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Telemedicine and Telementoring in Rhinology, Otology, and Laryngology: A Scoping Review

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Abstract

Objective. Telemedicine and telementoring have had a significant boost across all medical and surgical specialties over the last decade and especially during the COVID-19 pandemic. The aim of this scoping review is to synthesize the current use of telemedicine and telementoring in otorhinolaryngology and head and neck surgery.

Data Sources. PubMed and Cochrane Library.

Review Methods. A scoping review search was conducted, which identified 469 articles. Following full-text screening by 2 researchers, 173 articles were eligible for inclusion and further categorized via relevant subdomains.

Conclusions. Virtual encounters and telementoring are the 2 main applications of telemedicine in otolaryngology. These applications can be classified into 7 subdomains. Different ear, nose, and throat subspecialties utilized certain telemedicine applications more than others; for example, almost all articles on patient engagement tools are rhinology based. Overall, telemedicine is feasible, showing similar concordance when compared with traditional methods; it is also cost-effective, with high patient and provider satisfaction.

Implications for Practice. Telemedicine in otorhinolaryngology has been widely employed during the COVID-19 pandemic and has a huge potential, especially with regard to its distributing quality care to rural areas. However, it is important to note that with current exponential use, it is equally crucial to ensure security and privacy and integrate HIPAA-compliant systems (Health Insurance Portability and Accountability Act) in the big data era. It is expected that many more applications developed during the pandemic are here to stay and will be refined in years to come.

Keywords

telemedicine, telehealth, rhinology, otolaryngology, otology, audiology, laryngology

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Telemedicine is not a novel concept and has long been utilized across medical specialties, since the development of information and communication technologies (ICT), which are defined as ''digital technologies that facilitate the electronic capture, processing, storage, and exchange of information.''[1] The World Health Organization has adopted the following broad description of telemedicine, having recognized that there is not a single definitive definition: ''the delivery of health care services, where distance is a critical factor, by all health care professionals using information and communication technologies for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, research and evaluation, and for the continuing education of health care providers, all in the interests of advancing the health of individuals and their communities.''[2] Modern telemedicine approaches often encompass algorithms to aid in diagnosis and treatment. These approaches have paved the way toward the application of artificial intelligence and other exciting developments.

Importantly, telemedicine has had a boost during the COVID-19 pandemic, and otolaryngology is considered one of the highest-risk health care specialties with regard to exposure of staff and contraction and spread of SARS-CoV-2. Many endoscopic examinations and surgical procedures in otolaryngology are considered aerosol generating,[3] with an increased risk of viral transmission. Expansion of technology-centered remote delivery of care, where feasible and safe, has never been more needed than now. Hence, telemedicine has been in the spotlight during the COVID-19 pandemic, as utilizing the various forms of ICT has become an important way of providing health care from a distance, especially for high-risk patient groups seeking to minimize unnecessary exposures.

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Regardless of the current trend that has accelerated the adoption of telemedicine, its development in the specialty of otorhinolaryngology–head and neck surgery has been slow: it was first described in 1994,[4] with the number of publications increasing steadily over the years.

With this in mind, we aim to provide an up-to-date evaluation of the various applications of telemedicine in otorhinolaryngology–head and neck surgery. However, due to the broad nature of the question and the fact that the quality of published data is limited and heterogenous, a systematic review could not be performed; hence, a scoping review was conducted.

Materials and Methods

For methodology, we followed the PRISMA-ScR checklist[5] (Preferred Reporting Items for Systematic Reviews and Meta-analyses Extension for Scoping Reviews).

Information Sources and Search Strategy

Articles were searched in the PubMed database with the following thread of keywords:

> (telemed* [tw] OR telehealth [tw] OR ''tele-medicine''[tw] OR ''tele-health'' [tw] OR ''e-consult'' [tw] OR ''e-consultation'' [tw] OR econsult* [tw] OR telediagnos* [tw] OR ''tele-diagnostics'' [tw] OR telemedicine [mesh] OR ''video consult'' [tw] OR ''video consultation'' [tw] OR ''Video consultations'' [tw] OR ''Video visit'' [tw] OR ''video visits'' [tw] OR ''tele mentoring'' [tw] OR telementor* [tw] OR ((mentor* [ti] OR mentoring [mesh]) AND (telemed* [ti] OR ''telemedicine'' [mesh]))) AND (''Otolaryngology'' [Mesh] OR ''Otorhinolaryngologic Surgical Procedures'' [Mesh] OR ''Otorhinolaryngologic Diseases''[Mesh] OR ''Otologic Surgical Procedures''[Mesh] OR ''Nasal Surgical Procedures''[Mesh] OR ''Audiology''[Mesh] OR ent [ti] OR otolaryngolo* [ti] OR sinus* [ti] OR rhinolog* [ti]) AND English [lang] NOT (''animals'' [mesh] NOT ''humans'' [mesh]).

Articles were also searched in the Cochrane Library databases with the following thread of keywords: telemedicine AND ENT; telemedicine AND otolaryngology; telehealth AND ENT; telehealth AND otolaryngology. The date of the last search was December 15, 2020.

Eligibility Criteria

Eligibility criteria were peer-reviewed studies that described the application of telemedicine in the otolaryngology specialty. Due to the scarcity of available literature, no restrictions were set on patient demographics and study design; thus, case reports were also included. Research articles that did not describe the application of telemedicine in the field of otolaryngology were excluded. Reviews, editorials, commentaries, and all other nonresearch trial articles on telemedicine in otolaryngology were excluded.

Selection of Sources of Evidence

Search results from databases were downloaded and uploaded to Covidence, an online organizer platform where duplicates were removed. Using the eligibility criteria, 2 reviewers (A.Y. and D.K.) independently screened the titles and abstracts of all included articles. For full-text screening, the 2 reviewers independently screened the articles, and conflicts were resolved by discussion. The final full-text screened cohort was confirmed with a third reviewer (M.L.).

Data Extraction

Eligible full-text articles were read independently by the 2 reviewers to extract information regarding year published, study design, subspecialty, type of telemedicine, disease of focus diagnosis/prognosis, participant number/sample size, and outcomes. Level of evidence was determined by study design (1, randomized controlled study; 2, prospective cohort study, controlled study; 3, retrospective controlled study; 4, case report, case series).

Results

The search yielded 469 results, and after removal of duplicates, 461 were eligible for initial screening. All titles and abstracts were screened. An overall 408 articles were eligible for full-text screening. A total of 235 articles were excluded as they did not fit the inclusion criteria: article type was not original research; article did not focus on application of telemedicine in otolaryngology; or there was no full text available or no access. Full-text review was performed on the remaining 173 articles, and data were extracted (**Figure 1**).

Of all studies that fit the inclusion criteria, 18 focused on rhinology or skull base surgery, 33 on laryngology/head and neck surgery, 35 on comprehensive otolaryngology–head and neck surgery, 85 on otology or audiology subspecialty, 1 on maxillofacial surgery, and 1 on multiple subspecialties. In general, there has been a significant increase in the annual number of articles published on telemedicine in otolaryngology overall and for subspecialties (**Figure 2**).

For ease of review, we classified the articles per the approach used for telemedicine.

Virtual Encounters

A total of 164 articles were identified. Virtual encounters (VEs) were defined as consultations held by telephone- or video-based platforms (with real-time audio and/or visual communication with minimal latency) and store-and-forward telepractice services. These commonly included clinical assessments with the patients presenting to an ear, nose, and throat (ENT) specialist while connected from a remote site, and they encompass tele-screening, tele-rehabilitation, and post-operative follow-up via patient engagement tools. Applications of VE were classified into 5 subdomains: patient-physician interaction (Supplemental Table 1a and 1b, available online), physician-physician interaction (Supplemental Tables S2a and S2b), patient engagement tools (Supplemental Tables S3a and

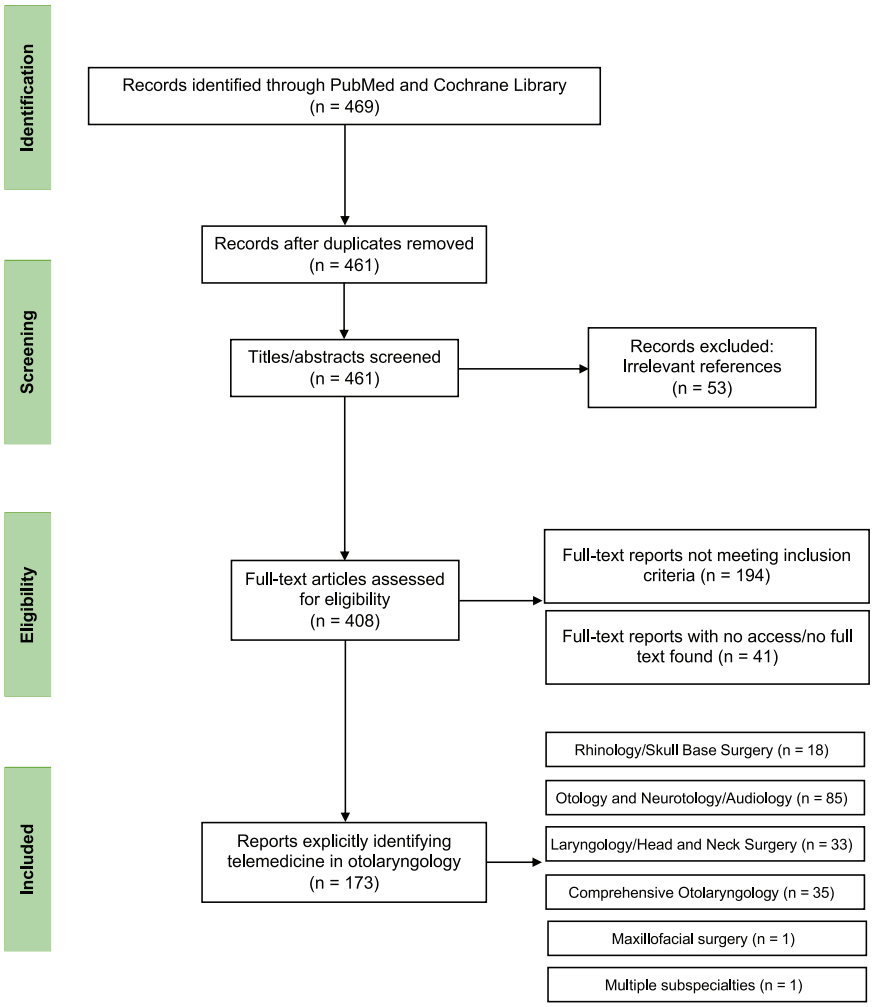

Figure 1. Search strategy flowchart.

S3b), tele-screening (Supplemental Tables S4a and S4b), and tele-rehabilitation (Supplemental Table S5a and S5b). Most studies focused on feasibility[6-75] or investigated concordance rates[4,76-151] between ≥2 cohorts, while a few examined the cost savings.[152-154]

Physician-Patient Interaction. Prior to COVID-19, studies and case reports demonstrated the feasibility of remote tele-visits[15,16,23,70] and sufficiency in providing patients with preliminary diagnoses, reducing referral wait time, allowing for postoperative tele-follow-up visits, or preventing unnecessary in-person otolaryngology visits.[7,8,11,13,68,155]

A major theme identified was antibiotic prescription patterns in the course of tele-management. For treatment of sinusitis, feasibility of VE was supported in literature,[14,83-85] but results on prescription patterns were contradicting. Some studies reported that physicians were more likely to prescribe antibiotics during tele-visits as compared with face-to-face (FTF) visits,[83] while others noted the opposite.[84,85] One study found no significant difference among methods of visit in adherence to antibiotic prescription guidelines.[150] For management of acute respiratory tract infections, a group of researchers noted that patient satisfaction was highest in those who had an antibiotic and corticosteroid prescribed during the tele-visit.[67]

A few studies focused on remote cochlear implant (CI) management, and feasibility was supported,[18-20,97] as patients with CIs or hearing aids can use tele-visits to undergo pure tone audiometry (PTA), tympanometry, and speech tests. Remote programming of CI is also possible, and when compared with CI programmed in-person, there was no significant difference in patients' performance at 3 months according a group of researchers.[151] Patient satisfaction for the telemedicine experience was high.[21-23,73,151] However, as expected, performance of audiology or speech tests was suggested to be better in a sound-treated booth.[28,96] For PTA conducted in a non–sound-treated booth, results were promising,[110,111] and others reported the test and retest thresholds between remote and in-person testing to be similar.[112,113] With regard to concordance rates, results were contradicting. Threshold differences of PTA conducted in remote sound booths were clinically acceptable and equivalent to in-person testing,[102-108] although 1 study found more errors generated when the personal computer–based audiometer was used in a telemedicine setup as compared with in-person appointment settings.[109]

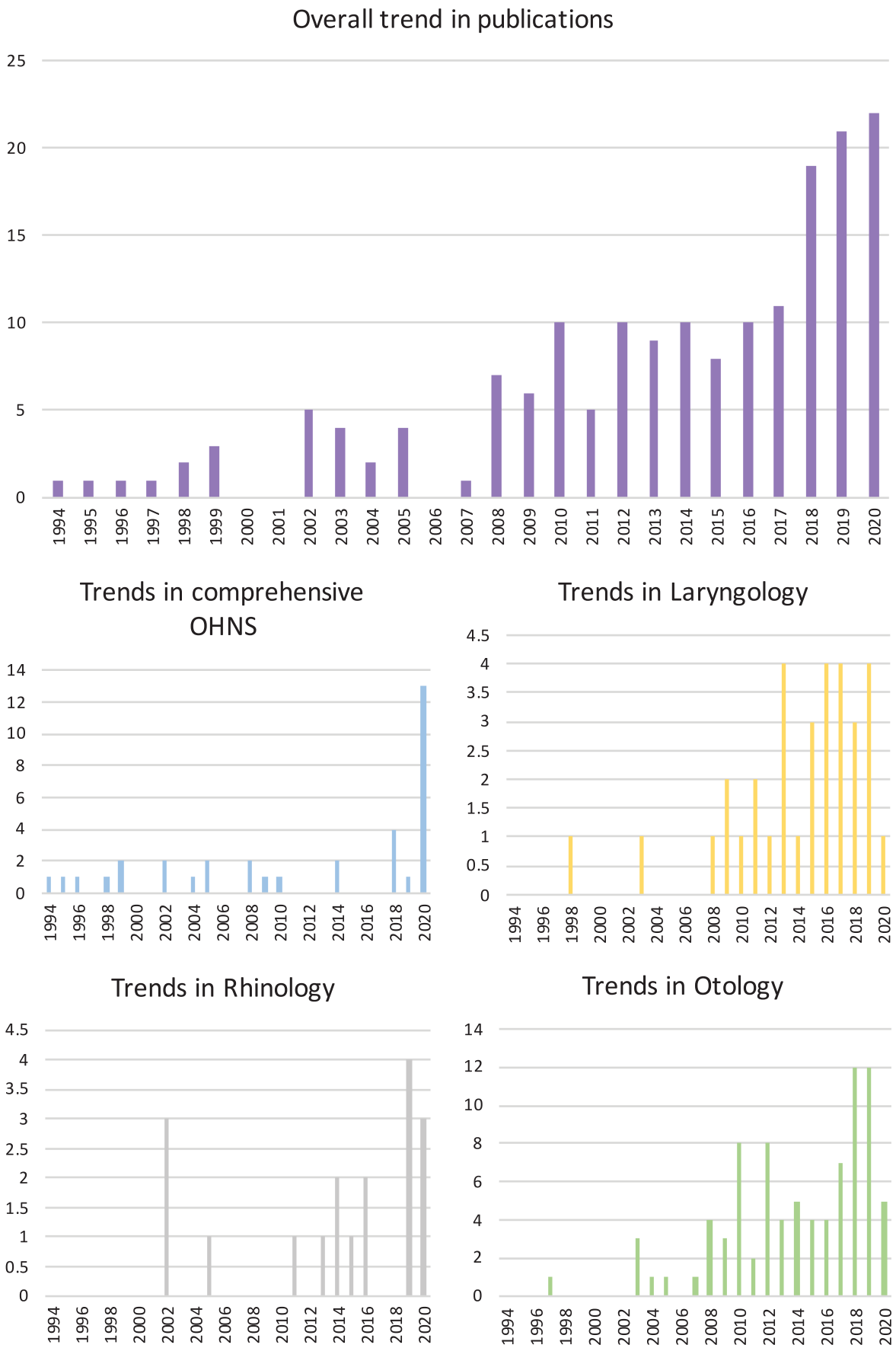

Figure 2. Trend in number of publications. OHNS, otolaryngology–head and neck surgery.

Most studies showed acceptable to high agreement between diagnosis made via telemedicine and that made through FTF encounters,[76-79,82,86-92,122] yet 2 noted disconcordance.[80,81] Common concerns for this discrepancy were with regard to image/recording quality of the physical examination.[6,8,29,156] A higher percentage of video otoscopy recording taken by nonphysicians was lower quality and unusable than that taken by physicians.[17,89,121,124] In a pediatric study, this was shown to improve upon appropriate training of parents on how to use an otoscope.[26] In contrast, usefulness of endoscopic videos taken by health care personnel can be limited.[25,118,148,149]

Nonetheless, when VEs were utilized for CI management, studies demonstrated no significant differences in performance of CIs, session duration, neural responses, electrode-specific measure, and threshold and comfort levels[18,93-101,123] as compared with those managed in person. When VE was used for dysphagia evaluations, results suggested that remote evaluation yielded substantial levels of agreement for treatment recommendations and subjective severity ratings as compared with traditional FTF evaluations,[114-117] with comparable efficacy. According to cost-efficiency analysis, tele-visits are more cost-efficient than in-person appointments.[86] At an institution level, the cost reduction was achieved after the number of tele-visits surpassed the threshold to pay off the fixed costs from the initial technology installment; for example, in 1 study this was reported at a threshold of 35 patients per year.[11,152,153]

During COVID-19, there has been a surge in literature describing the implementation and efficacy of the tele-clinic,[155-168] especially when compared with a similar period prior to the pandemic.[157,162] Some studies reported no-shows to be more frequent when the tele-visit was utilized,[158] while others noted attendance to increase.[160,168] Some reported reasons for no-shows included technical issues[158,159] or patients declining it due to no direct physical examination.[165] While there are numerous studies investigating the efficacy of otoscopes for ''at home'' use, during the pandemic, only 1 case series reported the use of a commercially available otoscope by patients for telemedicine purposes.[167] Nonetheless, patient satisfaction with telehealth encounters was high or improved as compared with standard care after implementation of the tele-clinics.[161,164,166] Furthermore, studies showed that patients preferred continued use of tele-visits in addition to,[160,163] and in some studies even instead of,[161] FTF office appointments.

Patient Engagement Tools. Various mobile- and internet-based platforms have been developed to facilitate patient engagement. Almost all articles except for 2 were published in the field of rhinology, which included management of allergy-related symptoms,[30,31,69,125,126] patient-reported outcome measures tracking after sinonasal surgery,[32] and remote nasal airflow evaluation.[33,34] Studies noted that mobile patient engagement tools aided with physician-patient communication efficacy,[125] helped diagnose allergies,[30] held advantages in improving adherence rate and average daily use of prescribed medications for patients with allergies,[31,69,126] allowed for remote nasal airflow evaluation,[33,34] and yielded high patient response rates when tracking patient-reported outcome measures.[32] For nonrhinology articles, one group showed the feasibility of using an online consultation service to connect potential patients interested in maxillofacial surgery to physicians who answered inquiries.[27] Another study investigated the utility of a mobile instant messenger in the postoperative management of pediatric tonsillectomy and found this to improve compliance with at-home care instructions.[66]

Physician-Physician Interaction. Twelve studies focused on tele-consultations, during which physicians remotely consulted another physician for better case management. Remote consultations among physicians were shown to be feasible and able to prevent unnecessary encounters for general otolaryngology outpatient clinics,[35,36] as well as more specialized audiologic management of CI cases.[37,38] ICT also allowed for remote observation and consultation for laryngeal intubation[39,40] and extubation.[41]

Results indicated that physician-physician tele-consultations had good interrater agreement for diagnostic indicators[127,128] and management recommendations[129] for patients with dysphagia. Virtual consultations among physicians also accurately predicted otologic surgery as compared with those from in-person appointments.[130] Two studies evaluated diagnostic accuracy for patients whose imaging was sent via ICT. The study population consisted of emergency ENT patients and pediatric patients with lateral neck x-rays. Results for both studies showed high accuracy.[4,131]

Tele-screening. In tele-screening (ie, telemedicine for the purpose of screening), the 18 eligible articles mostly focused on the field of otology. Almost exclusively, technology was used for hearing screening. These were described in articles from America,[42,132] Australia,[43-47] Brazil,[133] Canada,[48] Germany,[71] India,[74,134] Kenya,[72] South Africa,[49-51,75] and Tajikistan.[52] In general, results suggest feasibility. Tele-screening resulted in increased screening coverage, shortened referral waiting time, decreased outpatient and failure-to-attend appointments at tertiary centers from a remote community, and reduced costs.[43-48,50,51,71] Testing and identification during tele-screening were also suggested to be reliable and comparable to in-person screening.[42,52,132-134] In a rare study that investigated tele-screening in the adult population, it was found that an online screening test was feasible, but only a small portion of participants provided their contact information to proceed with a hearing evaluation and hearing aid trial.[49]

Tele-rehabilitation. In tele-rehabilitation, the 27 articles were mainly in the field of otology, audiology, laryngology, or head and neck cancer. The feasibility and effectiveness of various online-delivered or software-based therapies were investigated (eg, acceptance and commitment, auditory-verbal, cognitive-behavioral, voice, speech, and swallow) to manage tinnitus, chronic vestibular syndromes, hearing loss,

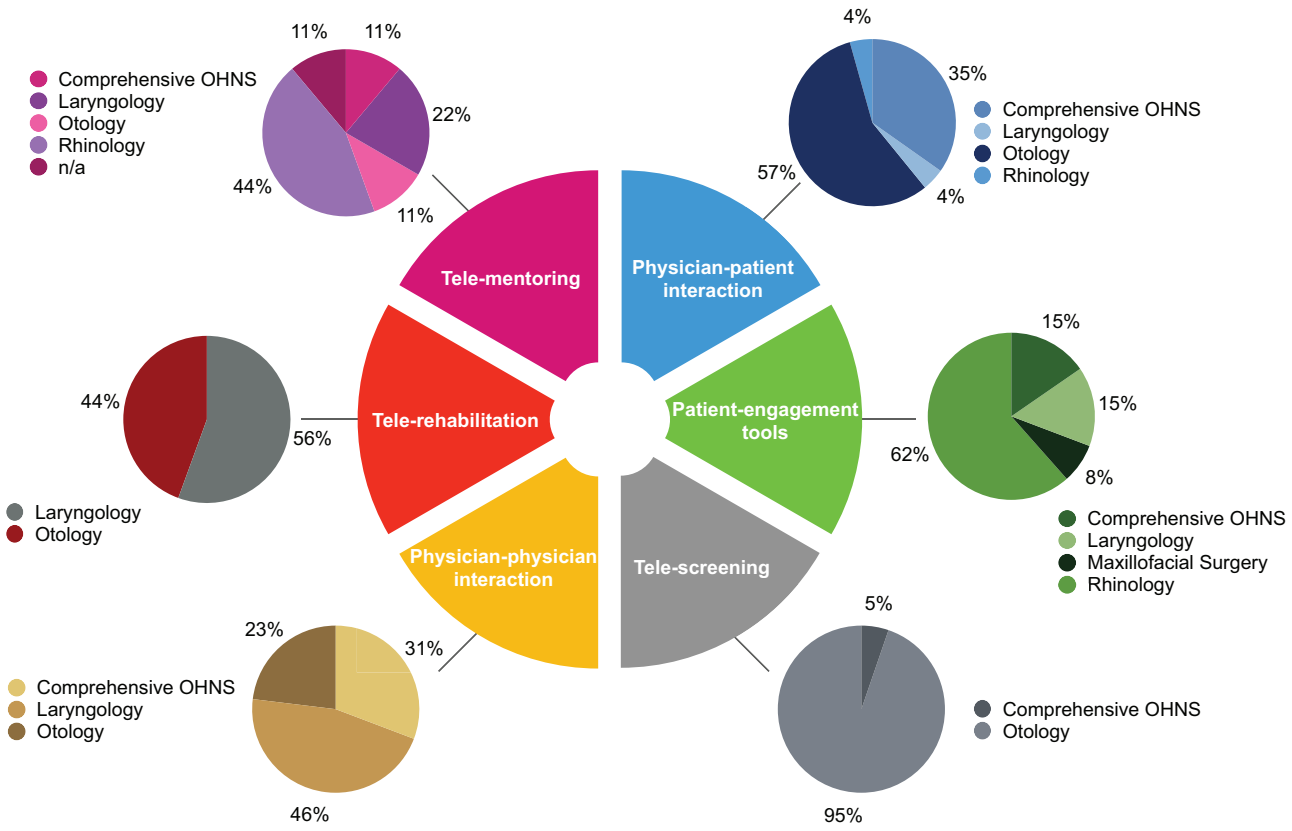

Figure 3. Subdomains of telemedicine applied in each subspecialty. OHNS, otolaryngology–head and neck surgery.

deafness,[53-57,135-140] speech/voice pathology, and dysphagia.[58-64,141-147,154] In articles focused in otology and audiology, tele-rehabilitation groups showed improvement in tinnitus severity,[53-57,136] vertigo severity,[137] and hearing aid problems,[138] with no significant difference in improvements from in-person therapy.[139,140] In articles concerned with the field of laryngology, tele-rehabilitation suggested cost-effectiveness[154] and improvements in vocal fold function, acoustic and physiologic parameters, nodule sizes, patient perceptions of voice-related quality of life,[61] vocal self-evaluation skill,[58] and vocal pattern.[59] Comparable levels of agreement were achieved between online and FTF environments.[60,141-143,145-147] Moreover, a higher adherence rate than that of patient-directed therapy[64] was found. Overall, patient and therapist satisfaction rates on tele-rehabilitation were also high.[59,61-63,65,144]

Telementoring

Nine studies evaluated the concept of telementoring (ie, mentoring by means of telecommunication or computer networks). Detailed results are illustrated in Supplemental Tables S6a and S6b (available online). Overall, results are encouraging and certainly show the feasibility of this approach.[169] When in-person surgical guidance and telementoring endoscopic sinus surgery were compared, no significant differences in clinical outcomes were observed.[170,171] Yet, the authors recommend that only surgeons of a certain training level and experience be telementored intraoperatively when acting as the primary surgeon.[172,173] Telementoring procedures have also been described,[174,175] including intubation, laryngoscopy, otoscopy, and nasopharyngoscopy, and 1 study identified a $25,450 reduction in travel expenses after implementing a tele-clinic,[176] demonstrating the potential of significant financial savings. However, Melo et al found that only the in-person group showed a statistically significant difference in pre- and posttraining performances for the overall score and individual topic scores when compared with remotely trained community health workers for nonprocedural tasks.[177]

Discussion

This scoping review of the literature provides an up-to-date summary of the current applications of telemedicine in otolaryngology and rhinology in particular, including the latest studies on the widespread use of telemedicine during the COVID-19 pandemic.[155-168] We aim to discuss our results related to the various subdomains that we have identified to appreciate the extensive work that has been done in this field. Interestingly, subspecialties focused on different subdomains of telemedicine, as summarized in **Figure 3**.

VE is one of the oldest and most common applications of telemedicine in otolaryngology, and coincidentally, most articles in telemedicine focused on this and related strategies. When VE was compared with in-person appointments, results

were promising,[18,76-79,82,86-108,112-117,122,123,151] with only a few studies reporting discrepancies.[81,109,118] Most studies demonstrated moderate (κ = 0.41-0.60) to substantial (κ = 0.61-0.80) diagnostic agreement between VE and FTF evaluations.[25,82,84,87,88,91,92,114-117,121,124,148-150,160] A major issue is the quality of the physical examination being conducted remotely, which obviously has a lot of limitations.[6,8,17,25,28,29,89,96,121,124,156] However, VE has been found to expand health coverage, prevent unnecessary visits, and save travel costs.[7,8,11,13-15,17,19,23,38,68,70,86,152-155] With the development of adaptors for mobile-based endoscopes, mobile/internet-based patient engagement platforms, and internet-based examination and analysis software, the applications of VE will be advanced.

The use of patient engagement tools was most widespread in rhinology, possibly because the subspecialty deals with the management of many common chronic conditions. Regardless of subspecialty, studies have shown that these tools can enhance diagnostic accuracy, management, and follow-up efficacy, as well as facilitate more efficient communication and improve adherence to medications.[27,30-34,66,69,125,126] Tele-rehabilitation has been applied in most subspecialities. One study investigated the feasibility of providing therapy via a mobile app,[58] pointing toward the likely future applications of many tele-rehabilitation services. With the development of interactive smart tools and artificial intelligence, tele-rehabilitation in times ahead may not even require a therapist but deal with many common tasks via programmed branching logics and permutations.

Tele-screening has been applied for screening of otologic conditions, in particular the remote screening of hearing disorders, mainly in the pediatric population.[42-48,50-52,71,72,132-134] It is another subset of telemedicine that has been increasingly incorporating automated algorithms to aid with its purposes. Results show great potential for tele-screening in rural communities with regard to the demonstrated testing reliability of remote hearing tests, cost-effectiveness, increase in the local screening rate, and efficient referral workflow. While tele-screening is still limited on the global level, this concept and the related technologies have a huge potential for more widespread use.

Tele-consultation has been utilized among providers within[36-40,130] and beyond[35,127-129] the confines of the country. It is also useful in connecting ENT providers with those from different specialties in emergency situations or when a complex case is encountered requiring multidisciplinary care,[4,41,131] underscoring its potential in the field of otorhinolaryngology.

Telementoring is another subdomain of telemedicine that we identified, and studies show that this can be an invaluable tool for the training. Surgical telementoring was mainly utilized and tested within the field of rhinology.[169-173] While studies show a positive experience, many identify the balance between high-quality video/audio transmission and reduction of lag time as a key challenge, but technological advances should easily overcome this in the years to come. It is intriguing to imagine that commercially available technologies, such as augmented or virtual reality, will be implemented in the use of surgical telementoring in ENT. Other technologies, such as Google glasses, allow for visualization of the entire operating room, which provides the mentor with the important aspect of situational awareness. Furthermore, with holistic projection of augmented or virtual reality via the glasses or on the screen, this may enhance the mentoring experience. While only a few articles reported the feasibility of tele-education in the field of otolaryngology so far,[174-177] this area of research shows great potential. One limitation is that surgical specialties, including ENT, require a high level of hands-on experience and FTF teaching for the initial period of surgical training. However, for training and mentoring the advanced surgical trainee, this concept represents an extremely useful adjunct in the education of the next generation of surgeons and physicians.

Taking all this into account, different subdomains of telemedicine have been assessed for different measurable outcomes. The most commonly investigated outcomes that we encountered during our analysis were feasibility, cost-efficiency, patient and/or physician satisfaction, waiting time, concordance between remote and local physicians, validity, reliability, and diagnostic accuracy of telemedicine. Interestingly, we observed a wide range of mean ages of adult patients surveyed, from 20 to 66 years,[12,21,23,61-63,70,73,76,79,156,166] and some studies also examined satisfaction among older patients. Moreover, various studies on the pediatric population reported parent satisfaction.[26,42,48,65,95] On the whole, the majority of patients have been pleased with their telemedicine experience, especially with the reduced traveling costs. The introduction of new telemedicine platforms and familiarization with these technologies for other purposes in daily life will facilitate the encounters and certainly improve patient satisfaction.

While this review aims to provide a detailed overview of the current applications of telemedicine in otorhinolaryngology, there are limitations. Due to the broad nature of the question and the fact that the quality of published data is limited and heterogenous, a systematic review could not be performed; hence, a more limited review (ie, scoping review) was conducted.

While it appears that telemedicine has more advantages than disadvantages, this approach must continue to be critically appraised, and more rigorous research needs to be conducted and demonstrate patient benefit at high levels of evidence to allow for its widespread adoption. While telemedicine does reduce traveling costs for patients and provide outreach care for those in rural areas, the patient must be aware of and consent to many limitations. Moreover, patients may prefer FTF appointments as they can facilitate the encounter by building a better rapport between the patient and the physician. Certain aspects of the clinical evaluation, such as endoscopies, will yield more information if performed by an experienced health care provider FTF, rather than by patients themselves. Details lost in the transmission of audio and video data is also a problem, as the physician's perception and understanding of the patient can be limited by the

technical quality of the VE. Moreover, some patients may not have access to such technology. All examinations, as far as the VE allows, should be standardized for all examination and analysis devices that can be self-administered by patients at home. The active engagement of patients in familiarizing themselves with the newly devised systems is crucial to allow providers to make accurate diagnoses.

The telemedicine market has shown exponential growth in recent years, but at the same time it is important to ensure security and privacy for the patient by the use of HIPAA-compliant systems (Health Insurance Portability and Accountability Act) that are integrated in the existing patient management software. This will allow for possible recording of parts of the examination and/or photodocumentation and will facilitate billing and coding. While telemedicine allows for easy access to care, licensing requirements need to be taken into account, in particular for patients who live in other states and who have never presented FTF in the state for which the physician's license has been granted.

Implications for Practice

COVID-19 has brought telemedicine center stage, but many studies had already demonstrated the huge potential of this concept. From VE to tele-education, telementoring, and platform development to allow for self-examination and rehabilitation at home, telemedicine is here to stay and will be further developed in years to come.

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Author Contributions

Angela Yang, design, data acquisition, data analysis and interpretation, drafting, revision; **Dayoung Kim**, design, data acquisition, data analysis and interpretation, drafting, revision; **Peter H. Hwang**, conception, design, data interpretation, revision, final approval; **Matt Lechner**, conception, design, data interpretation, revision, final approval

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Supplemental Material

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