

# The precaution strategy toward the COVID-19 pandemic in the operating room of a tertiary hospital in Taiwan

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## Abstract

**Background:** The pandemic of SARS-CoV-2 (COVID-19), which began in December 2019, spread mostly from person to person through respiratory droplets. A recommendation was issued to postpone all elective surgical practices. However, some confirmed or suspected COVID-19 patients required life-saving emergent surgeries.

**Methods:** To facilitate emergent surgical interventions for these patients, we have reviewed the current literature and established an algorithm of precautions to be taken by operating room team members during the COVID-19 pandemic.

**Results:** The initial algorithm of preparation for surgical intervention during the COVID-19 pandemic was relatively simple. However, the abrupt increase of confirmed COVID-19 cases due to returned overseas travelers since mid-March 2020 disrupted the routine hospital clinical service. Due to the large number of febrile patients, the algorithm was therefore revised according to travel history, occupation, contact and cluster history (TOCC), unexplained fever/symptoms, and emergent/nonemergent surgery. TOCC (+) patients presenting with otherwise unexplained fever/symptoms would be regarded as belonging to the fifth category of “severe special infectious pneumonia.” If the patient requires emergent surgery to relieve the non-life-threatening disorders, two times of negative COVID-19 tests are necessary before the operation is approved. For life-threatening situations without two negative results of COVID-19 tests, the operation schedule should be approved by the Chairman of Surgery Management Committee.

**Conclusion:** The application of a clear and integrated algorithm for operating room team members aids in effective personal protective equipment facilitation to keep both healthcare providers and patients safe as well as to prevent hospital-based transmission of COVID-19.

**Keywords:** Emergent surgery; Operating room; Pandemic; Precaution; SARS-CoV-2 (COVID-19)

## 1. INTRODUCTION

The catastrophic pandemic of SARS-CoV-2 (COVID-19), which began in December 2019, spreads mostly from person to person through respiratory droplets, although some studies also suggest the possibility of transmission by aerosol.<sup>1,2</sup> Even though social distancing and the use of masks prevented the rapid spread of COVID-19 in Taiwan, hospital-based transmission occurred at a small-scale in the early period of this pandemic. The abrupt increase of confirmed cases in March, 2020 due to returned

overseas travelers raised great concern and severely impacted routine hospital clinical practice. Even elective surgical practices were recommended to be postponed in the United States.<sup>3</sup> To strike a balance between the optimal utilization of limited personal protective equipment (PPE) and facilitation of urgent and emergent surgical interventions, we have reviewed the current literature<sup>4</sup> and established stepwise-tailored guidelines for precautions to be taken by operating room team members under the changing pandemic spread of the COVID-19.

## 2. METHODS

In response to the changing pandemic spread of COVID-19, an algorithm for operating room team members was developed in Taipei Veterans General Hospital, a tertiary hospital in Northern Taiwan. The algorithm was established by our surgeons, anesthesiologists, and the experts from our infection control department, and was approved by the hospital administration committee to ensure both a comprehensive strategy as well as institutional practice compliance. According to the definitions published by the Taiwan Centers for Disease Control (Taiwan CDC) on March 20, 2020, confirmed patients are defined as

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those having positive real-time polymerase chain reaction from a clinical specimen such as a nasopharyngeal or throat swab, expectorated sputum, or lower respiratory tract aspirates.<sup>5</sup> Suspected patients are defined as those who fail to comply with any of the first three items of the health statement and notification questionnaire for the New Coronary Pneumonia Epidemic Prevention in Taipei Veterans General Hospital (Supplementary Appendix 1, <http://links.lww.com/JCMA/A65>).

### 3. RESULTS

According to the guidelines of the infection control measures for patients with suspected or confirmed COVID-19 (Wuhan pneumonia) published by the Taiwan CDC on March 20, 2020, non-emergent surgery should be postponed until the case is released from isolation or the suspected condition has been ruled out accordingly. If a suspected or confirmed case must undergo emergent surgery, it should be arranged as the last operation of the day in that specific operative suite. If it cannot be scheduled as the last operation, there must be a sufficient time interval prior to the next operation to ensure complete ventilation, environmental cleansing, and disinfection of the operative suite.

#### 3.1. Algorithm of preparation for surgical intervention during the COVID-19 pandemic

The basic principle of permission for surgical intervention in suspected or confirmed COVID-19 cases is as follows (Fig. 1): First, when the surgeons decide to arrange an emergent operation, they should take the initiative to inform the Director of Operating Room (Vice-Chairman of the Surgery Management Committee), the on-duty physician of the anesthesia department, and the head nursing staff of the operative room. In case of any doubt, the Director of Operative Room will discuss with the Director of the Surgical Department and the Chairman of the Surgery Management Committee, respectively, to approve this emergent operation.

Second, the emergent operation will be designated to the operating suites with independent HEPA systems. To provide isolated transportation routes from isolation ward to operative room, a special transportation team, dedicated elevators and ambulance, was prepared if patients need to move from one building to another. During transportation, the routes will be traffic controlled and will be decontaminated with 0.06% bleach immediately after transportation. The operative room entry routes for surgical team members will be different from that of the cases.

Third, all the equipment, walls, and floors of the operating suits will be cleansed with 0.06% bleach after the operation. The cleansing principle will be to move from low-pollution areas to high-pollution areas accordingly. All disinfection process must be completed before the commencement of the next operation.

Fourth, if the surgical patient is not intubated yet, the anesthesiologist should decide whether the patient needs to be intubated before entering the operating room (Supplementary Appendix 2, <http://links.lww.com/JCMA/A65>). During transportation to the operating room, all patients must wear surgical masks and should enter the dedicated operating suite as soon as possible after their arrival at the nursing station.

#### 3.2. Strategy to prevent transmission during the anesthesia process and recovery phase after surgery completion

The infection control guideline to prevent transmission of COVID-19 during surgical intervention was provided by the Department of Anesthesiology. In accordance with the surgical infection control guideline, patients with good spontaneous breathing should wear surgical masks during transportation

from the ward to the operating room. Patients who are on ventilators should be transported to the operating room with a doctor escorting them, according to the surgical infection control guideline. For patients with signs of respiratory failure, rapid sequence intubation should be performed in a negative pressure isolation ward before the patients are sent to the operating room. Placing a disposable high-efficiency filtration device on the exhalation end of the endotracheal tube or breathing circuit is recommended accordingly.

After operation, suctioning of sputum and saliva must be performed before transportation. It is important to confirm, before transportation, that the patient is sufficiently anesthetized to avoid coughing during ventilator change. During transportation, steps must be taken to ensure that the breathing circuit does not slip off, and that the oxygen cylinder is full enough for transportation. Mobile ventilators should also have high-efficiency filtering devices. Extubation must be performed in the negative pressure isolation room or intensive care unit after evaluation by the in-charge physician.

#### 3.3. Guideline of infection control during perioperative period

##### 3.3.1. Protective measures for the operation room team against patients' droplets, contact, and air-borne infection.

The operating suite selection is based on the following steps: (1) The first choice is a negative pressure operating suite. (2) The second choice is the use of operating suites, which contain independent HEPA ventilation systems. Nonessential equipment in the operating suite should be moved outside the operating suite for temporary storage. Fixed equipment that cannot be moved should be completely covered with disposable covers, and the covers should be disposed properly after surgery. Along with the use of disposable ventilator tubing whenever possible, the inlet and outlet ends of the ventilator and the connection to the endotracheal tube of the patient should have high-efficiency filtering devices. Disposable medical materials and instruments should be used as many as possible; if reusable medical materials and instruments are selected, they should be cleansed, disinfected, and sterilized according to the manufacturer's product instructions after the operation. The standard PPE in addition to surgical mask includes the use of disposable surgical gowns and cloth sheets. Cloth used after surgery should be properly packed with double-layer red biohazard bags. Disposable PPE, including double-layer surgical gloves (capable of extending to cover the forearm), N95 masks, isolation gowns (bunny suit), waterproof isolation gown, eye protection equipment (full-face mask), waterproof leg covers and shoe covers, and waterproof hair caps should be used. The operating personnel should use PPE properly when entering and leaving the operating suite, and prepare the related required items such as disinfectant, dry cleansing hand lotion, and containers or garbage bags for disposal of contaminated items, etc. Staffs who come in contact with the patients or transportation devices such as wheelchairs or beds should wear PPE and execute hand washing with disinfection soap at all times.

##### 3.3.2. Infection control during operation.

Staff must wear complete protective equipment before entering the front room. Unhanded personnel must wear a pair of surgical gloves (capable of extending to cover the forearms), N95 masks, isolation gowns (bunny suit), waterproof isolation gown, eye protection equipment (full face mask), waterproof leg covers and shoe covers, and waterproof hair caps. Hand brushes must wear double-layer sterile surgical gloves, N95

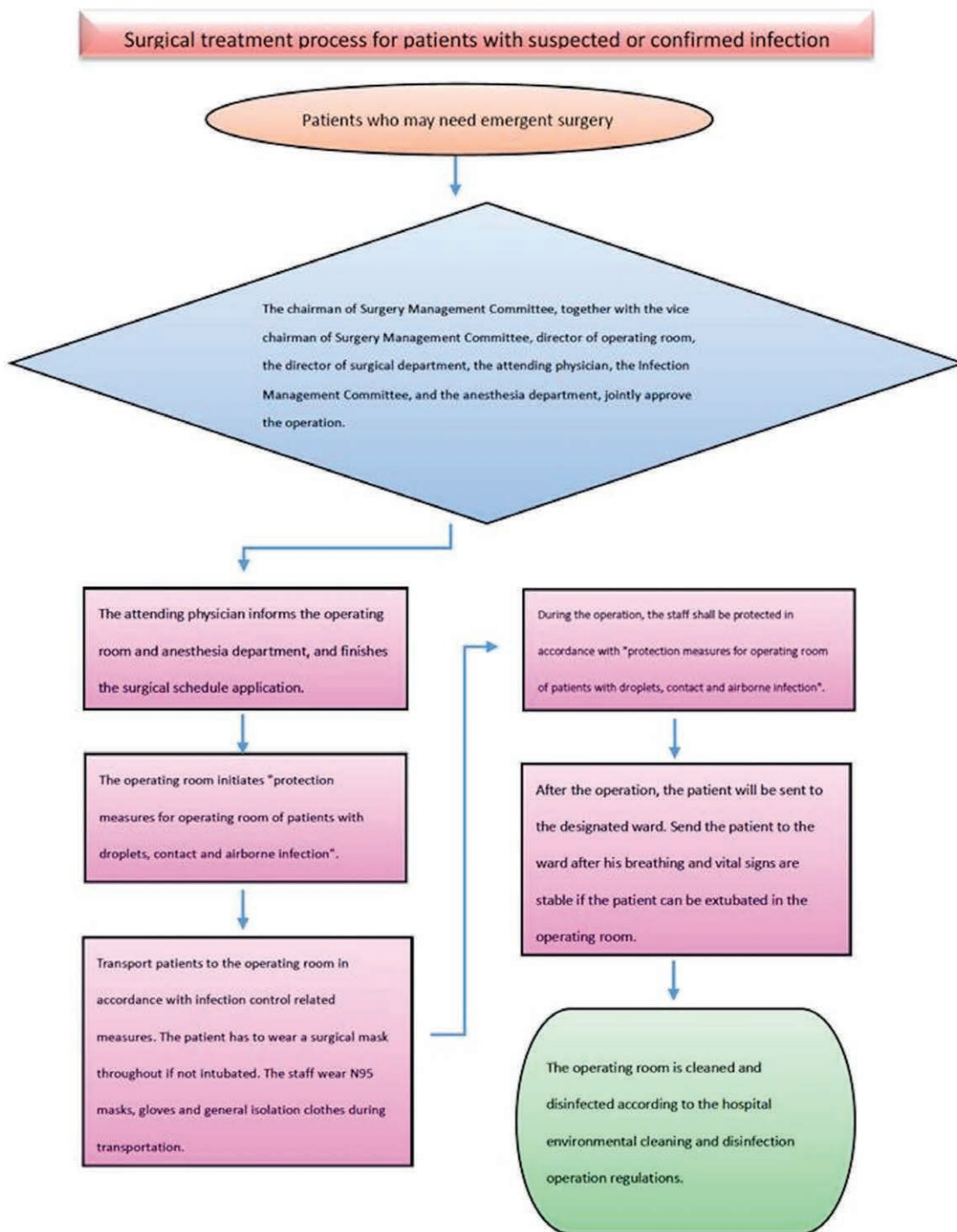


Fig. 1 Standard treatment process for patients with suspected or confirmed COVID-19 infection.

masks, isolation gowns (bunny suit), sterile waterproof surgical gowns, eye protection equipment (full face mask), waterproof leg covers and shoe covers, and waterproof hair caps. Strict restrictions should be implemented on the entry and exit of operating suite personnel and warning signs should be posted at the door of the operating suite accordingly. Care must be taken to avoid puncture with sharp objects and consequent exposure of blood and body fluids. The surgical team should strictly abide by the relevant regulations for the use of

sharp medical items, such as hands-free technique, neutral zone, verbal reminders when passing medical equipment with sharp objects, paying attention to the surgical area and sharp tools. During the operation, if there is a sharp object puncture injury and blood fluid exposure, the person should immediately stop the operation and wash the site with a copious amount of water and soap (mucosa is washed with only water), and follow the relevant procedures in the hospital notification and subsequent health monitoring.

### 3.3.3. Infection control after surgery.

For patients who cannot return to the isolation room immediately after surgery, it is recommended to observe anesthesia recovery course in an independent negative pressure recovery room or wait in the operating suite accordingly. Patients are then to be sent directly back to a negative pressure isolation ward or ICU with stable vital signs. The surgical team members should reduce their time spent within the operating room (Supplementary Appendix 2, <http://links.lww.com/JCMA/A65>). With regards to PPE removal, the staff should remove the first layer of outer gloves, outer layer of waterproof gown, the first layer of masks, hair caps and foot covers in the operating suite, and then remove the remaining PPE in the back room.

### 3.4. Revision of the algorithm of preparation for surgical intervention during COVID-19 pandemic

The above algorithm has been used since March 26, 2020. However, the abrupt increase of confirmed COVID-19 cases due to returned overseas travelers since mid-March 2020 disrupted the routine hospital clinical service. The health statement and notification questionnaire was revised, with diarrhea, anosmia, and ageusia being included as positive symptoms on April 6, 2020 (Supplementary Appendix 3, <http://links.lww.com/JCMA/A65>). The criteria of elective surgeries have been revised according to travel history, occupation, contact and cluster history (TOCC). Patients with TOCC (+) within 14 days, or TOCC (-) patients who present with unexplained fever (ear temperature  $\geq 38^{\circ}\text{C}$ ), abnormal smell and taste, and/or respiratory symptoms should not be admitted to hospital for elective surgery. Due to the large number of febrile patients in general wards and the emergency room, the revised algorithm of preparation for surgical intervention during COVID-19 pandemic was devised according to TOCC history, unexplained fever/symptoms, and emergent/nonemergent surgery to make the algorithm more practical (Figs. 2 and 3). Unless the fever etiology can be definitely confirmed by an infection expert, it should

be regarded as unexplained fever. TOCC history is of paramount importance, so two different algorithms were created, one for TOCC (+) group, and the other for TOCC (-). When a patient falls under evaluation within the algorithm, the attending surgeon has to routinely inform the operative room director (vice-chairman of the Surgery Management Committee) to discuss the feasibility of surgery and double check the evaluation process.

Briefly, for TOCC (-) patients with unexplained fever or symptoms requiring emergent surgery, the process is further divided according to presence or absence of a life-threatening condition (Fig. 2). For life-threatening situations, the attending surgeon must first consult an expert from the infection department to preoperatively conduct a test for COVID-19. The medical staff should wear PPE according to protection for suspected patients until the test results are revealed. For non-life-threatening situations, two negative results of COVID-19 testing are required to approve operation.

We classified TOCC (+) patients into two groups (Fig. 3): the first group consists of patients without fever or any other symptoms, while the second group is made of patients with unexplained fever and/or symptoms. The first group would be treated as TOCC (-) patients with unexplained fever or symptoms requiring emergent surgery, while the second group would undergo more stringent evaluation. TOCC (+) patients presenting with otherwise unexplained fever/symptoms would be regarded as belonging to the fifth category of “severe special infectious pneumonia.” All the patients belonging to this group should be admitted into special epidemic prevention ward preoperatively according to quarantine policy. If the patient requires emergent surgery to relieve the non-life-threatening disorders, two times of negative COVID-19 tests are necessary before the operation is approved (Fig. 3). For life-threatening situations without two negative results of COVID-19 tests, the operation schedule should be approved by the Chairman of Surgery Management Committee.

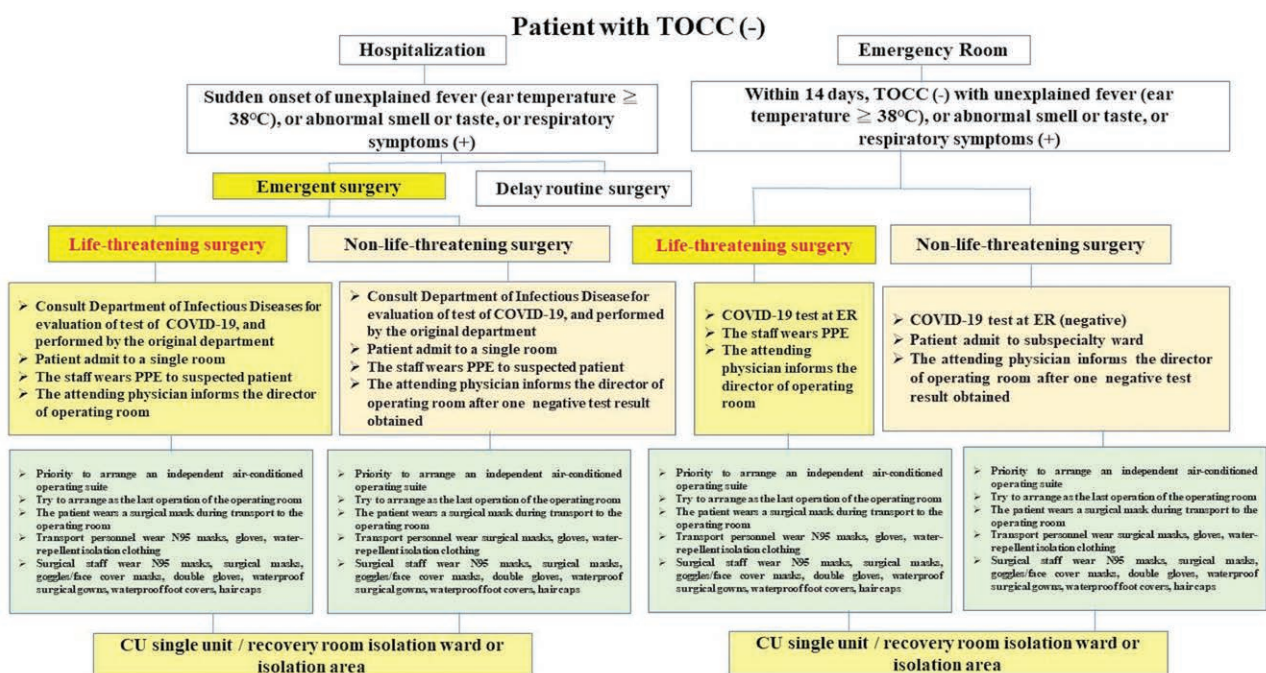
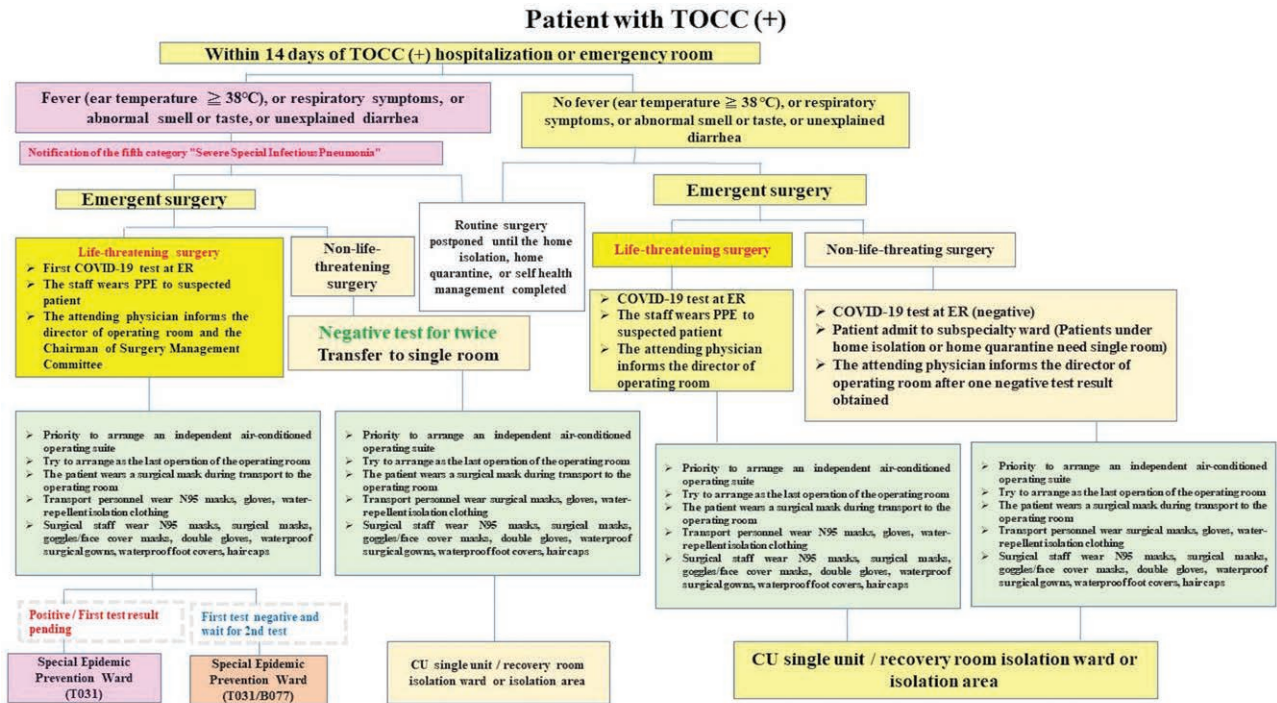


Fig. 2 Algorithm of preparation for surgical intervention during COVID-19 pandemic for patients with TOCC (-). TOCC = travel history, occupation, contact and cluster history.



**Fig. 3** Algorithm of preparation for surgical intervention during COVID-19 pandemic for patients with TOCC (+). TOCC = travel history, occupation, contact and cluster history.

**4. DISCUSSION**

In this study, we developed an algorithm for operating room team members in Taipei Veterans General Hospital in response to the pandemic spread of COVID-19. After the abrupt increase of confirmed COVID-19 cases due to returned overseas travelers since mid-March 2020, the algorithm was further revised according to TOCC history, unexplained fever/symptoms, and emergent/nonemergent surgery for more practical clinical use.

In the decision tree algorithm for precautions to be taken by operating room members reported by Forrester and colleagues,<sup>4</sup> patients were initially triaged by acuity into urgent and emergency procedures. They assumed all patients undergoing emergency procedures to be infected by COVID-19 until proven otherwise. Urgent cases were stratified into high- and low-risk procedures, depending on the anticipated viral burden at the surgical site and the likelihood that a procedure would aerosolize the virus, classified as aerosol-generating procedures accordingly.<sup>4</sup> In Taiwan, initially, we did not have many COVID-19 cases. Therefore, the initial algorithm for operating room team members established in Taipei Veterans General Hospital was relatively simple. However, the abrupt increase of confirmed COVID-19 cases from returned overseas travelers since mid-March 2020 disrupted routine hospital clinical service, and made the initial algorithm not practical due to a large number of febrile patients in general wards and the emergency room. The algorithm for surgical intervention during COVID-19 pandemic was therefore devised according to TOCC history. TOCC (+) patients who presented with otherwise unexplained fever/symptoms were regarded as belonging to the fifth category of “severe special infectious pneumonia” and were the most critical portion of the algorithm. Two negative COVID-19 tests were necessary before the operation was approved in case these patients required emergent surgery

to relieve non-life-threatening disorders. For life-threatening emergent surgery without two negative results of COVID-19 tests, the operation schedule would need to be approved by the Chairman of Surgery Management Committee. As compared to the algorithm reported by Forrester and colleagues,<sup>4</sup> our final algorithm was revised according to TOCC history, unexplained fever/symptoms, and emergent/nonemergent surgery. Our algorithm performed well to meet requirements in different clinical scenarios during the COVID-19 pandemic.

In this report, we propose the strategy to prevent transmission during the anesthesia process and recovery phase after completion of surgery. We also provide guidelines for infection control during the perioperative period, including infection control during operation and after surgery. However, cleansing and disinfection of the operating suite environment is also an important part of the infection control. After the operation, the operating suite environment should be cleansed and disinfected, and fresh air should be then ventilated for 40 minutes with more than 35 cycles of air exchanges per hour. The cleansing principle of the operating suite is to cleanse from a high place downwards, and from the relatively clean periphery of the room to the central, higher-contaminated area. Environmental cleansing personnel’s recommendations for PPE when performing environmental clearance include masks, gloves, waterproof isolation clothing, eye protection equipment (full-face mask), hair caps, and foot covers above the N95 level (inclusive) protective equipment.

Some limitations of this study should be mentioned. As the COVID-19 pandemic is well controlled in Taiwan, the number of confirmed cases is very small. In our institute, there are currently no confirmed patients requiring surgery. Therefore, the algorithm for operating room team members in Taipei Veterans General Hospital may need further revision after possible surgery of confirmed cases performed in the future. Furthermore, the algorithm was developed and executed in Taipei Veterans

General Hospital, a tertiary hospital in Taiwan. Accordingly, the application of the algorithm in other hospitals in Taiwan or worldwide may require further adjustment.

In conclusion, since the COVID-19 pandemic and its impact may last for months or even years, the application of a clear and integrated algorithm for operating room team members, including the surgical team, anesthesia team, and other healthcare providers, aids in effective PPE facilitation to keep both healthcare providers and patients safe as well as to prevent hospital-based transmission of COVID-19.

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#### APPENDIX A. SUPPLEMENTARY DATA

Supplementary data related to this article can be found at <http://doi.org/10.1097/JCMA.0000000000000457>.

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