

Bronchoscopy in the COVID-19 Era

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Abstract: Bronchoscopy is an aerosol-generating procedure with important diagnostic and therapeutic indications. However, in the era of the coronavirus disease 2019 (COVID-19) pandemic, airway procedures can put health care providers at an increased risk of exposure and transmission of COVID-19. We have reviewed and summarized guidelines from various societies of respiratory medicine to stratify the indications for bronchoscopy and optimize preprocedural, procedural, and postprocedural preparation. Appropriate measures can help decrease exposure to health care workers when performing this aerosol-generating procedure.

Key Words: bronchoscopy, COVID-19, aerosol-generating procedure
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Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), which causes coronavirus disease 2019 (COVID-19), was first identified in December 2019 in Wuhan, Hubei province, China. Over the course of a few months, it changed the approach to patient care in nearly every country on earth and across almost every spectrum of care. Health care has been markedly transformed by the 2019 coronavirus pandemic. Although the mortality appears to be lower for COVID-19 when compared with other coronavirus outbreaks such as severe acute respiratory syndrome (SARS) and Middle East respiratory syndrome (MERS), the higher communicable spread of SARS-CoV-2 together with its long incubation period and asymptomatic shedding have resulted in a death toll exceeding SARS and MERS outbreaks combined.¹ Specifically, asymptomatic virus shedding poses the greatest difficulty in successfully managing the spread of the virus. Emerging data have demonstrated that up to 79% of documented cases have extremely mild symptoms or no clinical signs whatsoever while still shedding the virus.^{2,3} It is this population that requires vigilant consideration when deciding on how to efficiently treat patients for conditions necessitating procedural intervention.

SARS-CoV-2 enters the body through contact with mucosal surfaces and replicates within the respiratory tract, where the viral load is the highest.⁴ Infected patients introduce viral particles into the air with expiratory activities such as breathing, speaking, coughing, sneezing, and during procedures such as suctioning, endotracheal intubation, and bronchoscopy. Each of these activities leads to aerosols of different sizes originating from different areas of the upper respiratory tract, which are subject to desiccation after being exhaled.⁵ Many divide aerosols into categories of small droplets (sometimes

exclusively referred to as aerosols) and large droplets. World Health Organization (WHO) has traditionally defined droplets as being $>5\ \mu\text{m}$ in size. Droplet nuclei or aerosols, particles arising from desiccation of suspended droplets, are defined as being $<5\ \mu\text{m}$ in size.⁶ Aerosol-generating procedures may also create opportunities for direct contact and fomite transmission.⁷ Aerosolizing procedures pose the greatest risk for transmission of this virus, thereby placing health care professionals at an increased risk of exposure. As early as January 2020, the first providers who were caring for COVID-19 patients were documented as contracting the disease and tragically the first provider death was confirmed in an otolaryngologist practicing in Wuhan, China.^{8,9} Pulmonologists, otolaryngologists, oral surgeons, ophthalmologists, and anesthesiologists are among the specialties known to be at an increased risk for infection, given the procedures they perform in or near the upper aerodigestive tract.^{10,11}

Bronchoscopy remains one of the highest risk procedures within this population of patients due to its detectable disruption of airway mucosa and the increased pressures utilized to oxygenate and ventilate patients during the procedure. Secondary to the close contact between the medical personnel involved in the bronchoscopy and the patient, coughing and suction can produce significant amounts of droplets or aerosols, contaminating indoor equipment, procedure room's air, all personnel present, and even resulting in a higher risk of patient-to-patient cross-infection.¹² Nonetheless, bronchoscopy remains an imperative and important method for the diagnosis and treatment of respiratory illnesses that in certain instances cannot be postponed pending further progression of disease and clinical deterioration. Therefore, it is critical to stratify the patients requiring prompt bronchoscopic intervention along with those patients who may benefit from a delayed procedure.

Many strategies have endeavored to minimize risk of transmission from airway procedures in COVID-19 patients. Examples described include a closed, in-line suction system to seal the bronchoscope during percutaneous tracheostomy, a reusable acrylic barrier enclosure during standard intubation, and utilizing disposable drapes to create a contained tent immediately around the patient.^{13–15} To protect providers and patients alike, standardized approaches must be implemented to minimize the risk of exposure while preserving the ability to perform medically appropriate aerosolizing procedures such as bronchoscopy.¹⁶

In this review, we will discuss guideline-driven outlined steps to ensure the least amount of risk for the health care team involved with bronchoscopy, including patient selection, preprocedural practices, postprocedural cleaning, and handling of the respiratory samples obtained.

PRE-PROCEDURE PREPARATION

Bronchoscopy is an aerosol-generating procedure that puts health care workers at an increased risk of exposure and infection, hence discussion and planning with all involved personnel before

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the procedure is essential to ensure the procedure runs smoothly and exposure risks are limited. Temperature, travel, exposure, and symptom screening should be considered. Patients should wear a surgical mask in the pre-procedure area, bronchoscopy suite, and in the recovery area. In the interest of conserving personal protection equipment (PPE) and minimizing staff exposure as much as possible, the participating personnel should be limited to only those needed for the procedure—bronchoscopist, bronchoscopy assistant, and anesthesia team, if necessary. No observers, students, apprentices, or trainees should be in the procedure room.

Reports of asymptomatic carriers and studies showing early viral shedding in mild or prodromal stage of the disease are worrisome for potential viral spread during an aerosol-generating procedure.^{17–19} As the COVID-19 testing capabilities have improved with a shortened turnaround time and health care facilities are gradually allowing elective procedures, pre-procedural COVID-19 testing should be obtained and verified along with a review of epidemiological and clinical markers of the active disease, ideally closely timed before the planned procedure, barring an emergent indication for bronchoscopy.^{7,20,21} Debate remains on the balance of this resource use versus questionnaire screening, especially in areas where there is low prevalence and likely lower yield in testing.^{22–24} Ultimately, the decision to implement pre-procedural COVID-19 testing should take testing capability, availability, and regional disease prevalence into consideration. Regardless, precautions should be taken to minimize transmission even with testing given the false negativity rate with testing.

LOW SUSPICION OR COVID-19 NEGATIVE PATIENTS

Guidelines have been published for performing bronchoscopy in patients with low suspicion for COVID-19 or negative COVID-19 testing.²⁵ As patients with COVID-19 can be asymptomatic or presymptomatic, precautions should be taken to protect both the patient as well as the procedure personnel even in the setting of a pre-procedural negative test in an area where community transmission of COVID-19 infection is present.²⁶ Society guidelines (Table 1) recommend personal protective equipment (PPE) including N-95 respirator mask or powered air purifying respirators, face shield/eye protection, gown, and gloves.^{12,16–21,28–30} These are recommendations that have been put forth by both the major societies of respiratory disease and are similar to guidelines by anesthesia societies for aerosol-generating procedures.³¹ These recommendations protect health care providers while allowing for continuation of clinical care.

Additional recommendations suggested by some societies include preference of transnasal approach using a slotted mouth and nose protector, avoiding rigid bronchoscopy with jet ventilation, and avoiding atomized lidocaine.^{12,21,29} The individual patient and their indications should be considered in the setting of institutional resources when considering these recommendations.

HIGH SUSPICION OR COVID-19 POSITIVE PATIENTS

Suspected or known COVID-19 positivity is considered to be a relative contraindication to bronchoscopy, given the clear risks to the participating staff.³² Furthermore, only under rare circumstances should bronchoscopy be performed for the sole purpose of obtaining a specimen to test for COVID-19.³³ COVID-19 testing is recommended to be performed via nasal swabs.¹²

Bronchoscopy should be limited to emergent or urgent indications (Table 2). In the guidance put forth by the American Association for Bronchology and Interventional Pulmonology (AABIP), urgency of indications is outlined.¹⁶ Emergent

indications are considered to be moderately symptomatic or worsening tracheal/bronchial stenosis, symptomatic central airway obstruction, massive hemoptysis, and migrated stent. Urgent indications include lung mass or mediastinal/hilar lymphadenopathy suspicious for cancer, whole lung lavage, foreign object aspiration, mild to moderate hemoptysis, and suspected pulmonary infection in immunocompromised patients.

After taking into consideration risks and benefits, if the decision is made to proceed with a diagnostic or therapeutic bronchoscopy, measures can be taken to lower droplet transmission.^{12,16–21,28–30} Personnel should be strictly limited and the procedure should be performed in an airborne infection isolation room or negative pressure room. All personnel should properly don N-95 respirator and eye protection or a powered air purifying respirator, gown, and gloves. When doffing, the N-95 respirator, gown, and gloves should be discarded. When available and feasible, a disposable bronchoscope should be used.^{21,28} The patient's nose and mouth should be covered with a medical mask slotted for transnasal or transoral access. Cough should be minimized pharmacologically. Following proper doffing of PPE, meticulous hand hygiene should occur.

The Center for Disease Control and Prevention (CDC) has guidelines to determine when a recovered patient may have transmission-based precautions discontinued.²⁷ Presently, discontinuation of transmission-based precautions is recommended to be based on either a test-based strategy or a symptom-based strategy. For symptomatic COVID positive patients, transmission-based precautions can be discontinued if at least 73 hours has passed since recovery (resolution of fever without fever-reducing medication) and improvement in respiratory symptoms and at least 10 days has passed since the first symptoms appeared. The test-based strategy includes negative results of SARS-CoV-2 RNA molecular assay from at least 2 consecutive specimens obtained ≥ 24 hours apart in addition to the resolution of fever and improvement of respiratory symptoms. In patients who remain asymptomatic but test positive for COVID-19, a period of 10 days from the first diagnostic test or 2 negative specimens obtained ≥ 24 hours apart may be used. As the body of evidence increases, this is subject to change. Therefore, practices should follow the updated guidelines.

POST-PROCEDURE SPECIMEN HANDLING AND SCOPE MANAGEMENT

Bronchoscopy is not the recommended test of choice for diagnosing COVID-19.¹² However, if this testing modality is required, lower respiratory tract specimens sent for SARS-CoV-2 testing should include at least 2 to 3 mL of fluid and be placed in a sterile, dry container with appropriate labeling.³⁴ The samples should be transported to an appropriately qualified laboratory, accompanied by any required COVID-19 testing form, to ensure safe and proper processing. Routine viral testing and microscopic staining and examination can be processed in a biosafety level 2 (BSL-2) laboratory.³⁵

Post-procedural considerations are equally important for the safety of health care personnel and prevention of nosocomial transmission of COVID-19. According to one study, SARS-CoV-2 can remain aerosolized for up to 3 hours and was viable on plastic and stainless steel surfaces for up to 72 hours.³⁶ Following bronchoscopy, the patient should be recovered according to local protocol. All staff involved should then doff PPE and perform hand hygiene as described above. All horizontal and work surfaces, video monitors and hardware should then be disinfected with EPA-approved cleaners. As bronchoscopy is an aerosol-generating procedure, any bronchoscopy on a suspected or confirmed COVID-19

TABLE 1. Pre-procedure and Intra-procedure Considerations

References	Preprocedure Testing and Considerations	Tested Negative and/or Not Suspected	Suspected or Confirmed	Recovered
CHEST/AABIP ^{16,20}	Corona virus disease 2019 (COVID-19) nasopharyngeal testing Screen for travel and symptoms. Postpone if recent travel to country with CDC level 2 or higher warning Limit personnel Airborne infection isolation room (AIIR) or negative pressure room	N-95 respirator and face shield OR a powered air purifying respirator (PAPR) Gown, gloves	N-95 respirator and eye protection OR a powered air purifying respirator Gown, gloves Disposable bronchoscope when available Discard N-95 respirator following procedure	Suggest timing of the procedure customized based on the indication, the severity of the COVID-19 infection and time from symptom resolution Similar PPE
Centers for Disease Control and Prevention (CDC) ²⁷	Limit in-room providers to essential personnel. No visitors AIIR		N-95 or higher-level respirator (disposable filtering face piece respirators, PAPR, and elastomeric respirators) Eye protection, gloves, gown	
International Expert Panel ²¹	COVID-19 nasopharyngeal testing Screen for travel, COVID-19 patient contact Temperature screen Limit personnel Patients with history, clinical findings, or typical CT pattern should be categorized as “Probable” irrespective of swab Room with natural ventilation or negative pressure rooms	Filtering facepiece (FFP) 2 mask Disposable safety glasses or face shield Disposable gowns and gloves, cap Transnasal access with slotted mouth and nose protector If rigid bronchoscopy is unavoidable, use conventional ventilation and reduce aerosol leakage	Same PPE and approach as COVID negative with the exception: FFP3 mask (if not available FFP2 masks). Discard after the procedure Disposable protective suit, protective clothing, disposable gloves, and disposable shoe cover	FFP2 mask Disposable gowns and gloves, cap
Group of Interventional Respiratory Medicine, Chinese Thoracic Society ¹²	Temperature and symptom screen Limit personnel Negative pressure room (for suspected or confirmed)	Surgical mask but N-95 if sick contact Glasses or eye mask Gown, gloves, cap No atomized lidocaine.	Surgical mask with face shield Positive pressure hood Protective suit, isolation gown, goggles, shoe covers, gloves	
Spanish Society of Pneumology and Thoracic Surgery (SEPAR), Spanish Association of Respiratory Endoscopy (AEER) ²⁸	COVID-19 PCR Screen travel history, contact risk, symptoms Limit personnel Negative pressure room	FFP2 or FFP3 depending on risk (sick contacts) Eye protection Gown, gloves	FFP3 full face mask Full-face or full-frame fitted eye protection Long-sleeved waterproof gown, gloves Reduce cough with sedation Disposable bronchoscope if possible	
German Respiratory Society (DGP) ²⁹	Limit personnel	Re-used N-95 Eye protection Gown, gloves Avoid jet ventilation	FFP3 mask Safety glasses Avoid jet ventilation. Closed circuit	
Argentine Association of Bronchoesophagology (AABE) ³⁰	Screen symptoms, travel history, or contact with patients with COVID-19 Limit personnel AIIR for suspected or confirmed	Appropriate isolation precautions should be followed	Respiratory protection (N-95) Gown, gloves, boots, cap, and eye protection Disposable bronchoscopes should be used first line when available	Bronchoscopy for any elective reason should be postponed until after full recovery and the patient is declared free of infection

TABLE 2. Indications for Bronchoscopy in Suspected or Confirmed COVID-19

References	Indications
CHEST/AABIP ^{16,20}	Limited role in the diagnosis of coronavirus 2019 (COVID-19) Consider in intubated patient if upper respiratory samples negative and other diagnosis is considered that would significantly change management Suggest postponing all nonemergent bronchoscopies Urgent/emergent reasons considered only if intervention is deemed necessary or significant alteration in clinical prognosis is expected with delay
International Expert Panel ²¹	Nasopharyngeal smear is negative 2 times and clinically there is still diagnostic uncertainty of COVID-19 infection Other diagnoses are considered that would significantly change clinical management An urgent life-saving intervention is necessary (hemoptysis, higher-grade benign or malignant central airway stenosis or foreign body aspiration) Secretion management in lobar and complete lung collapse during mechanical ventilation, where physiotherapy, prone positioning, or recruitment maneuvers have been unsuccessful Radiologic worsening, nosocomial superinfection Artificial airway management (orotracheal tube position, difficult intubation, tracheostomy guidance)
Group of Interventional Respiratory Medicine, Chinese Thoracic Society ¹²	Bronchoscopy should not be used as a routine means for the diagnosis of 2019-nCoV infection sampling. Criteria for use of bronchoscopy in the care of a patient with COVID-19: 1. Receiving mechanical ventilation 2. Severe atelectasis found on chest x-ray revealing a large area of reduced transparency in both lung tissues 3. Suctioning does not clear secretions and pO ₂ ≤ 40 mm Hg 4. Throat swab is negative for severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) nuclei acid but patient was highly suspected for COVID-19 Any patient meeting the first criteria and any 1 of the other 3 was deemed appropriate for fiberoptic bronchoscopy
Spanish Society of Pneumology and Thoracic Surgery (SEPAR), Spanish Association of Respiratory Endoscopy (AEER) ²⁸	If 2 COVID-19 PCR samples are negative and clinical suspicion persists In hospitalized patients with confirmed COVID-19, repeated upper and lower airway samples can be collected to demonstrate viral clearance, the frequency of which will depend on local resources When there is an alternative or added diagnostic suspicion that has clinical or therapeutic relevance for the patient (especially in immunocompromised patients) Lobar or total pulmonary atelectasis occurs Massive hemoptysis with hemodynamic instability that requires endoscopic maneuvers to control bleeding For the removal of a foreign body For the treatment of an obstruction of the central airway that is symptomatic or hinders the therapeutic management of the patient As an aid to ventilatory support measures, such as the need for endotracheal intubation or the performance of a percutaneous tracheotomy and the management of its complications The rest of the indications, when there is no clinical repercussion or does not make management difficult, should be postponed until the patient is free of the disease
Argentine Association of Bronchoesophagology (AABE) ³⁰	Extremely limited role in the diagnosis of COVID-19 and only be considered in intubated patients if the upper airway samples are negative and other diagnoses are considered to significantly change clinical management Relatively contraindicated in patients with suspected and confirmed COVID-19 infections. Bronchoscopy should be postponed until after full recovery and the patient is declared free of infection for indications including lung/bronchial mass, mediastinal/hilar lymphadenopathy, pulmonary infiltrates and mild to moderate airway stenosis Bronchoscopy (flexible and rigid) for urgent/emergent reasons should be considered only if bronchoscopic intervention is necessary for life saving. Indications include: life-threatening hemoptysis; severe stenosis of the airway; suspected secondary infectious etiology or malignant condition causing significant endobronchial obstruction

patient should be followed by an appropriate air turnover time. Bronchoscopists should consult with their local infection control experts to determine this duration based on the ventilation capabilities of the room. Disposable equipment should be discarded and medical waste collected with routine biohazardous waste.³⁵ The AABIP recommends that single-use bronchoscopes be considered as first line, if available, for any suspected or confirmed COVID-19 patient. All reusable bronchoscopes should be reprocessed with standard manual cleaning followed by high-level disinfection. There are no current recommendations supporting the use of additional cleaning procedures. Reprocessing staff should be appropriately experienced and wear full PPE.^{16,37}

SUMMARY

The COVID-19 pandemic has changed the approach to bronchoscopy to maximize the safety of involved health care providers. Patients continue to need urgent and emergent diagnostic and therapeutic bronchoscopy for a variety of indications even during a pandemic involving an easily aerosolized and transmissible virus. Bronchoscopy can be safely performed by taking the appropriate preprocedural, procedural, and post-procedural precautions and having a tiered approach to bronchoscopy to appropriately risk stratify urgent and emergent procedures. Ongoing data should be collected on exposures and transmission in this health care setting.

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