The Laryngoscope

Utility of Telemedicine for Diagnosis and Management of Laryngology-Related Complaints during COVID-19

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Objectives/Hypothesis: To investigate the concordance in diagnosis and management between initial telemedicine visits and subsequent in-person visits with laryngoscopy for laryngology-related complaints during COVID-19.

Study Design: Retrospective cohort study.

Methods: Patients who presented to a tertiary care center with laryngology-related complaints (voice, swallowing, airway, general throat complaints and others) and completed initial telemedicine visits and subsequent in-person visits with laryngoscopy between March and October 2020 were included (n = 250). Preliminary diagnoses and managements provided during initial telemedicine visits were compared with the diagnoses and managements during subsequent in-person visits with laryngoscopy. Multivariable logistic regression analysis was performed to compare concordance rates in diagnosis and management by chief complaint categories after adjusting for relevant demographic and clinical factors.

Results: Overall concordance rates in diagnosis and management between the initial telemedicine visit and subsequent laryngoscopy exam were 86.1% and 93.7%, respectively. Mean (standard deviation) days until laryngoscopy from the initial visit were 21.2 (23.0). Concordance rates were not associated with patient's age, gender, preferred language, provider, telemedicine visit duration, or days until laryngoscopy. Management concordance rate was relatively lower among patients with general throat complaints in comparison with voice-related complaints (odds ratio: 0.27; 95% confidence interval: 0.08–0.90). Management changes after laryngoscopy included need for further imaging, procedures, voice therapy, and referral to other specialists.

Conclusion: Concordance rates in diagnosis and management remained high between the initial telemedicine visit and subsequent in-person visit with laryngoscopy for new patients presenting with laryngology-related complaints during the COVID-19 pandemic. While laryngoscopy is still essential to confirm diagnosis and provide appropriate management, telemedicine may be a feasible alternative to provide suitable empiric therapy until laryngoscopy can be safely performed.

Key Words: Telemedicine, telehealth, otolaryngology, COVID-19, diagnosis concordance, management concordance.

Level of Evidence: 4

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INTRODUCTION

In order to minimize exposure during the COVID-19 pandemic, otolaryngologists transitioned many clinical encounters to telemedicine. Telemedicine has enabled otolaryngologists to maintain their clinical practices while protecting themselves and patients through social distancing. It was especially critical to implement telemedicine within laryngology clinics given the initial concern about potentially aerosol generating procedures such as laryngoscopy during the COVID-19 pandemic.[1–3]

Previous studies have reported high satisfaction rates with telemedicine among patients and otolaryngologists.[4–10] Telemedicine has been utilized in otolaryngology clinics by a diverse population, with no difference in demographics, insurance, and socioeconomic level between patients seen during the pandemic and patients seen during the same time period in previous years.[11,12] While telemedicine is highly rated among patients and providers and enables diverse populations to have access to care, few studies have evaluated the accuracy of preliminary diagnoses or management provided during telemedicine in otolaryngology.

Diagnostic accuracy and efficacy of empiric therapy provided during telemedicine visits are of particular interest in order to determine the feasibility of telemedicine in effectively managing patients. High reliability and accuracy of diagnosis have been reported in patients with various otolaryngological complaints including otologic conditions, rhinosinusitis, peritonsillar abscess, and nasal fracture.[13–23] In terms of management provided through telemedicine, one study found that telemedicine was associated with a lower rate of outpatient antibiotic treatment for acute rhinosinusitis compared with the previous year, and another study found that there is high sensitivity

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between otolaryngologists in the ability to determine which patients presenting with peritonsillar abscess would require prompt in-person evaluation.[21,23]

While laryngoscopy can likely be safely delayed in the majority of patients, little is known about the utility of telemedicine for initial diagnosis and management of new patients presenting with laryngology-related complaints.[24–26] In this study, we aim to investigate the concordance in diagnosis and management provided during the initial telemedicine visit and subsequent in-person visit with laryngoscopy at a tertiary care center laryngology clinic.

MATERIALS AND METHODS

Study Population

A retrospective chart review was performed to identify all patients who had a telemedicine appointment in a single tertiary care center laryngology clinic with three laryngologists. Patients that were eligible for inclusion were new adult patients (≥18 years old) who were seen through an initial telemedicine appointment and a subsequent in-person appointment with laryngoscopy from March 17 to October 26, 2020. This study was approved by the University of Southern California (USC) Institutional Review Board (HS-16-00003).

New patients seen during the study period were given the option of telemedicine or in-person visit depending on his or her preference. Telemedicine visits were strongly recommended to minimize direct physical contact. During the study period, 90.4% (376/416) of new patients were seen via telemedicine. Patients only seen through telemedicine without an in-person follow-up were excluded from the study. Total of 126 patients were excluded for following reasons: laryngoscopy was not indicated after the initial telemedicine visit (n = 85), follow-up laryngoscopy was indicated but patient was lost to follow-up (n = 25), and follow-up laryngoscopy was performed after the study period ended (n = 16).

Study Variables

Demographic factors (age, gender, race, and preferred language) along with specific variables relating to their clinical encounters (chief complaints, provider seen, encounter duration, and days until in-person laryngoscopy from initial telemedicine visit) were recorded on an online REDCap (Research Electronic Data Capture) database. Study data were collected and managed using REDCap electronic data capture tools hosted at the University of Southern California.[27,28] Chief complaints were categorized into 5 groups: 1) voice-related (i.e., hoarseness, voice loss, and voice changes), 2) swallowing-related (i.e., difficulty swallowing, food sticking, and regurgitation), 3) general throat complaints (i.e., throat pain, throat discomfort, throat clearing, postnasal drip, and globus sensation), 4) airway-related (i.e., breathing difficulties, subglottic/tracheal stenosis, and airway obstruction), and 5) others (i.e., tonsil stone, tonsillitis, drooling, bloody mucus, and hemoptysis).

Outcome Measures

Diagnoses and management plans from initial telemedicine visits and subsequent in-person visits with laryngoscopy were collected from chart review. Preliminary diagnoses and management plans were provided based on patient history and available physical exam via videoconference, perceptual voice analysis, and clinical swallow evaluation as indicated, outside medical records and available prior work-up. The majority of preliminary diagnoses listed were specific (i.e., suspected vocal fold paralysis, phonotraumatic lesion, laryngitis, laryngeal spasm, muscle tension dysphonia, reflux, subglottic stenosis, tonsillitis, malignancy, etc.) and they were compared with the final diagnoses after in-person visits with laryngoscopy. Preliminary diagnoses were recorded as "uncertain" when they were unclear based on the clinic note and deferred to after the in-person visit with laryngoscopy. Uncertain preliminary diagnoses were counted as discordant when final diagnoses were given after the follow-up visit.

Preliminary management plans provided after telemedicine encounters were broad, ranging from behavioral/dietary modification, vocal hygiene, hydration, referral to Speech Language Pathologist (SLP) for voice therapy, reflux medications (i.e., H2-blockers, proton pump inhibitors, alginates), imaging (i.e., Modified Barium Swallow Study [MBSS], computed tomography [CT], magnetic resonance imaging [MRI], and ultrasound [US]), and future need for procedures (in-office botox injection, injection laryngoplasty, microlaryngeal surgery, etc.). Management was determined to be discordant if management changed or additional interventions were offered after the subsequent in-person visit with laryngoscopy.

Concordance in diagnosis and management were determined by two independent research personnel who did not provide care to the study cohort. Data were reviewed in detail in iteration if any discrepancy was noted between two reviewers until consensus was reached. Final outcomes were determined after a series of team discussions. Overall concordance rates were calculated separately for both diagnosis and management.

Telemedicine and Follow-up Protocol

Telemedicine appointments were conducted using the USC Telecare Application. Prior to their appointment, patients were instructed to download the USC Telecare App on their preferred device and given a link to the USC Telecare Portal. They were also instructed to connect through the app at least 10 minutes before their appointment time to enter the virtual waiting room and complete their online check-in. After the patient had finished their check-in, their provider was able to begin the telemedicine appointment.

Once the telemedicine appointment was completed, the patient was scheduled for an in-person follow-up appointment. The timeframe for the in-person visit was determined by the treating clinician based on the urgency of the presumed diagnosis. Initially, patients were instructed to complete a COVID-19 test prior to their appointment to confirm their negative status. Once this was complete, the patient was allowed into the clinic for the in-person encounter and laryngoscope examination. All patients underwent a standardized COVID-19 symptom screening prior to entering the clinic building. After July 2020, COVID-19 negative status was no longer required for patients undergoing in-person examination and laryngoscopy.

Statistical Analysis

Fisher's exact test and t-test were used to compare categorical and continuous variables, respectively. Concordance rates were calculated by percentage separated by diagnosis and management for all cohorts and for each chief complaint category. Univariable logistic regression analysis was performed to explore the association between chief complaint and concordance rates. Multivariable logistic regression analysis included other relevant variables including age, gender, race, preferred

language, provider, telemedicine duration, and days until laryngoscopy. All analyses were conducted using STATA 16 (StataCorp, College Station, TX). Significance was set at $P < .05$, two-tailed.

TABLE I.
Study Cohort Sample Characteristics (n = 250).

Characteristics	N (%) Total = 250
Age, mean years (SD)	50.1 (17.0)
Sex, n (%)	
Female	137 (54.8)
Race/ethnicity, n (%)	
White	91 (36.4)
Black	8 (3.2)
Hispanic	33 (13.2)
Asian	37 (14.8)
Other	81 (32.4)
Preferred language, n (%)	
English	233 (93.2)
Non-English	17 (6.8)
Chief complaint, n (%)	
Voice	128 (51.2)
Swallowing	23 (9.2)
Airway	20 (8.0)
General throat complaints	54 (21.6)
Others	25 (10.0)
Telemedicine encounter duration, mean minutes (SD)	30.7 (10.1)
Days until laryngoscopy, mean days (SD)	21.2 (23.0)

SD = standard deviation.

RESULTS

The study cohort included 250 new patients who were initially seen with videoconference telemedicine visits and completed follow-up in-person visits with laryngoscopy during the study period. Patient and encounter characteristics are summarized in Table I. Mean days between the initial telemedicine visit and in-person visit laryngoscopy were 21.2 ± 23.0 days. Number of patients for each chief complaint category was 128 (51.2%) for voice, 23 (9.2%) for swallowing, 20 (8.0%) for airway, 54 (21.6%) for general throat complaints, and 25 (10.0%) for others. There were no differences in patient's age, gender, race, preferred language, telemedicine visit duration, and follow-up days by chief complaint category.

Overall concordance rates in diagnosis and management between the initial telemedicine visit and subsequent in-person visit with laryngoscopy were 86.1% (215/250) and 93.7% (234/250), respectively. The corresponding concordance rates for both diagnosis and management were presented by chief complaint in Figure 1.

The association between concordance rates in diagnosis and management and chief complaints was explored using univariable and multivariable logistic regression models (Table II). There were no statistical differences in concordance rates of diagnoses by chief complaint. The concordance rates in management were significantly lower among patients with general throat complaints (odds ratio: 0.27, 95% confidence interval [CI]: 0.08–0.90) in comparison with voice-related complaints. When adjusted for patient demographics, provider, and relevant clinic factors, the differences were no longer significant (odds ratio: 0.28, 95% CI: 0.06–1.26).

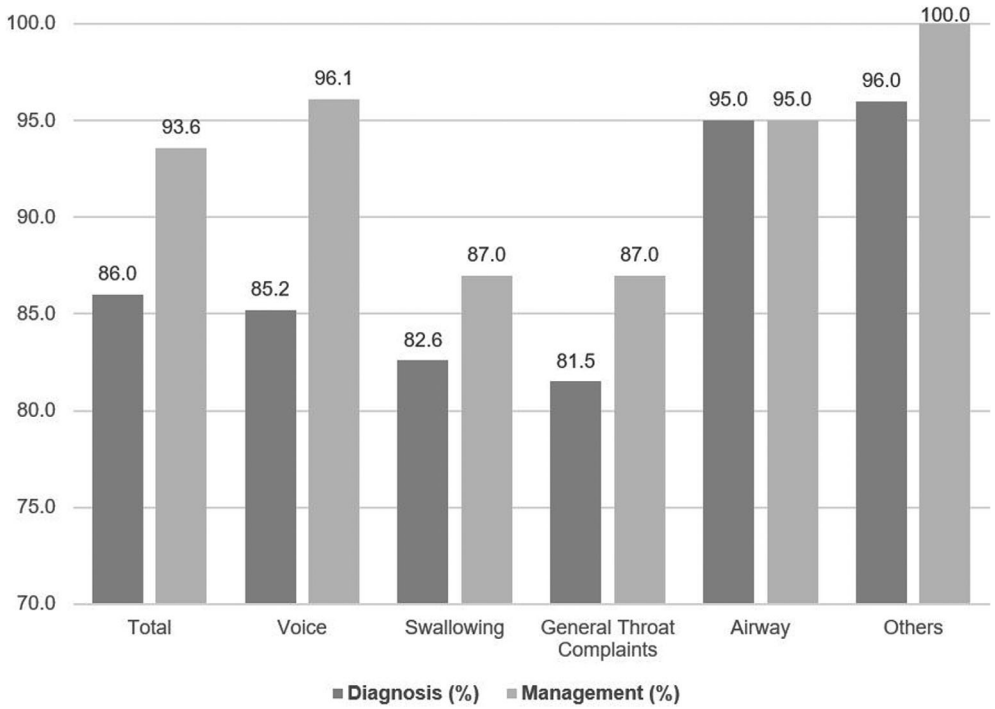

Fig. 1. Concordance rates in diagnosis and management between initial telemedicine visit and subsequent laryngoscopy exam by chief complaint.

TABLE II.
Association Between Chief Complaint Type with Diagnostic and Management Concordance Between Initial Telemedicine Visit and Subsequent Laryngoscopy Exam by Univariable and Multivariable Logistic Regression Models.

	Concordance in Diagnosis				Concordance in Management			
	Univariable		Multivariable*		Univariable		Multivariable*	
	Odds Ratio [95% CI]	*P*-Value	Odds Ratio [95% CI]	*P*-Value	Odds Ratio [95% CI]	*P*-Value	Odds Ratio [95% CI]	*P*-Value
Chief complaint								
Voice	ref	–	ref	–	ref	–	ref	–
Swallowing	0.83 [0.25–2.70]	.76	0.94 [0.26–3.40]	.92	0.27 [0.06–1.22]	.09	0.29 [0.05–1.65]	.16
Airway	3.31 [0.42–26.22]	.26	3.55 [0.42–30.2]	.25	0.77 [0.09–6.98]	.82	0.91 [0.09–9.70]	.94
General throat complaints	0.77 [0.33–1.78]	.54	0.67 [0.26–1.76]	.42	**0.27† [0.08–0.90]**	**.03**	0.28 [0.06–1.26]	.10
Others	4.18 [0.53–32.8]	.17	4.82 [0.57–40.5]	.15	n/a	n/a	n/a	n/a

*Multivariable models were adjusted for chief complaint, age, gender, race, language preference, provider, telemedicine encounter duration, and days until laryngoscopy.
†<.05.
CI = confidence interval.

Pre- and post-laryngoscopy diagnoses were rated to be discordant among 35 patients (14%). Although diagnosis was discordant, 19 patients (54.3%) were rated to have concordant management without any additional or different management plans (i.e., new medication, imaging, surgical intervention, or voice therapy) added after the follow-up in-person visit. Table III summarizes pre- and post-laryngoscopy diagnosis and management plans for 16 patients with discordant pre- and post-laryngoscopy diagnosis and management. After laryngoscopy, 5 patients required additional imaging (i.e., CT, MRI, and US), 6 patients were recommended with different procedures, and 2 patients were referred to gastroenterologists. One patient was admitted to inpatient from clinic for airway monitoring and tracheostomy.

DISCUSSION

In our study examining the concordance in diagnosis and management between the initial telemedicine visit and subsequent laryngoscopy exam in a tertiary care center outpatient setting, the overall concordance rates were high at 86.0% and 93.6% for diagnosis and management, respectively. Although telemedicine should not replace in-person physical exam and laryngoscopy for laryngology-related complaints, it can be effectively used to provide a preliminary diagnosis and management plan and appropriate triaging during the COVID-19 pandemic or in situations where a patient may not have easy access to a laryngologist or tertiary care center.

This is the first study to investigate the diagnosis and management concordance rates between the pre-laryngoscopy telemedicine visits and post-laryngoscopy in-person visits for laryngology-related complaints. Previous studies have assessed the accuracy of diagnosis based on history and specific exam findings available via telemedicine on various otolaryngological complaints ranging from otologic conditions (based on video-otoscopy images),[15,16,18–20,29–33] peritonsillar abscess (based on phone captured intraoral images),[21] nasal fracture (based on phone captured face images),[14,34] and dysphonia (based on telephone voice)[35,36] and other general otolaryngology consults from general practitioners.[17,22,37–39] The diagnostic concordance rates from these studies were overall high between 64% and 100%.[26,40] However, it is difficult to compare the concordance rates from previous studies to the current study as chief complaints, setting, telemedicine format, and outcome measures vary substantially by report. Previous studies that were mostly conducted prior to the COVID-19 pandemic focused on the role of telemedicine in improving access to otolaryngologists and its cost-effectiveness via conducting telemedicine between otolaryngologists and general practitioners or family members at home. Our study investigated the role of telemedicine in the special circumstances of the COVID-19 pandemic in which in-person visits and potentially aerosolizing instrumentation, such as laryngoscopy, were vastly limited for the safety of the patients and physicians.

Most chief complaints included in our cohort were voice-related (51%), and their diagnostic and management concordance rates remained high at 85.6% and 96.2%, respectively. High concordance rates for voice-related complaints in our study are consistent with two previous studies that have assessed the diagnostic accuracy of voice analysis based on telephone visits among patients presenting with dysphonia.[35,36] Wormald et al. reported 92% sensitivity and 75% specificity of diagnosing vocal fold paralysis.[35] Johnson et al. reported 90% sensitivity and 95% specificity for distinguishing spasmodic dysphonia, vocal tremor and other voice disorders.[36] Telemedicine visits with high-quality audio can deliver adequate auditory diagnostic information as physicians can ask patients to perform sustained and dynamic vocalization tasks and read standardized passages. Although clinical diagnoses need to be confirmed with laryngoscopy, empiric therapies such as voice rest, hydration strategies, and referral to SLP for voice therapy can be initiated. Based on the preliminary diagnosis from telemedicine,

TABLE III.
Summary of Patients with Disconcordant Diagnosis and Management.

	Chief Complaint		Pre-laryngoscopy		Post-laryngoscopy	
			Diagnosis	Management	Diagnosis	Change in Management
1	Voice	Raspy voice	Intubation related paralysis	- Consider injection laryngoplasty if indicated after laryngoscopy	Anterior glottic web	- Procedure (in-office procedure to excise anterior commissure glottal web)
2	Voice	Raspy voice	Intubation related vocal fold lesion	- Vocal hygiene - Laryngoscopy for further evaluation	Vocal fold scar, polypoid corditis	- Procedure (suspension microlaryngoscopy with microflap removal and steroid injection)
3	Voice	Voice changes	Phonotraumatic vocal fold lesion	- Vocal hygiene - Laryngoscopy for further evaluation	Muscle tension dysphonia, laryngeal spasm	- Voice therapy
4	Voice	Voice loss	Phonotraumatic vocal fold lesion	- Vocal hygiene - Laryngoscopy for further evaluation	Unilateral vocal fold paralysis	- CT neck and chest- Procedure (in-office vocal fold injection laryngoplasty after imaging)
5	Voice	Raspy voice	Dysphonia of uncertain etiology	- Vocal hygiene - Laryngoscopy for further evaluation	Bilateral hemorrhagic polyp vs. laryngeal papillomatosis	- Procedure (suspension microlaryngoscopy with microflap and possible CO_2 laser excision of vocal fold lesion)
6	Swallowing	Difficulty swallowing	Reflux, chronic laryngitis, laryngospasm	- Dietary, behavioral, medical management of reflux- Respiratory retraining- Voice therapy- Laryngoscopy for further evaluation	Bilateral vocal fold paralysis	- CT neck, chest
7	Swallowing	Difficulty swallowing, tonsil stone	Dysphagia of uncertain etiology, tonsilolith	- Modified barium swallow study with esophageal follow- Laryngoscopy for further evaluation	Esophageal dysphagia, gastrojejunal outlet syndrome	- Referral to gastroenterology
8	Swallowing	Difficulty swallowing, regurgitation	Dysphagia of uncertain etiology	- Laryngoscopy for further evaluation- Videoesophagram	Esophageal dysmotility	- Referral to gastroenterology and multidisciplinary discussion
9	General throat complaints	Frequent throat clearing	Reflux	- Dietary, behavioral, medical management of reflux- Laryngoscopy for further evaluation	Vocal fold atrophy	- Voice therapy
10	General throat complaints	Globus sensation	Globus sensation of uncertain etiology	- Laryngoscopy for further evaluation	Compression from thyroid	- Thyroid ultrasound
11	General throat complaints	Throat burning	Throat pain of uncertain etiology	- Laryngoscopy for further evaluation	Throat pain and neck fullness of uncertain etiology	- CT neck
12	General throat complaints	Globus sensation	Reflux	- Dietary, behavioral, medical management of reflux- Laryngoscopy for further evaluation	Unilateral vocal fold hemorrhagic polyp, base of tongue mass	- MRI neck to evaluate base of tongue mass- Consider surgery to remove base of tongue mass and redundant epiglottic tissue and polyp
13	General throat complaints	Sore throat	Allergic rhinitis, tonsilolith	- Conservative management of tonsilolith- Nasal saline rinses- Laryngoscopy for further evaluation	Chronic laryngitis, reflux, recurrent tonsillitis	- Antibiotics for acute tonsillitis- Dietary, behavioral, medical management of reflux
14	General throat complaints	Throat pain	Reflux	- Dietary, behavioral, medical management of reflux- Laryngoscopy for further evaluation	Muscle tension dysphonia	- Voice therapy
15	General throat complaints	Globus sensation	Reflux	- Dietary, behavioral, medical management of reflux- Laryngoscopy for further evaluation	Hyoid bone syndrome, laryngeal spasm	- Chemodenervation of the superior laryngeal nerve and thyrohyoid joint region
16	Airway	Difficulty breathing	Subglottic stenosis	- Laryngoscopy for further evaluation - Return precautions for worsening airway symptoms	Bilateral vocal fold paralysis	- Inpatient admission for airway monitor- Procedure (awake tracheostomy, direct laryngoscopy)

CT = computed tomography; MRI = magnetic resonance imaging.

physicians may discuss possibilities of a need for procedures such as in-office injection laryngoplasty or microlaryngeal surgeries for expectation management.

Management concordance rates for the swallowing-related and general throat complaints (i.e., throat pain, discomfort, and globus sensation) were relatively lower in comparison with voice-related complaints. Video-enabled telemedicine can provide helpful preliminary information such as global swallowing function and change in voice quality/aspiration symptoms after swallow.[24] However, accurate diagnosis often requires additional assessments including laryngoscopy along with modified barium swallow study, CT or MRI. Conservative management with acceptable benefit-to-risk ratios was often recommended empirically including dietary and behavioral management of reflux, proton pump inhibitors, H2-blockers, alginates, antibiotics, and steroids based on appropriate history and preliminary diagnosis. As differential diagnoses for general throat complaints were largely broad, it was difficult to provide specific management for these patients prior to in-person exam with laryngoscopy.

Diagnostic and management concordance rates for airway-related complaints were high at 95%. Detailed history-taking including patient's prior history of trauma, intubation, tracheostomy, and relevant surgeries may have guided the physicians to determine accurate diagnosis prior to laryngoscopy. Many patients with airway-related complaints had previous work-up prior to presenting to a tertiary care center given the acuteness of the airway symptoms. It is important to note that the small percentage of cases with misdiagnosis or mismanagement can cause critical morbidity in these patients. One patient in our cohort who presented with presumed subglottic stenosis and stable airway during the initial telemedicine visit was scheduled for an expediated COVID-19 test and follow-up appointment for in-person exam and laryngoscopy. The patient was noted to have bilateral vocal fold paralysis during the follow-up in-person exam and was directly admitted as an in-patient for airway monitoring and tracheostomy. Initial telemedicine visits can be used for appropriate triaging during the COVID-19 pandemic for airway-related complaints.

During the telemedicine visits, it is imperative to counsel patients on the limitations of the diagnosis and management provided based on telemedicine visits without laryngoscopy. Physicians should obtain detailed histories and available exams and recognize urgent issues that need expedited follow-up (i.e., symptomatic airway obstruction, aspiration, severe dysphagia, suspected malignancy, etc.).[24] Based on the preliminary diagnosis from the initial telemedicine visit, appropriate empiric management, counseling and reassurance can be provided to the patients but does not and should not replace in office laryngoscopy. Further work-up (e.g., MBSS for dysphagia, CT and/or MRI for suspected neoplasm) can be ordered prior to in-person encounters as needed to optimize recourse utilization.

There are several limitations to this study. It is unknown whether all potential differential diagnoses were considered during the initial telemedicine visit unless specified in the clinic note due to the retrospective design. Therefore, we were unable to evaluate sensitivity, specificity, negative predictive value, or positive predictive value for each diagnosis. Instead, we assessed the concordance rates between the pre-laryngoscopy and post-laryngoscopy diagnosis and management based on the available records from chart review. Second, new patients were given the option of choosing telemedicine versus in-person visits which may have introduced biases into the study results. However, all patients were strongly recommended to be seen via telemedicine to minimize physical contact during the COVID-19 pandemic and majority of the new patients (over 90%) were seen via telemedicine during the study period. Thirdly, the study results are susceptible to observer bias as the data analysts assigning concordance were unable to be blinded. Two study personnel have reviewed the data independently and the concordance was determined conservatively whenever the outcomes were conflicting. Detailed subgroup analysis for each chief complaint was not performed due to low sample size. Future studies with higher sample size as the data on telemedicine expand are warranted to explore other factors associated with diagnostic and management concordance for each chief complaint. Additionally, the telemedicine visits were conducted by laryngology subspecialty-trained physicians in our cohort and the results may be different based on the physicians' training and experiences. Despite the listed limitations, our study is the first to demonstrate the telemedicine model as a feasible initial option to provide preliminary diagnosis and management for laryngology-related complaints until laryngoscopy can be safely performed with high concordance in diagnosis and management.

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