

Recommendation about the perioperative prevention of infection to healthcare workers and the anesthesia management of children with SARS-CoV-2 infection

Jinjin Huang,¹ Yaoqin Hu,¹ Jiangmei Wang,¹ Dongpi Wang,¹ Zhirui Zhu,¹ Zhiyong Hu,¹ Ziyang Jin,¹ Hongfei Lin,¹ Wenfang Huang,¹ Weiqing Shen,¹ Yilei Jiang,¹ Miaofeng Hu,¹ Jingzhen Wu,¹ Yaojun Suo,¹ Qiang Shu^{2,3}

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ABSTRACT

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) has spread widely and persistently over 100 countries. New challenges have occurred in the perioperative management of airway and anesthesia in children diagnosed with SARS-CoV-2 infection. According to current publications and to our own experiences in anesthesia management for cases with SARS-CoV-2 suspected, we reviewed concerns about the perioperative prevention of SARS-CoV-2 to medical staff and the anesthesia strategy to the patient.

diagnosed with SARS-CoV-2.⁴ Anesthesiologists need to get information from medical record, and talk with supervising physician and the parents. The key points that need to be known are the symptoms such as fever ($>37.3^{\circ}\text{C}$), cough, sore throat and the chest CT scan, which should be confirmed by anesthesiologist and surgeon⁵ and/or positive test to SARS-CoV-2 by real-time PCR.

Anesthesia procedure Preoperative sedation

The pediatric patient is prone to be anxious when separated from parents, which leads to saliva spraying with SARS-CoV-2. Midazolam or dexmedetomidine should be given before the patient enters the operating room (OR) from his parents. Surgical mask should be put on all the way.

Preparation for the surgery

Negative-pressure (below 5 Pa) OR with separate entrance and exit should be ready for the surgeries. Laminar flow and clean air conditioning in the OR should be shut off if there is no negative-pressure OR. Air circulation system with virus inactive should be installed temporarily if possible. Materials and machines should be ready enough according to the type of surgery. Other irrelevant appliance should be removed out of OR. An obvious signboard of isolated surgery should be hung outside the door. Experienced anesthesiologists and nurses should be assigned to manage the surgery. As few doctors and nurses should be required as possible. Two anesthesiologists should be involved, one attending and one resident. Everyone who enters the OR should receive strict training

INTRODUCTION

The spread of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) has presently become the most serious public health concern. The first cases were reported in Wuhan, Hubei Province, China,¹ and additional cases have been reported in over 100 countries around the world. Among these cases, children including infants are prone to CoV-2 infection.^{2,3} New challenges have occurred during the perioperative management of airway and the anesthesia of children with SARS-CoV-2 infection. To ensure the safety of surgical pediatric patients and healthcare workers, this article aims to describe a proposal for the prevention of infection and for perioperative anesthesia management.

Clinical reception

Protocols and plans for emergency surgeries should be done in a hospital assigned for patients with SARS-CoV-2. Selected surgeries should be postponed in principle. The decision of whether limited surgeries should be performed requires multidisciplinary team consultation. Patients suspected of SARS-CoV-2 are treated the same way as those



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¹Department of Anesthesiology, Children's Hospital, Zhejiang University School of Medicine, Hangzhou, China

²National Clinical Research Center for Child Health, Hangzhou, China

³National Children's Regional Medical Center, Hangzhou, China

Correspondence to

Dr Qiang Shu; shuqiang@zju.edu.cn

for putting on or off protective clothing. One would not be permitted to manage the patient unless he/she put on the clothes with tertiary prevention correctly according to Technical Guideline for Prevention and Control of Novel Coronavirus Infections at Medical Institutions⁶ and gets the permission from the prevention supervisor.

Materials and staff at operation

Disposable supplies are the best choice. Three filters are recommended. One is filter with heat and moisture exchanger at the top of endotracheal tube. The other two are filters placed on the both sides of the breathing loop inlet and outlet, respectively. Two anesthesiologists and three nurses are involved. Circulating nurse transports the patient to negative-pressure OR with the help of a resident. Optimal transport bed is the one with increased crew protection along the assigned private route. Disposable surgical blanket is the substitute when increased crew protection is not acquired. A surgical frame should be put above the head to keep the airway open. Patient would be reassessed by the attending nurse after entering the OR. Instrument nurse and first circulating nurse should be present inside the OR. The second circulating nurse is responsible for delivery at the buffer room. The second circulating nurse should get dressed with secondary containment. Participants for transportation should put on the clothes with tertiary prevention.

Anesthesia management

Symptoms of most children and infants with SARS-CoV-2 are mild, such as fever and cough.⁴ Proper anesthesia plan should be given with personalized precision medicine to every infant. The general principle is the adequate oxygen supply, optimal anesthesia medicine with minimum side effect, avoiding cough reflex and agitation and ensuring the safety of both patient and staff.^{5,6}

Anesthetic protocol and principles

In order to avoid droplet and possible aerosol pollution from patients' respiratory tract caused by unanticipated crying, intravenous sedatives or mask-inhaled, sevoflurane should be used for induction. As for the American Society of Anesthesiologists (ASA) class I–II patients with stable cardiopulmonary function, on the basis of satisfying surgical operation, it is recommended to apply intravenous anesthesia without intubation combined with regional nerve block or caudal block anesthesia excluding stomach satiation, brain surgery, craniofacial, ear-nose-throat (ENT) surgery, cardiothoracic and laparoscopic surgery. Maintain patients' spontaneous breathing and oxygen inhalation by continuous positive airway pressure (CPAP) with an airtight mask, then keep monitoring and prepare for intubation as soon as possible. As recommended, patients with a preoperative ASA class III and above or in severe cases are anesthetized with tracheal intubation, intravenous and inhalational technique combined with general anesthesia. Low flow closed air is required. Lung-protective ventilation

should have lower tidal volume (3–8 mL/kg) and limited plateau pressure (below 30 cm H₂O).⁷ Intubation should be performed by an experienced anesthesiologist to ensure first-time success of intubation. In cases of difficult airway, the laryngeal mask should be placed after first failure for intubation to avoid the risk of infection caused by repeated attempts of intubation.⁸ Proper removal of protective equipment is recommended under the guidance of infection control protection supervision. Protective clothing should be discarded in a double-folded, yellow, medical garbage bag and wrapped in designated area.

The key points of protection during endotracheal intubation are to prevent patients from coughing during the operation and to prevent the discharge of patient secretions. The following necessary notes should be taken into consideration: (1) *oxygen supply before induction*: remove the medical protective masks or surgical mask while mask oxygen inhalation; (2) *induction*: there should be rapid induction of anesthesia and intubation, adequate muscle relaxation to prevent cough. Medication should be taken in the following order: midazolam, propofol/etomidate, rocuronium, fentanyl/sufentanil. Opioids should be injected slowly to avoid choking and coughing. Tracheal intubation should be performed after spontaneous breathing disappears and muscle relaxes completely; (3) before tracheal intubation, the anesthesiologist should wear an additional layer of rubber gloves; then remove them immediately after intubation is finished. A laryngoscope should be used for intubation. The disposable transparent laryngoscope sleeves should be discarded after use. For hand-held lens handles, a protective sleeve cover (specimen bag or sterile ultrasound probe cover, tightly sealed with a rubber band) should be used, the protective cover after use should be discarded and then repeatedly wiped and disinfected with hydrogen peroxide disinfection wipe or alcohol cotton; (4) *judgment of catheter depth*: the distance scale of the tube to the incisor, the degree of bilateral thorax undulation, the CO₂ waveform of the ventilator's expiration and the breathing parameters for comprehensive judgment should be observed. It is not easy to judge the depth of the catheter by auscultation of breathing sounds; (5) for patients with oral secretions, if without airway obstruction, it is recommended to perform airway aspiration after completing the tracheal intubation. Disable central suction, enable electric suction device, use closed suction system for tracheal suction to prevent secretion pollution.

Proposed medicine for anesthesia management is propofol, remifentanyl pump or sevoflurane inhalation and rocuronium intermittent bolus. Keep intensive intraoperative monitor. Monitor invasive blood pressure and central venous pressure if necessary for hemodynamic stability. Critically ill children might have pathological conditions such as acute lung injury, acute respiratory distress syndrome, heart failure, acid-base imbalance and electrolyte disorders, in which case more attention and close monitoring is needed.⁹

Extubation and transfer

Patient with CPAP is observed for 5–10 min in OR and then transported to the isolated ward postoperatively. Those with intubation need to be reassessed after surgery. If children with mild diseases and stabilized condition are under monitoring, extubation could be carried out after tracheal suction under deep sedation. Before extubation, an appropriate amount of lidocaine is injected intravenously and mouth and nose are covered with two pieces of warm and moist gauze to avoid the discharge of secretions caused by choking. Indications for extubation are regular spontaneous respiration, tidal volume over 6 mL/kg and end-expiratory carbon dioxide partial pressure (PetCO₂) below 50 mm Hg. Antagonists are not recommended for the patient. Appropriate postoperative analgesia can reduce crying or agitation after extubation. Patient could be sent to the isolation ward directly after extubation if the Steward score is ≥ 5 .

To avoid children waking up or moving during transport, it is recommended to deepen the anesthesia or to give additional muscle relaxant before the severe children leave the OR. The patient is transferred to the isolation ward directly after extubation. Care should be provided to enhance respiratory support and organ functional support in time, and prevent secondary infections. Extracorporeal membrane oxygenation (ECMO) should be supported if necessary.^{2 10}

Patient should be transported back to the ward with the same bed and the same route before surgery. Staff involved in transport should put on the new clothes with tertiary prevention.

Postoperative special issues

Perioperative infection prevention

All medical waste should be discarded into double-folded, yellow, medical garbage bag or buckets in strict accordance with relative rules and made sure that 'novel coronavirus infection' logo is specifically marked.

Anesthesia machines should be routinely disinfected with anesthesia sterilizer. Video laryngoscopes, anesthesia carts and other anesthesia facilities should also be wiped and disinfected with hydrogen peroxide disinfection wipes. The infection control team should check and record the disinfection for trace-back investigations.

Proper removal of protective equipment is recommended under the guidance of the infection control and protection supervisor. Protective clothing should be discarded in a double-folded yellow medical garbage bag and wrapped in designated area.

Perioperative infection control

All healthcare staffs are vulnerable to infection. Patients' blood, body fluids, secretions and discharge are all contagious which must be isolated. Anesthesiologists must prevent blood and non-blood infections from being transmitted. During the operation, anesthesiologists should try to keep a certain distance from the operating bed to prevent blood contamination of children on the bed.

The sharp instruments in OR should be carefully recovered and treated to prevent stab wounds and the iatrogenic occupational exposure. Iatrogenic occupational exposure treatment should be started immediately once it happened.¹¹ Furthermore, much attention should be paid to tracking and management after contacting with suspected or confirmed cases. After exposed to those suspected of or confirmed with SARS-CoV-2, one's complete blood count, C reactive protein and pulmonary imaging should be evaluated individually if symptoms such as fever, cough or fatigue occur. Each case should be reported to the department, and isolated from the outside. Specially trained staff should be set up in each department for recording and keeping trace of the suspected cases in order to take following measures: postoperative infectious prevention should be performed in accordance with the relevant regulations of the 'Hospital Air Purification Management Regulations' and 'Medical Institution Disinfection Technical Specifications'.

CONCLUSION

Owing to special physiological and pathophysiological characters of children (especially infants and young children), it is necessary for medical staff to follow the requirements strictly for the protection from novel coronavirus infections in airway management and perioperative anesthesia management, in order to avoid passive infection during airway management and other contacting operations. Appropriate anesthetic technique provides adequate oxygen and the best role in protecting the organ functions, which contribute to the pediatric treatment and disease control of epidemic situations of novel coronavirus infection.

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