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Special Article

Anesthesia for Patients Undergoing Anesthesia for Elective Thoracic Surgery During the COVID-19 Pandemic: A Consensus Statement From the Israeli Society of Anesthesiologists

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Anesthesia for thoracic surgery requires specialist intervention to provide adequate operating conditions and one-lung ventilation. The pandemic caused by severe acute respiratory syndrome—associated coronavirus 2 (SARS-CoV-2) is transmitted by aerosol and droplet spread. Because of its virulence, there is a risk of transmission to healthcare workers if appropriate preventive measures are not taken. Coronavirus disease 2019 (COVID-19) patients may show no clinical signs at the early stages of the disease or even remain asymptomatic for the whole course of the disease. Despite the lack of symptoms, they may be able to transfer the virus. Unfortunately, during current COVID-19 testing procedures, about 30% of tests are associated with a false-negative result. For these reasons, standard practice is to assume all patients are COVID-19 positive regardless of swab results. Here, the authors present the recommendations produced by the Israeli Society of Anesthesiologists for use in thoracic anesthesia for elective surgery during the COVID-19 pandemic for both the general population and COVID-19—confirmed patients. The objective of these recommendations is to make changes to some routine techniques in thoracic anesthesia to augment patients' and the medical staff's safety.

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Key Words: COVID-19; thoracic surgery; bronchoscopy; pain management; postoperative care

UNLIKE IN MOST SURGERY, aerosol-generating procedures during anesthesia for thoracic surgery are not limited to intubation and extubation, but may occur throughout the surgery. These include, but are not limited to, bronchial blocker (BB) insertion, endotracheal intubation with double-lumen tubes (DLT), and bronchoscopy, which are required to provide adequate operating conditions and one-lung ventilation (OLV).

The pandemic caused by severe acute respiratory syndrome—associated coronavirus 2 (SARS-CoV-2) is transmitted by aerosol and droplet spread.¹ Because of its virulence, there is a risk of transmission to healthcare workers if appropriate

preventive measures are not taken. Unfortunately, for current coronavirus disease 2019 (COVID-19) testing procedures, about 30% of tests are associated with a false-negative result.²

Moreover, the clinical presentation of coronavirus infection may be masked by previously existing respiratory conditions. A typical thoracic surgery patient may present with cough, a certain degree of shortness of breath, fever, and fatigue. The decision-making regarding the risk of COVID-19 based only on history details or physical examination may be difficult in these circumstances. For these reasons standard practice is to assume all patients are COVID-19 positive regardless of swab results.

Although guidelines have been produced for thoracic surgery, these assume that the patient is COVID-19 positive and that the patient is presenting for urgent or emergent surgery.^{3,4} In Israel, elective surgery resumed on May 1, 2020, and there

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is a need for a pragmatic set of recommendations that address issues specific to COVID-19, while allowing as normal workflow as possible.

Here the authors present the recommendations produced by the Israeli Society of Anesthesiologists for use in thoracic anesthesia for elective surgery during the COVID-19 pandemic for both the general population and COVID-19–confirmed patients (Table 1). The objective of these recommendations is to make changes to some routine techniques in thoracic anesthesia to augment patients' and medical staff's safety.

Methods

These recommendations were developed initially by 2 experienced thoracic anesthesiologists who conducted a MEDLINE and PubMed search relating to COVID-19 and other similar viral epidemics (SARS, swine flu, Middle East Acute Respiratory Syndrome). The initial set of recommendations were then sent to the heads of all the cardiothoracic anesthesiology departments in Israel for review. Once these comments were incorporated into the original document, they underwent a second round of review by the Israeli Society of Anesthesiologists faculty members, and the final set of recommendations was accepted. Communication was carried out via WhatsApp, e-mail, and Zoom. The authors received input from 4 of 6 department heads in the first round and 15 of 18 faculty members in the second round. These recommendations were originally published by the Israeli Society of Anesthesiologists in Hebrew on May 12, 2020.

Preoperative COVID-19 Screening

COVID-19 patients may show no clinical signs at the early stages of the disease or even remain asymptomatic for the whole course of the disease. Despite the lack of symptoms, they may be able to transfer the virus.⁵⁻⁷ One of the first studies of the SARS-CoV-2 transmission suggested that about 44% of secondary transmission could have been caused by asymptomatic carriers.⁵ The Israeli Ministry of Health reported that 20% of patients who tested positive for COVID-19 infection were symptom-free at the time of sampling.⁸

Reverse transcription polymerase chain reaction (RT PCR) screening for SARS-CoV-2 should be performed for all patients up to 72 hours before presenting for thoracic surgery. The usual sampling sites are nasopharynx and posterior oropharynx; lower airway tract material can be collected as well. However false-negative results are reported, and the sensitivity of a single nasopharyngeal swab can be as low as 30% to 60%.⁹ The sensitivity can be improved by repeating the test or collecting a sample from lower airways.⁹

A new emerging serology test for antibodies for SARS-CoV-2 may provide an additional tool in patients with high clinical suspicion for coronavirus infection and negative PCR results. Some of these test systems are designed as point-of-care and are potentially able to detect the antibodies in the patient's plasma or even whole blood samples in 15 minutes.

Table 1

A Summary of the Recommendations of the Israeli Society of Anesthesiologists for Patients Undergoing Anesthesia for Elective Thoracic Surgery During the COVID-19 Pandemic

	Recommendations
COVID-19 screening	<ul style="list-style-type: none"> • SARS-CoV-2 RT PCR for all patients up to 72 hours prior to presenting for thoracic surgery, including surgeries for known or suspected malignancy • For symptomatic patients or those with a high index of suspicion but a negative RT PCR consider CT. • Because of the potential for false-negative results and asymptomatic patients, all patients should be treated as COVID-19 positive during the perioperative period. • Do not delay emergency (urgent or immediate) surgery for COVID-19 screening.
PPE	<ul style="list-style-type: none"> • Standard PPE to be worn by healthcare providers involved in aerosol-generating procedures or any team members within 2 meters of the aerosol-generating procedure • Standard PPE includes a minimum of: <ul style="list-style-type: none"> ◦ Headcover ◦ N95 mask or equivalent ◦ Goggles or face shield ◦ Waterproof gown ◦ Gloves • N95 masks or equivalent should be worn by all team members for the duration of the operation. • Disposable PPE should be changed between patients. • Reusable PPE should be cleaned appropriately between patients.
Preparing the OR	<ul style="list-style-type: none"> • Keep OR personnel to a minimum. • Health care providers assigned to the thoracic OR should not be asked to work in other ORs during thoracic surgery. • Where possible use a negative pressure OR.
Intubation	<ul style="list-style-type: none"> • Rapid sequence intubation with high-quality preoxygenation regardless of fasting status • Avoid mask ventilation where possible. • Use video laryngoscopy for all intubations. • Confirm ETT position using capnography in preference to auscultation.
Lung separation	<ul style="list-style-type: none"> • 3D modeling, where available, should be used when developing an airway plan for patients with a known or suspected difficult airway or those for whom achieving OLV is suspected to be challenging. • Consider DLT in preference to BB for patients who do not have a known or suspected difficult airway. • Use bronchoscopy to confirm DLT or BB placement. • Place an antiviral filter or HME on the open nonventilated lumen of the DLT.
Bronchoscopy	<ul style="list-style-type: none"> • Use a disposable single-use bronchoscope in preference to multiuse bronchoscopes. • Optic bronchoscopes with an eyepiece rather than a video screen should be used only as a last resort. • Preoxygenate with 100% O₂ ventilation for a number of minutes, and ensure the anesthetic depth is sufficient to prevent coughing. Nerve stimulator for neuromuscular block monitoring may be used.

(continued)

- Stop ventilation before introducing the bronchoscope, and complete the procedure during apnea if possible.
 - Reduce the number of the scope insertions and removals.
 - After removal, the scope must be cleaned and kept in a closed container until no longer required.
 - After surgery, a disposable scope can be discarded.
 - A regular bronchoscope needs to be cleaned from secretions, the working channel flushed with water, and then to be put in a closed container and sent for processing according to hospital policy.
- Extubation
- Extubation outside the operating room should be reserved for patients with confirmed COVID-19 infection or those requiring postoperative ICU or HDU care.
 - All suctioning should be performed prior to the reversal of neuromuscular blockade to prevent coughing.
 - Consider switching any infraglottic device for a supraglottic device before emergence to minimize coughing.
 - Immediately after extubation supplemental oxygen should be supplied via a Hudson mask.
- PACU
- Patients should be placed in an area with adequate monitoring to detect postoperative respiratory complications.
 - Healthcare workers should wear adequate PPE to protect against aerosol droplets.
 - Epidural or erector spinae anesthesia is the preferred method for postoperative pain control.
 - Consider applying an appropriate filter to a chest drain with a large air leak.

BB, bronchial blocker; COVID-19, coronavirus disease 2019; CT, computed tomography; DLT, double-lumen tube; ETT, endotracheal tube; HDU, high-dependency unit; HME, heat and moisture exchanger; ICU, intensive care unit; O₂, oxygen; OLV, one-lung ventilation; OR, operating room; PPE, personal protective equipment; RT PCR, reverse transcription polymerase chain reaction; SARS-CoV-2, severe acute respiratory syndrome–associated coronavirus 2.

Although these tests are becoming more readily available, their accuracy and specificity are yet to be determined.¹⁰

Interestingly, in contrast to laboratory testing, the sensitivity of radiologic examination for detection of coronavirus disease may be higher.² Computed tomography (CT) done in symptomatic patients with suspected COVID-19 had been shown to detect specific patterns of viral pneumonia in 97% of patients.⁹ Another Chinese study reported that 67% of asymptomatic patients had specific findings associated with coronavirus pneumonia on a CT scan.¹¹ If a recent CT scan is available, it can be reviewed with a focus on viral pneumonia patterns.

Surgery for known or suspected thoracic malignancies is considered to be expedited rather than urgent or immediate surgeries.¹² These surgeries should be performed promptly; however, all scheduling should take into account the need for COVID-19 screening a minimum of 72 hours before surgery. Emergent surgery for life-threatening conditions or those who will have serious deterioration in their clinical condition if surgery is postponed should not be delayed for COVID-19 screening.

Recommendations

- SARS-CoV-2 RT PCR for all patients up to 72 hours before presenting for thoracic surgery, including surgeries for known or suspected malignancy
- For symptomatic patients or those with a high index of suspicion but a negative RT PCR consider CT.
- Because of the potential for false-negative results and asymptomatic patients, all patients should be treated as COVID-19 positive during the perioperative period.
- Do not delay emergency (urgent or immediate) surgery for COVID-19 screening.

Personal Protective Equipment (PPE)

Multiple national and international societies of pulmonologists recommend postponing elective procedures in COVID-19–suspected patients. Of note, the same high level of personal protective equipment for healthcare practitioners involved is recommended regardless of the COVID-19 status of a patient.¹³

Most of the published guidelines recommend a minimum of head cover, goggles or face shield, N95 mask or equivalent, gown, and double gloves for a healthcare provider involved in aerosol-generating procedures. In addition, the authors recommend all team members to wear N95 masks or equivalent throughout the surgery, as aerosol generation in these procedures is not limited to intubation and extubation, but may include multiple bronchoscopies, equipment repositioning, and surgical manipulation of airways resulting in air leaks and spillage of biologic material.

To conserve supply, some items of reusable PPE, such as face shields and some types of N95 masks, should be cleaned appropriately between patients. If PPE is to be reused between patients, then there should be local policies as to which items are to be reused, how and when they are to be cleaned, and how often they should be changed.

Care should be taken when donning and doffing PPE to avoid accidental self-contamination. The use of an observer to assist in proper donning and doffing may be considered.

Recommendations

- Standard PPE to be worn by healthcare providers involved in aerosol-generating procedures or any team members within 2 meters of the aerosol-generating procedure
- Standard PPE includes a minimum of:
 - Headcover
 - N95 mask or equivalent
 - Goggles or face shield
 - Waterproof gown
 - Gloves
- N95 masks or equivalent should be worn by all team members for the duration of the operation.

- Disposable PPE should be changed between patients.
- Reusable PPE, such as face shields and some types of N95 masks, should be cleaned appropriately between patients.

- Confirm ETT position using capnography or point-of-care lung ultrasound in preference to auscultation.

Preparing the Operating Room

As stated previously, thoracic surgery includes multiple aerosol-generating procedures throughout the operation. Operating room (OR) personnel should be kept to a minimum. Healthcare providers assigned to thoracic surgery cases should not be simultaneously assigned to other operating rooms or asked to provide breaks, to prevent the risk of cross-contamination.

Where possible, all thoracic surgery should be performed in an OR that has a negative-pressure system. If a negative-pressure room is not available, the surgery can be performed in an OR with standardized air exchange ventilation. The doors of the room must be kept closed to provide the optimal air exchange rates.³

Recommendations

- Keep OR personnel to a minimum.
- Healthcare providers assigned to the thoracic OR should not be asked to work in other ORs during thoracic surgery.
- Where possible, use a negative-pressure OR.

Intubation

There are multiple published guidelines for anesthesia induction and intubation in COVID-19–suspected patients.^{9,14–19} Their key concepts may be applicable for any patient undergoing thoracic surgery during the coronavirus pandemic. These recommendations include high-quality preoxygenation, rapid-sequence induction with avoidance of mask ventilation, and the use of video laryngoscopy for intubation.²⁰ The use of a Plexiglas box or plastic sheeting to reduce aerosol spread during intubation has also been described.²¹ These may be considered, where available, and where the practitioner is experienced in their use. After intubation, the correct position of the endotracheal tube (ETT) can be verified by capnography, saturation, depth of tube insertion, point-of-care lung ultrasound, and observation of symmetry of chest excursions. Lung auscultation is not recommended as it may be difficult while wearing PPE.²² Lung auscultation was shown to have low sensitivity for correct double-lumen tube positioning, which usually requires reconfirmation with fiberoptic bronchoscopy.⁴

Recommendations

- Rapid-sequence intubation with high-quality preoxygenation regardless of fasting status
- Avoid mask ventilation where possible.
- Use video laryngoscopy for all intubations.

Lung Separation

When choosing the appropriate equipment for lung separation for thoracic surgery, the same key concepts of prevention of aerosol formation, biologic material spillage, and decreasing exposure apply. The final decision of which piece of equipment is most suitable for a specific patient to achieve OLV must be made on a patient-specific basis. Neither DLT nor BB has been found to be superior in the quality of lung separation. However, 2 differences were noticed in meta-analyses of comparison data, which may support the DLT as a primary choice:

- 1 Intubation and positioning of a left DLT were found to be faster and easier compared with different types of BB.²³
- 2 BB compared with a left DLT were more likely to require repositioning and bronchoscopy during surgery.²⁴

If difficult intubation is suspected, the airway management plan should focus on a device with the highest possible chance of first-attempt success. A stepwise approach, with a selection of different types of airway equipment and mask ventilation between the attempts, is not recommended as it may lead to significant spillage of biologic material. Once the airway is secured with an endotracheal tube, BB should be considered for lung isolation instead of a reintubation attempt with DLT. The latter maneuver performed with or without the usage of tube-exchanging catheters is associated with a high failure rate and may also worsen the exposure to airway secretions.²⁵

There are several newer solutions for the management of lung separation available that are worth mentioning in a overview of COVID-19 preparedness. Disposable endotracheal tubes and double-lumen tubes with an embedded camera show the airway image in real-time throughout surgery (ViviaSight, Ambu, Denmark). Placement and monitoring of the correct position of these tubes, as well as the introduction of a bronchial blocker, can be achieved with minimal or no need for bronchoscopy or circuit disconnections.²⁶ These devices are recommended by recent Association of Cardiothoracic Anesthesia and Critical Care expert consensus opinion.⁴

Virtual reality simulators and 3-dimensional (3D) airway model printout can be useful in planning airway management in cases with suspected difficulties to avoid unnecessary trial and error in choosing airway equipment.^{27–30}

Auscultation to confirm appropriate positioning of equipment used for OLV (DLT, BB) should be avoided. It may be difficult to use a stethoscope when wearing full PPE. In addition, confirming DLT position via auscultation requires unnecessary exposure to aerosol formation when checking each lumen separately.

To avoid releasing aerosols into the OR environment, an antiviral filter or heat moisture exchanger (HME) filter, should be attached to the open connector of the nonventilated lumen.²² Similarly, if continuous positive airway pressure

(CPAP) is required for the nonventilated lung, the CPAP circuit should be attached via a filter.⁴ Any suction catheter inserted via the ETT or DLT should be kept in a closed container when not in use, to avoid contamination of equipment or personnel.

Recommendations

- 3D modeling, where available, should be used when developing an airway plan for patients with a known or suspected difficult airway or those for whom achieving OLV is suspected to be challenging.
- Consider DLT in preference to BB for patients who do not have a known or suspected difficult airway.
- Use bronchoscopy to confirm DLT or BB placement.
- Place an antiviral filter or HME on the open nonventilated lumen of the DLT.

Perioperative Bronchoscopy

Perioperative bronchoscopy is a significant part of any thoracic anesthesia and is usually performed by the anesthesiologist. Bronchoscopy performed in awake or sedated patients is relatively contraindicated due to a high probability of patients retching and coughing, leading to an elevated risk of viral transmission to healthcare workers.³¹

The guidelines do not provide any specific recommendations for a bronchoscopy performed in an anesthetized and/or mechanically ventilated patient. A case series report from China described fiberoptic bronchoscopy experience in ventilated COVID-19 patients. The main indication was a lavage of secretions and sample taking. The procedures were performed during apnea, with high levels of PPE, including wearing a powered air-purified respirator. Interestingly, each sample taken from alveolar fluid for SARS-CoV-2 PCR came back positive, and nasopharyngeal swabs taken from the same patients were negative.³²

Even though a patient under general anesthesia with muscle paralysis is better able to tolerate bronchoscopy and the risk of coughing is minimal, the possibility of aerosolization and spillage of biologic material remains significant. A number of actions can be applied to prevent this and to shorten the procedure time. As such, the number insertions and removals of the bronchoscope should be kept to a minimum. Similarly, single-use bronchoscopes are preferable as they can be disposed of immediately rather requiring resterilization, thus reducing the chance of accidental spillage of viral particles during transport.^{3,4} If disposable bronchoscopes are not available, SARS-CoV-2 on multipurpose bronchoscopes is effectively eliminated by routine sterilization protocols for endoscopic equipment.³¹

Recommendations

- Use a disposable single-use bronchoscope in preference to multiuse bronchoscopes.

- Optic bronchoscopes with an eyepiece rather than a video screen should be used only as a last resort.
- Preoxygenate with 100% O₂ ventilation for several minutes, and ensure the anesthetic depth is sufficient to prevent coughing. Nerve stimulators may be used for neuromuscular block monitoring.
- Stop ventilation before introducing the bronchoscope, and complete the procedure during apnea if possible.
- Reduce the number of the scope insertions and removals.
- After removal, the scope must be cleaned and kept in a closed container until no longer required.
- After surgery, a disposable scope can be discarded.
- A regular bronchoscope needs to be cleaned from secretions, the working channel flushed with water, and then to be put in a closed container and sent for processing according to hospital policy.

Extubation

There are very few published recommendations for extubation in patients with suspected COVID-19 undergoing surgery. Emergence from anesthesia brings back protective airway reflexes that may cause retching, salivation, or coughing. DLTs have a larger external diameter than regular endotracheal tubes. The larger areas of contact with the airway are reported to cause more coughing than with a regular ETT.³³

Some of the current guidelines recommend transferring an intubated patient to a single-occupancy negative-pressure room for emergence and extubation.³ Because of significant logistical difficulties, such as the availability of negative-pressure rooms and the need for nursing staff trained in the management of patients in the immediate perioperative period, this recommendation is reserved for confirmed COVID-19 patients or those requiring postoperative intensive care unit (ICU) or high-dependency (HDU) care.

For most routine cases in thoracic surgery, a more practical approach for extubation may be feasible. If a patient meets the usual criteria for extubation, including a return of consciousness, spontaneous ventilation, and adequate muscle strength, then extubation can be done in the OR. Oral and pharyngeal suction should be performed prior to the reversal of neuromuscular blockade. A major concern is to prevent coughing and/or a need for mask ventilation. Intravenous lidocaine, propofol, opioids, or dexmedetomidine may be given to attenuate cough reflex, yet these agents may slow down the emergence and delay extubation and so should be timed appropriately.³³⁻³⁵

One study from Canada described the exchange of a DLT for a supraglottic airway device at the end of surgery. For spontaneously breathing patients, a significant reduction in coughing on emergence and extubation was reported.³³ Another method reported to prevent an excessive spillage of secretions on extubation is to cover the head and torso of a patient with a transparent plastic sheet.³⁶ PPE with airborne protection capabilities should be worn by any staff member in the room at the time of extubation. After extubation, a Hudson

mask should immediately be applied to the patient. This decreases the risk of hypoxia, and if there is any coughing, aerosol and viral particles will be trapped in the mask.

Recommendations

- Extubation outside the OR should be reserved for patients with confirmed COVID-19 infection or those requiring postoperative ICU or HDU care.
- All suctioning should be performed prior to the reversal of neuromuscular blockade to prevent coughing.
- Consider switching any infraglottic device for a supraglottic device before emergence to minimize coughing.
- Immediately after extubation, supplemental oxygen should be supplied via a Hudson mask.

Postoperative Care Unit

Respiratory complications are not uncommon in the immediate postoperative period in thoracic surgery patients. Lung atelectasis, pulmonary edema, broncho-obstructive episode, or hypoxemia are typical events requiring immediate attention.³⁷

Management of these complications frequently includes drug administration by inhalation, physical therapy for assisted cough and airway drainage, administration of a CPAP, or other noninvasive ventilatory support measures. Due to increased aerosolization during these procedures, early transfer of a patient from a common postoperative care unit (PACU) to an HDU or ICU with less occupancy may be considered. If the treatments are delivered in a PACU, then the patient's bed should be moved to a distance from other patients, and healthcare staff treating the patient should wear airborne level PPE.

If the patient requires reintubation in the PACU then the same precautions should be taken as for intubation in the OR, including rapid-sequence intubation, PPE, and ETT confirmation by capnography in preference to auscultation.

Regional anesthesia may be effective in the prevention of postoperative respiratory complications. Thoracic epidural catheter placement should be considered if not contraindicated.³⁸ Erector spinae plane blocks have the advantage that they can be used in patients who are anticoagulated when epidural or paravertebral anesthesia is contraindicated. However, their effect on postoperative respiratory function is not clear.³⁹

Management of chest drains after surgery may also require adjustments. Although the presence of SARS-CoV-2 in the pleural fluid has not been described, the previously noted concepts of infection precautions may be applied in a suspected or confirmed COVID-19 patient. If a significant air leak is noted in an underwater seal system, this may lead to contamination of the patient's surroundings. The successful use of a bacterial filter connected to an underwater seal system has been described.^{40,41}

Recommendations

- Patients should be placed in an area with adequate monitoring to detect postoperative respiratory complications.
- Healthcare workers should wear adequate PPE to protect against aerosol droplets.
- Epidural or erector spinae anesthesia is the preferred method for postoperative pain control.
- Consider applying an appropriate filter to a chest drain with a large air leak.

Conclusions

The current COVID-19 pandemic is providing additional challenges for an already challenging group of patients. As lockdowns and restrictions begin to ease, the number of patients presenting for urgent and elective surgery will add to these issues. However, with suitable precautions and planning, anesthesia can be safely provided to thoracic surgery patients without endangering the healthcare workers looking after them. Here, the authors have given a comprehensive set of recommendations for the management of confirmed or suspected COVID-19 patients presenting for thoracic surgery for the entire perioperative period from preoperative assessment to postoperative pain control.

Conflict of Interest

None.

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