It also alleviated the pressure and exposure risk of the doctor in charge in the isolation wards. On account of the participation of anesthesiologists, the management of sedation and muscle relaxants for invasive mechanical ventilation, as well as the management of drug withdrawal and weaning from ventilator, was more standardized. In addition, anesthesiologists also provided resuscitation and supportive treatment under the guide of invasive monitoring and ultrasonography examination.

Since February 2020, more than 30 anesthesiologists were allocated to 8 isolation ICUs in the hospital, who participated in the treatment of more than 800 patients with COVID-19, including more than 300 severe and critical cases. The experience of perioperative management and emergency tracheal intubation of patients infected with COVID-19 has been summarized and presented in several publications.⁶⁻⁹

What Can Anesthesiologists Learn from the Front Lines?

Participating in the treatment of patients with COVID-19 improved the anesthesiologists' airway skills, in particular for patients with respiratory infections, as well as expanding knowledge of respiratory drugs (eg, aminophylline, glucocorticoids) and multiple means of oxygen therapy and ventilation. Our experience treating patients with COVID-19 also improved anesthesiologists' comfort and knowledge for the continuous management of critically ill patients. Participating in the whole process of COVID-19 treatment means that clinicians should not only focus on the temporary improvement but also consider the whole course and long-term prognosis for the patients. Anesthesiologists are used to focusing on patients' short-term treatment and outcome. For example, critically ill patients would be sent to the ICU after surgery, and transferred out of the ICU after extubation and achieving hemodynamic stability. During the treatment of COVID-19 in isolation wards, anesthesiologists, as well as other physicians, need to pay close attention to changes in patients' conditions, and make appropriate triage decisions. The multidisciplinary teams that worked in the isolation wards allowed physicians from different specialties to work together in patient care, with each providing their own areas of expertise and sharing their knowledge with other team members. This model of care was important to provide a constant high level of care, in the setting of understaffing and burnout seen during the pandemic.

The Response of Anesthesiology Societies in China: Chinese Association of Anesthesiologists and Chinese Society of Anesthesiology Task Force

In the early phase of the outbreak, the Chinese Society of Anesthesiology (CSA) and the Chinese Association of Anesthesiologists (CAA) jointly formed a task force and quickly drafted recommendations concerning the perioperative management of patients infected with the novel coronavirus.⁷ These recommendations from the experts on the front lines aimed to provide suggestions on how to manage patients with COVID-19 in both the perioperative setting and in airway management for patients outside the OR. Moreover, CSA and CAA jointly set up the COVID-19 Prevention and Control Online Platform for Anesthesiologists on the official Web sites of both societies, with the goal to answer questions from anesthesiologists all over the country. According to incomplete statistics, more than 800 Chinese anesthesiologists and anesthetic nurses participated in the frontline medical work in Hubei Province. To provide assistance to providers experiencing psychological issues related to the pandemic, CAA and CSA also established a platform to provide free mental health care to all anesthesiologists and anesthetic nurses caring for patients with COVID-19. In addition, both associations held several online experience-sharing meetings with official anesthetic associations/societies around the world to share their firsthand experiences.

Research During the Pandemic

The pandemic presented an unprecedented challenge to rapidly develop new diagnostic, preventive, and therapeutic strategies. From the beginning of the pandemic, we collected and reported anesthesia-related clinical characteristics, as well as clinical outcomes of patients with confirmed or suspected COVID-19, and drafted protocols and procedures for anesthetic and airway management, as well as for infection control in the preanesthesia and OR settings.^{9–11} Tracheal intubation in patients with COVID-19 was often necessary but had intrinsic danger to the anesthesiologist performing the procedure because of the potential for exposure to secretions and aerosols. The Chinese experience and guidelines for emergency endotracheal intubation in critically ill patients with COVID-19 were summarized, which helped keep health care workers safe and provide optimal airway management.^{6,8}

The health of pregnant women, newborns, and children has also attracted much attention during the pandemic. Soon after COVID-19 presented, a case of successful spinal anesthesia was reported in a woman with confirmed COVID-19 undergoing emergency cesarean section, and a case of successful combined spinal and epidural anesthesia during an emergent cesarean delivery.^{12,13} Moreover, the effects of underlying cardiovascular diseases on patients with COVID-19 have also been explored, as well as the damage caused by SARS-CoV-2 infection to the cardiovascular system.¹⁴ It has been found that SARS-CoV-2 infection may damage the cardiovascular system, manifested as changes in cardiac structure and function, especially in the left heart and ascending aorta. In addition, anesthetic nurses also played key roles in caring for patients with COVID-19 in Fangchang Hospital, in the isolation wards, or in the ICU for critical cases. Results of the research conducted by anesthetic nurses showed that they can quickly adapt to the treatment and management of patients with COVID-19 because of their proficient skills in airway and respiratory management, as well as their rich experience in emergency responses and the use of life support equipment.¹⁵

Contribution to Guidelines

Consensus from experts who managed patients with COVID-19 could provide information in a more direct, structured, efficient, and reproducible way. Since the onset

of COVID-19, the authors have drafted and published a series of professional recommendations and expert consensus statements concerning infection prevention and control in the Department of Anesthesiology, lessons learned and international expert recommendations on emergency tracheal intubation, and anesthetic management of special patient populations (elderly, maternal, and pediatric). As the medical order gradually returned to normal, the authors drafted the work recommendations for perioperative management during the recovery period following the pandemic. This series of expert recommendations and consensus could help health care providers, particularly anesthesiologists, optimize the care of patients, the safety of their colleagues, and the public.

SUMMARY

Based on our experiences during the COVID-19 pandemic, the authors established protocols, guidelines, and a response system to effectively provide care to patients, while keeping ourselves safe from infection. With the pandemic ongoing, the so-called new normal in our practice will be based on ongoing training and education for staff, the ability to rapidly deploy health care providers when needed, and effective resource management. Because the future of the COVID-19 pandemic remains uncertain, constant updating and sharing of information will foster better care for patients, and a safer work environment for clinicians.

CLINICS CARE POINTS

- An emergency response system, that includes a new work model with proper allocation of manpower and medical resources, should be implemented as soon as possible when a disaster occurs.
- The protection of medical providers and patients are equally critical for a contagious deadly disease like COVID-19.
- Cancel or delay surgery when a deadly contagious disease with unknown etiology is suspected.

DISCLOSURE

The authors have nothing to disclose.

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