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Pre-Procedural COVID-19 Nasopharyngeal Swab Has Good Concordance with Bronchoalveolar Lavage in Patients at Low Risk for Viral Infection

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Abstract
Background: The coronavirus disease 2019 (COVID-19) pandemic has drastically affected hospital and operating room (OR) workflow around the world as well as trainee education. Many institutions have instituted mandatory preoperative SARS-CoV-2 PCR nasopharyngeal swab (NS) testing in patients who are low risk for COVID-19 prior to elective cases. This method, however, is challenging as the sensitivity, specificity, and overall reliability of testing remains unclear. ***Objectives:*** The objective of this study was to assess the concordance of a negative NS in low risk preoperative patients with lower airway bronchoalveolar lavage (BAL) specimens obtained from the same patients. ***Methods:*** We prospectively sent intraoperative lower airway BAL samples collected within 48 h of a negative mandatory preoperative NS for SARS-CoV-2 PCR testing. All adult patients undergoing a scheduled bronchoscopic procedure for any reason were enrolled, including elective and nonelective cases. ***Results:*** One-hundred eighty-nine patients were included. All BAL specimens were negative for SARS-CoV-2 indicative of 100% concordance between testing modalities. ***Conclusions:*** These results are promising and suggest that preoperative nasopharyngeal SARS-CoV-2 testing provides adequate screening to rule out active COVID-19 infection prior to OR cases in a population characterized as low risk by negative symptom screening. This information can be used for both pre-procedural screening and when reintroducing trainees into the workforce.

Introduction

The coronavirus disease 2019 (COVID-19), caused by the SARS-CoV-2 virus and declared a pandemic by the WHO on March 11, 2020, has significantly disrupted healthcare systems globally [1]. As it is spread by both aerosol and droplet transmission, aerosol-generating procedures such as endotracheal intubation and bronchoscopy are particularly high-risk for disease spread. This has profoundly affected case scheduling and work-

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Table 1. Demographics and clinical features of patients who underwent preoperative SARS-CoV-2 testing (n = 189)

Age, years	60.8±14.3
20–30 years	10 (5.3)
31–40 years	9 (4.8)
41–50 years	15 (7.9)
51–60 years	43 (22.8)
61–70 years	60 (31.7)
71–80 years	41 (21.7)
>80 years	11 (5.8)
Sex	
Women	79 (42)
Men	110 (58)
Underlying pulmonary disease	87 (46)
Lung transplant	37 (19.6)
Chronic airway stenosis/obstruction	15 (7.9)
COPD	12 (6.3)
Lung cancer	9 (4.8)
Interstitial lung disease	5 (2.6)
Asthma	4 (2.1)
Pulmonary embolism	1 (0.005)
Sarcoidosis	1 (0.005)
Pulmonary coccidiomycosis	1 (0.005)
Bronchiectasis	1 (0.005)
Chronic tracheostomy	1 (0.005)
Comorbid conditions	119 (63)
Hypertension	46 (24.3)
Diabetes mellitus II	33 (17.5)
Malignancy, not lung	31 (16.4)
Cardiac disease	14 (7.4)
Hyperlipidemia	12 (6.3)
Connective tissue disease	7 (3.7)
CKD	4 (2.1)
Other	4 (2.1)
Cirrhosis	3 (1.6)
With 2 of above	34 (18)
With 3 or more of above	5 (2.6)
Symptoms	
None	120 (63.5)
Dyspnea	52 (27.5)
Cough	17 (9)
Chest imaging	
CT	157 (83.1)
Chest X-ray	23 (12.2)
None	9 (4.8)
Days prior to procedure	37.6±63.9
Chest imaging (COVID-19 classification) (n = 180)	
Negative	104 (57.8)
Indeterminate	53 (29.4)
Atypical	31 (17.2)
Typical	1 (0.006)

Values denote n (%) or mean ± SD. CT, computed tomography; COVID-19, coronavirus disease 2019.

flow in both operating rooms (ORs) and procedure suites across the country and worldwide. Additionally, the role that trainees play in both academic and community hospitals is crucial for medical education and patient care. As many societies are recommending all procedures should be done by the most experienced operator, how to safely reintroduce trainees into this workflow has been challenging [2].

Shortly after COVID-19 being declared a pandemic, multiple societies issued statements recommending postponing or cancelling all elective surgeries, invasive procedures, and endoscopies for the foreseeable future until more information was gathered regarding the COVID-19 surge and hospital infrastructure preparedness [2–5]. As approximately 48.3 million ambulatory surgical and nonsurgical procedures are performed annually in hospitals and surgical centers in the USA, the task of safely reopening OR's has been vast and complex. Many institutions have mandated negative NS sampling immediately prior to any elective surgery or procedure, as recommended by the American Society of Anesthesiologists [6]. This, however, has its own challenges due to inconsistent test availability and turnaround time, as well as variable sensitivity and specificity of testing. Additionally, the viral load in an asymptomatic patient may be low, thus contributing to a false-negative result. In a cohort of 1,014 suspected COVID-19 cases, 30% of the cases with negative NSs (n = 308) were ultimately reclassified as either highly likely or probable positives given their clinical presentation and imaging features [7]. A study from China of 205 patients with COVID-19 examined the diagnostic yield of various sampling sites and found that bronchoalveolar lavage (BAL) had the highest rate of positivity at 93%, with sputum at 72% and nasal swabs at only 63% [8]. The purpose of this study was to rapidly and anonymously collect data on patients who have had preoperative SARS-CoV-2 NS testing with short interval BAL samples to evaluate overall rates of positivity as well as the correlation between testing modalities.

Materials and Methods

This prospective study was performed between March 15, 2020, and November 9, 2020, at the University of California, Los Angeles (UCLA), Ronald Reagan, and Santa Monica Medical Centers. Institutional Review Board approval was submitted and ultimately waived. This study was approved by the UCLA Committee for COVID-19 Research. All adult patients undergoing a scheduled bronchoscopic procedure for any reason were enrolled, in-

cluding elective and nonelective cases. Intubated patients were excluded from the study. All patients had a negative mandatory routine SARS-CoV-2 PCR nasal swab within 48 h prior to the procedure. All patients were verbally screened for COVID-19 symptoms at the time of procedure scheduling and within 48 h of arrival to the OR; all were deemed low risk for viral infection. The screening process included the following questions, based on the US Center for Disease Control (CDC) guidelines for screening [9]: 1. have you experienced any of the following symptoms in the past 48 h not due to a chronic condition – fever, chills, cough, shortness of breath, fatigue, muscle or body aches, headache, loss of taste or smell, sore throat, congestion, runny nose, nausea, vomiting, and diarrhea? 2. Within the past 14 days, have you been in close physical contact with a person who is known to have COVID-19 or has symptoms of COVID-19? 3. Have you tested positive for COVID-19 or are you waiting on test results? A patient had to answer "no" to all questions in order to be deemed "low-risk" for COVID-19.

Each patient underwent their scheduled bronchoscopic procedure. We then performed a BAL on all patients, which was sent for COVID-19 PCR testing. The BAL was performed in standard fashion by wedging the bronchoscope into the chosen lobar or segmental airway. Varying amounts of fluid were instilled per patient to ensure a minimum of 20 mL of fluid return in order to send for all ordered studies, including SARS-CoV-2 PCR. Patient demographics were recorded, and test results from the preoperative nasal swab and the follow-up BAL were analyzed. The most recent chest imaging, which included either radiograph or computed tomography (CT), performed prior to the procedure was reviewed and graded based on consistency with COVID-19 appearance. The grading scale had 4 tiers: "typical," which included multifocal peripheral consolidation, rounded opacities, and/or nodules, "indeterminate," which included multifocal nonperipheral consolidation, "atypical," which included focal lobar consolidation, pleural effusion, perihilar interstitial infiltrates, bronchial wall thickening, atelectasis, and lymphadenopathy, and "negative," meaning either only edema present or no signs of pneumonia. This classification system was regularly used by UCLA radiologists and was adapted from the Radiological Society of North America Expert Consensus Statement on Reporting Chest CT Findings Related to COVID-19 [10, 11].

Standard descriptive statistics were employed using mean and standard deviation for continuous variables and frequency and percentage for categorical variables. Specificity and negative predictive value were calculated for both testing modalities.

Results

A total of 189 patients were enrolled in the study. The average age was 60.8 years with 18% of patients 50 years old and younger and 40.8% 60 years old and younger. Nearly half of patients had underlying lung disease at baseline. Twenty percent of patients had received either single or double lung transplantation previously. Over 60% of patients had at least 1 comorbid condition, with hypertension, diabetes mellitus, and a nonpulmonary malignancy being the most common at 24, 18, and 16%, respectively. Demographics are shown in Table 1. Over 63% of patients were asymptomatic at the time of bronchoscopy, while 28% reported chronic dyspnea and 9% reported chronic cough. No patients complained of anosmia or ageusia. Ninety-five percent of patients had chest imaging, either radiograph or CT, prior to their procedure. These were classified based on the UCLA COVID-19 classification system. Fifty-eight percent were classified as negative, while 30% were indeterminate, 17% were atypical, and only 1 case was read as typical.

The majority of procedures were elective. All BAL specimens were collected within 48 h of the mandatory preoperative NS, with an average time between sampling of 40.4 h. The indications for bronchoscopy varied, and were most commonly performed for suspected, or confirmed lung cancer biopsies (36%), central airway obstruction or stenosis (30%), and post-lung transplant surveillance (19%). The right middle lobe was sampled most frequently (47%) followed by the right lower lobe at 30%. Procedural details are shown in Table 2.

Table 3 shows the initial upper airway swab and the follow-up lower airway BAL COVID-19 results. We found no discordant testing. All BAL samples were negative, suggesting that the upper airway preoperative nasal swab sampling was accurate, with a false-negative rate and specificity of 100%.

Table 2. Procedural description (n = 189)

Indication for bronchoscopy, *n* (%)	
Cancer diagnosis	68 (36)
Airway stenosis/obstruction	57 (30.2)
Post-transplant surveillance	36 (19)
ILD evaluation	15 (7.9)
Infectious work-up	8 (4.2)
Tracheobronchomalacia evaluation	2 (1.1)
Hemoptysis	2 (1.1)
Tracheostomy exchange	1 (0.005)
Procedure type, *n* (%)	
Elective	163 (87)
Nonelective	25 (13)
BAL location, *n* (%)	
Right middle lobe	89 (47.1)
Right lower lobe	56 (29.6)
Left lower lobe	25 (13.2)
Left upper lobe/lingula	14 (7.4)
Right upper lobe	5 (2.6)
Time between sampling techniques, h	40.4±9.8

Table 3. SARS-CoV-2 PCR results by modality

Testing modality	SARS-CoV-2 PCR result, *n* (%)	
	negative	positive
Upper airway nasal swab	189 (100)	0 (0)
Lower airway BAL	189 (100)	0 (0)
Negative predictive value	100	
Specificity	100	

BAL, bronchoalveolar lavage.

Discussion/Conclusion

Perioperative protocols in the era of COVID-19 are rapidly evolving and shifting over time as knowledge is gained and testing improves. The current American Society of Anesthesiologists guidelines recommend preoperative COVID-19 nasopharyngeal PCR testing prior to all OR cases. However, variability in testing methods and a paucity of data in this area has led to the continued use of increased levels of personal protective equipment as well as general unease with scheduling elective procedures. Additionally, how and when to safely reintroduce trainees in all fields is unclear with many societies recommending procedures be performed by the most experienced operator given the risk for virus transmission in less experienced practitioners.

In this study, we evaluated the concordance of COVID-19 testing in lower airway BAL samples done within 48 h of a screening preoperative NS and found no discrepancies. The majority of patients were from Los Angeles County, where the total number of COVID-19 positive cases reached over 311,000 by the closing date of the study. In a population of just over 10 million people, this equates to a prevalence of 3.1% [12]. All patients in this study were deemed low risk for COVID-19 based on a symptom screening questionnaire. Additionally, upon review of available pre-procedural imaging, only one patient was deemed to have a typical pattern for COVID-19 on chest imaging. It should be noted that when high clinical and/or radiograph suspicion exists, a single negative NS may not be sufficient to rule out COVID-19 [13].

To our knowledge, this is the largest series of its kind. This study is in agreement with a recently published series of 79 inpatients who were tested for SARS-CoV-2 by both NS and BAL and found a 97.5% agreement in sampling techniques [14]. We did exclusively perform BAL sampling rather than bronchial wash, primarily as this likely would have been performed in the majority of our patients, regardless. We recognize that the diagnostic performance of BAL compared to bronchial wash in COVID-19 patients may be similar [15].

The major limitation of this study is that a larger sample size is needed to reach appropriate statistical power to definitively confirm these findings. However, these results are promising and suggest that preoperative nasopharyngeal SARS-CoV-2 testing is adequate pre-procedural screening to rule out active COVID-19 infection in low-risk patients. We propose that this information can be used for both preoperative screening and when reintroducing trainees into the workforce.

Statement of Ethics

This study was deemed exempt by the University of California Los Angeles IRB. It was reviewed by the UCLA special review commission for COVID-19-related research and was approved.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

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Author Contributions

All the authors contributed to study design, data collection, and manuscript writing/review.

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