

# A practice of anesthesia scenario design for emergency cesarean section in patients with COVID-19 infection based on the role of standard patient

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**SUMMARY** The new coronavirus (COVID-19) has been characterized as a world pandemic by WHO since March 11, 2020. Although it is likely that COVID-19 transmission is primarily via droplets and close contact, airborne transmission and fecal-oral route remains a possibility. The medical staff working in the operating room, such as anesthesiologists, surgeons and nurses, are at high risk of exposure to virus due to closely contacting patients. The perioperative management is under great challenge while performing surgeries for patients suffering COVID-19, including emergency cesarean section, which is one of the most common surgeries under such circumstances. How to prevent medical staff from cross-infection is an issue of great concern. In this article, we give a practice of anesthesia scenario design for emergency cesarean section in a supposed standard patient suffering COVID-19, aimed to optimize the work flow and implement the protective details through simulation of a real operation scenario, which may be useful for training and clinical practice of anesthesia management for patients suffering COVID-19 or other fulminating infectious diseases.

**Keywords** COVID-19, SARS-CoV-2, anesthesia management, cesarean section, scenario design

## 1. Introduction

The new coronavirus (COVID-19) outbreak in many countries of the world and has been characterized as a world pandemic by the World Health Organization on March 11, 2020 (1). It is now generally considered that the transmission happens mainly through respiratory droplets and close contact (2,3), and in some exceptional cases airborne or aerosols may also be involved (4). The medical staff working in the operating room (OR) are at high risk of exposure to virus due to close contact with patients, procedures of surgeries and anesthesia being possible to produce airborne or aerosols in a comparatively confined space. However, urgent and emergency surgeries for confirmed or highly suspected COVID-19 patients, especially emergency cesarean sections are inevitable. Thus, it is important to provide systemic preventive precautions and training to improve the personal protective ability during perioperative anesthesia management.

In this article, we provide our practice and experience for planning a training program for an

anesthesia scenario based on the role of a standard patient to optimize work flow and implement protective details.

## 2. Methods and Results

### 2.1. Establishment of emergency response team

In order not to disturb regular operation and anesthesia work, we recruited doctors and nurses based on voluntary registration and established emergency response teams (ERTs) including 6 formal ERTs and 3 backup ERTs. Each ERT included two senior anesthesiologists, a resident doctor and an anesthesia nurse with department head. The ERT has been regularly arranged and scheduled and each ERT takes charge of one week of anesthesia work for surgical patients with confirmed or highly-suspected COVID-19 in turns. The staff included in ERT must be strictly trained and practiced wearing and undressing personal protective equipment (PPE), including adequate precautions, good hand hygiene, properly fitted N-95 masks and other essential PPE.

2.2. Establishment of surgical and anesthesia rule and workflow for cesarean section based on the role of a standard patient

It is necessary to establish an understandable rule and workflow for surgeons, anesthesiologists and nurses, which must be strictly obeyed and performed by all departments to obtain interdisciplinary cooperation (Figure 1). It is important to classify the normal, suspicious and confirmed patients by screening the patient from COVID-19 before being admitted to the hospital or being sent to OR.

2.3. Anesthesia scenario setting

A suspected COVID-19 pregnant woman had been sent to the appointed fever clinic in our hospital. The on-duty physician immediately performed the detection of nucleic acid nose or throat swab after consulting the infection expert and reporting to the Hospital Infection Administration Division. In accordance with the contingency plan, all departments were on their way: the Prevention and Health Section was responsible for the infectious disease report; the Hospital Infection Administration Division directed nosocomial infection control; and the director of the Infectious Disease Department carried out medical treatment and called for obstetric consultation. 4 hours later the nucleic acid test was shown to be positive for coronavirus. Obstetricians decided that this confirmed COVID-19 patient needed emergency cesarean because the woman had a mild pneumonia with complete placenta previa and 38 weeks

gestation and the fetal heart rate was getting faster in the last half hour. Dedicated OR equipped with a negative pressure system was standby and surgery related staff were in place immediately.

2.4. Anesthesia scenario process

The process of anesthesia scenario setting for this emergency cesarean section is summarized in Figure 2.

*Report:* The notice of emergency cesarean with a confirmed COVID-19 pregnant woman was immediately reported to the department head and on call ERT.

*Preoperative preparation:* ERT members moved quickly based on their own responsibility (Table 1). Equipment, consumables, drugs and so on should follow the strict principle of "only in" policy, which means they can't be taken out of the dedicated OR. Only the necessary items need to be brought in. Possible use or backup items are placed in a nearby clean OR, including anesthetics for general anesthesia, intubation supplies with visual laryngoscope, crystal and colloid, pressurized bag, arterial pressure transducer, central venous catheter, emergency cart and difficult airway cart.

*Personnel protection and staff arrangement:* All the in-room staff were in place and carried out level 3 PPE under the guidance of infection specialist (Figure 3A and 3B). Related instruments, equipment and drugs needed for the surgery were checked again. A senior anesthesiologist and resident doctor were in the room, another senior anesthesiologist and the anesthesia nurse

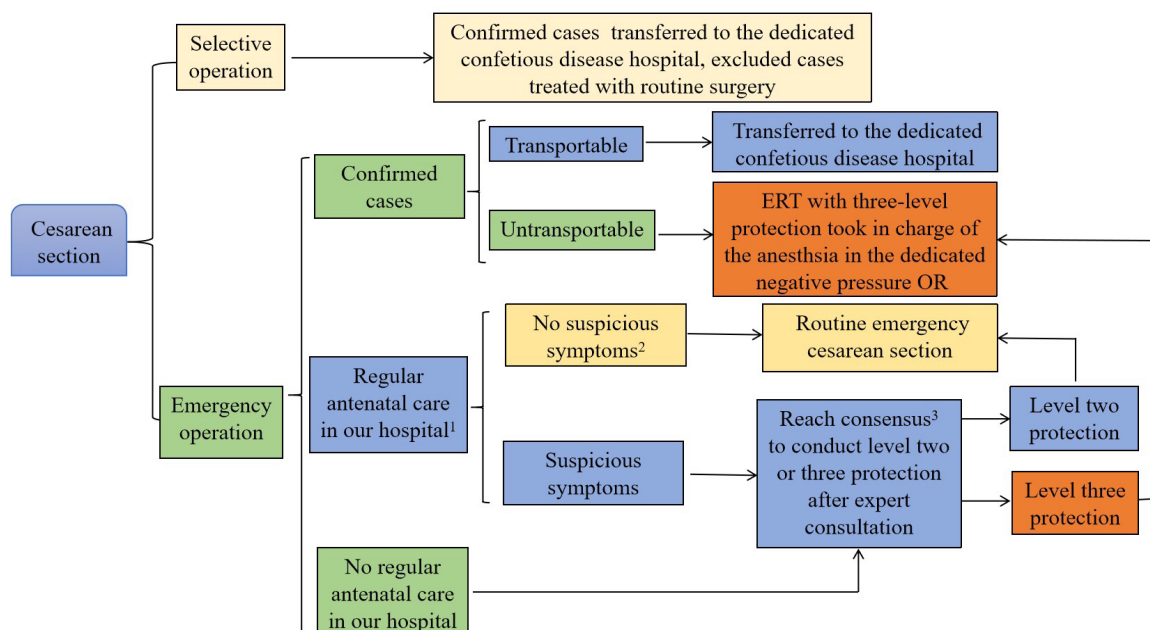


Figure 1. The surgical and anesthesia rule and workflow for cesarean section. Annotate:1) Regular antenatal care in our hospital (including whole blood cell count and nucleic acid test for COVID-19, expert consultation and chest CT screening if necessary). 2) Suspicious symptoms including contact history; fever, cough and other respiratory symptoms; chest CT screening not excluded. 3) Consensus among the anesthesiology director, obstetrics director and operating room director.

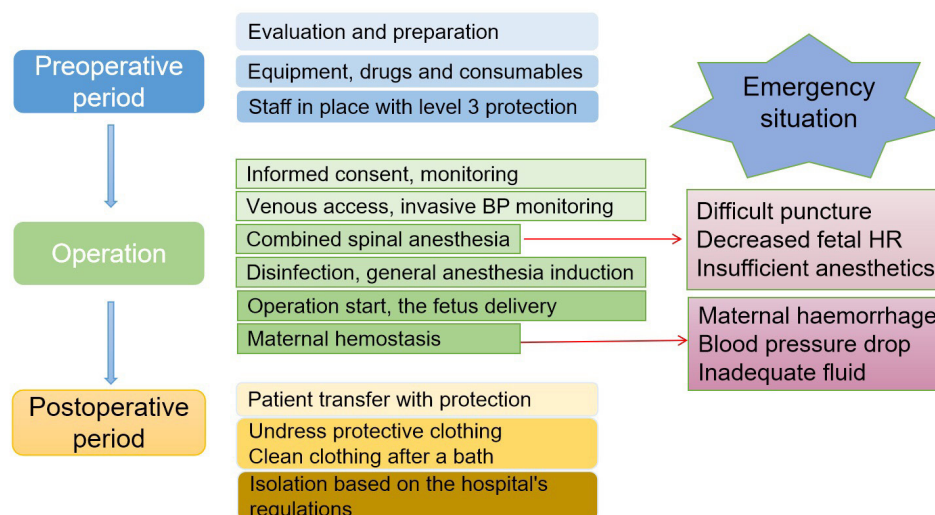


Figure 2. Flow chart of the anesthesia scenario setting-emergency cesarean section with a confirmed COVID-19 pregnancy woman.

were on standby to provide guidance or support in a clean OR nearby. Department head (team leader) took the responsibility of communication and cooperation with other departments.

*Informed consent and monitoring:* Patient was sent to the negative pressure OR strictly following planned route in advance with a clean area, semi-contaminative (buffer area) and contaminative area, as shown in Figure 3C. The patient signed the informed consent paper after entering the OR. The patient wore a protective mask all the time, and supplementary oxygen was given over the mask through a nasal catheter with low oxygen flow 2-3 L/min. Two venous accesses and invasive BP monitoring were established.

*Prevention and treatment of emergency or unexpected situations during operation:* Emergencies including hypotension, nausea and vomiting, and arrhythmia and massive bleeding may occur. 15 minutes after the fetus' delivery, massive bleeding occurred and blood pressure dropped quickly to 60/35 mmHg within 5 minutes. Routine treatment proceeded with fluid infusion and vasopressor drugs. The backup ERT members were ready to replenish the colloid solution, vasoactive drugs and apply for blood transfusion. A backup anesthesiologist was ready to participate in the rescue whenever necessary. The newborn was handled by a neonatologist and sent to the neonatal unit for isolated medical observation. The group remembered to change gloves and disinfect hands, avoiding contamination of other areas of the OR.

*Patient Transit:* The patient was transferred to the Infection Disease Department through the dedicated patient delivery route.

*Postoperative Clean and Sterilize:* After handover of the patient, the relevant medical staff undressed from the PPE under the guidance of an infectious specialist, and put on clean clothing after a bath and had rest based on the hospital's regulations. The OR and anesthesia

machine will be sterilized following the guidance of the institute. The nurse will deal with the disinfection and treatment of postoperative medical items and waste.

### 3. Discussion

Emergency surgery for confirmed or suspected COVID-19 patients may take a longer time to prepare than general emergency operations because of the special requirements for preoperative wear of PPE and patient transfer. Therefore, it should need rapid action with close cooperation and orderly preparation to shorten the waiting time. Repeat practice and training of perioperative management is necessary for this kind of patient, and is important. Spinal anesthesia is still recommended as the primary choice of anesthesia for cesarean delivery in a confirmed COVID-19 pregnant woman (5). However, general anesthesia can be used in patients with contraindications of spinal anesthesia or serve as a backup plan in case of spinal anesthesia failure or intraoperative conversion to general anesthesia.

The ERT in our department are scheduled on a weekly basis. This schedule will minimally disturb regular anesthesia work and allow staff to obtain enough rest after operations. Each member of the ERT has his own responsibility (Table 1).

The dedicated operating room for COVID-19 surgeries should be equipped with a negative pressure system. Patients with general anesthesia should be fully preoxygenated under autonomous respiration to avoid high flow oxygenation as it may increase the production of viral droplets and aerosols (6). Two layers of wet gauze can be used to cover the patient's mouth and nose. The use of a breathing circuit filter is recommended during surgery (Figure 3D) because its use can effectively prevent the anesthesia machine from contamination by bacteria and viruses (7). To avoid potential exposure risk

**Table 1. Anesthesia Precaution Checklist for COVID-19 infected patients**

Items	Confirmation (√)
<b>1. Preoperative preparation:</b>	
<b>a. ERT anesthesiologists:</b>	
<ul style="list-style-type: none"> <li>● Communication with relevant departments</li> <li>● Preoperative evaluation</li> <li>● Informed consent paper for anesthesia</li> </ul>	
<b>b. ERT nurse:</b>	
<ul style="list-style-type: none"> <li>● Preparation of drugs, equipment and consumables in dedicated OR</li> <li>● Preparation of drugs, equipment and consumables in a backup clean OR nearby</li> <li>● Anti-mist treatment for goggles and glasses with iodophor or bath lotion half an hour in advance</li> </ul>	
<b>2. Personal protective equipment:</b>	
<ul style="list-style-type: none"> <li>● Level 3 personal protective equipment under the guidance of infection specialist: hand hygiene, operating scrubs, disposable hair cover, n95 mask, surgery mask, goggles/face shield, protective clothing overall, medical latex gloves, boot covers, isolation gown</li> </ul>	
<b>3. Patient transfer and reconfirmation:</b>	
<ul style="list-style-type: none"> <li>● Dedicated access to transport patients. The patient must wear a surgical mask or N95 mask all the time</li> <li>● Reconsideration of drugs, equipment and consumables by the in-room anesthesiologists</li> <li>● Other ERT members and nurse on standby in the clean OR nearby</li> <li>● Spare drugs, consumables, emergency cart, difficult airway cart in place</li> <li>● Effective and timely communication between ERT members through network video or walkie-talkie</li> </ul>	
<b>4. Patient entry to the dedicated OR:</b>	
<ul style="list-style-type: none"> <li>● Signature of informed consent for anesthesia</li> <li>● Monitoring, establishment of venous access</li> </ul>	
<b>5. Anesthesia:</b>	
<b>a. Spinal anesthesia</b>	
<ul style="list-style-type: none"> <li>● Patient with a surgical mask or N95 mask</li> <li>● Supplementary oxygen given over the mask</li> <li>● A backup plan of general anesthesia</li> </ul>	
<b>b. General anesthesia</b>	
<ul style="list-style-type: none"> <li>● Visual laryngoscope with disposable laryngeal lenses as first choice</li> <li>● Breath filters installed between the proximal end of the endotracheal tube and the distal end of the circuit</li> <li>● Fully preoxygenation with appropriate oxygen flow</li> <li>● Two layers of wet gauze to cover the patient's mouth and nose</li> <li>● Modified rapid sequence induction with sufficient muscle paralysis</li> <li>● Avoid coughing and/or bucking</li> <li>● Oral or tracheal suction performed with a closed suction system after intubation</li> </ul>	
<b>6. Unexpected difficult airway:</b>	
<ul style="list-style-type: none"> <li>● Place Laryngeal mask if it meets the needs of surgery</li> <li>● Notify pending support if endotracheal intubation required</li> </ul>	
<b>7. Treatment of intubation utensils:</b>	
<ul style="list-style-type: none"> <li>● Take off the outer layer gloves and put on new latex gloves after hand hygiene</li> <li>● Alcohol to sterilize the laryngoscope handle three times before putting in the prepared specimen bag separately for further treatment postoperation</li> </ul>	
<b>8. Supplement of drugs and consumables during operation:</b>	
<ul style="list-style-type: none"> <li>● Sent in the OR from the backup OR nearby through the semi-contaminated area</li> <li>● Blood transfusion: all the prepared work done by the backup ERT member before transfusion</li> </ul>	
<b>9. patient transit:</b>	
<ul style="list-style-type: none"> <li>● Be clear about the dedicated patient delivery routes</li> <li>● Inform the infectious department and get ready for this patient</li> <li>● Clean files and patient contacted files separately stored</li> <li>● Attention to staff protection in transit</li> </ul>	
<b>10. Isolation:</b>	
<ul style="list-style-type: none"> <li>● Undress PPE and put on clean clothing after a bath</li> <li>● Isolation based on the hospital's regulations</li> </ul>	

of aerosols or droplets contamination, modified rapid sequence induction with sufficient muscle paralysis is recommended. Opioid analgesics should be given after loss of consciousness and muscle relaxant to reduce stiffness of the chest wall. It is also very important to take measures to avoid coughing and/or bucking during anesthesia induction, intubation, extubation and the recovery period (5,8). Video laryngoscopes are a good choice for normal trachea intubation. For spinal anesthesia, the infected patient must wear a surgical mask or N95 mask all the time.

Maintain smooth communication among departments. The team leader and the backup ERT stay

in a clean OR nearby in case of emergency or need of rescue. The transfer route, protection requirements of patient and transported staff should be clearly aware before the surgery and exactly implemented after the operation.

Anesthesia drills for different types of operations are required at regular intervals to get continuous feedback and improvements. On this basis, we have developed the "Anesthesia Precaution Checklist for COVID-19 infected patients" (Table 1) and require that each item of the checklist be ascertained or implemented before entering the infectious surgical room.

In conclusion, the ERT members should be fully



**Figure 3** Some methods to protect medical staff from infection in operation room during the practice of anesthesia scenario. (A) The procedure of wearing PPE. Operating scrubs→shoe covers→hand hygiene→n95 mask→surgical mask→hair cover→goggles→protective clothing→boot covers→gloves→goggles/face shield→isolation gown→gloves; (B) The procedure of undressing PPE. (Contaminative area) Isolation gown→outer gloves→hand hygiene→new gloves→goggles/face shield→hand hygiene→(first buffer area) unclasp the boot covers→outer gloves→hand hygiene→new gloves→protective clothing→hand hygiene→(second buffer area) hand hygiene→hair cover→goggles→new gloves→surgical mask→n95 mask→hand hygiene→shoe covers and shoes→gloves→(clean area) clean clothing after a bath; (C) The area division around negative pressure OR and the patient in-and -out route. Annotate: 1) Dedicated elevator for patient transmit, 2) Buffer area, 3) Dedicated OR, 4) Clean OR. Areas in grey mean semi-contaminative area, areas in white are clean while area in yellow is the contaminative area. The red lines represent the in-and-out route for covid-19 patients. The green line is for the evacuation of in-room medical staff; (D) The placement of the breath filters.

trained in advance based on safe medical practices and nosocomial infection prevention protocols. Everyone must make sure they can wear and take off the PPE correctly through training and appraisals. Anesthesia drills for different types of operations are required at regular intervals to get continuous feedback and improvements.

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