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Mobile Technology-Based Real-Time Teleotolaryngology Care Facilitated by a Nonotolaryngologist Physician in an Adult Population

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Abstract

Objectives: Telehealth can improve access to specialist care. Very few reports of the use of smartphones for teleotolaryngology exist. The objective of this study is to evaluate the use of mobile teleotolaryngology facilitated by a nonotolaryngologist physician.

Methods: A prospective study in adult patients attending a general otolaryngology outpatient clinic. The telehealth encounter with a remote otolaryngologist was facilitated by a final-year medical student simulating a general physician prior to the scheduled visit. The patient and the remote otolaryngologist rated their satisfaction with the encounter. The remote otolaryngologist formulated a diagnosis and rated the level of certainty of this diagnosis. Diagnoses from the telehealth encounter and the face-to-face encounter were compared.

Results: Forty-eight patients with an average age of 42.5 years participated in this study. In 79.2% of the consultations, there was concordance between the diagnoses. The average patient and remote otolaryngologist satisfaction with the encounter was 9.5 ± 0.9 and 8.7 ± 1.3, respectively. Twenty-four of the 48 visits (50%) were defined as unnecessary. In the otology group, concordance rates and rates of preventable visits were highest.

Conclusions: Synchronous telehealth consultations, facilitated by a general physician, can be an alternative to visiting a general otolaryngology clinic, especially for otologic patients.

Keywords

telehealth, telemedicine, telecare, smartphone, otolaryngology

Introduction

"Telehealth is the provision of health care remotely by means of a variety of telecommunication tools, including telephones, smartphones, and mobile wireless devices, with or without a video connection."[1] There is considerable international interest in the potential of telehealth to improve the convenience, quality, safety, and cost-effectiveness of health care.[2] Telehealth can improve access to health care, increase efficiency, and more evenly distribute specialty care.[3] Despite a large number of studies and systematic reviews on the effects of telehealth, high-quality evidence to inform policy decisions on how best to use telehealth in health care is still lacking.[4]

One review of more than 150 articles concluded that potential effectiveness could only be attributed to teleradiology, telepsychiatry, transmission of echocardiographic images, and consultations between primary and secondary health providers.[5] A review analyzing the suitability of telehealth as an alternative to face-to-face encounters concluded that establishing systems for patient care using telecommunications technologies is feasible; however, the results were inconclusive regarding clinical benefits and outcomes.[6] Major obstacles in the areas of reimbursement, legislation, and malpractice regarding telehealth remain to be surmounted.[3]

Telehealth can be either interactive (synchronous) or delayed (asynchronous).[3] In an asynchronous consultation, relevant information is collected and forwarded to a remote specialist. A synchronous consultation attempts to parallel the doctor-patient encounter. Ideally, this would consist of

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high-resolution video conferencing and some remote control of diagnostic tools that can be operated either by a remote health care professional or directly by the patient.

In the near future, many medical advances will probably be linked to smartphones, which 90% of the world population will have by 2020.[1] There have only been limited reports regarding the use of telehealth in otorhinolaryngology (teleotolaryngology), and very few reports of the use of mobile technology for teleotolaryngology exist.[7-9] Pedersen et al[10] and Pedersen and Holand[11] described the use of endoscopic cameras and videoconferencing systems. Other reports of teleotolaryngology have described specific services related to military medicine,[12,13] the use of prerecorded still images for clinical assessments,[14-16] and diagnostic accuracy.[17] Smith et al[18] found that videoconferencing is an effective method of assessing ear, nose, and throat conditions of pediatric patients and for prescreening potential surgical admissions to a tertiary hospital. An additional study comparing pediatric patients seen via video conference and in person found that the diagnosis was the same in 99% of cases and surgical management decisions were the same in 93% of cases.[19] It has also been found that asynchronous teleotolaryngology is well suited for the diagnosis and treatment of ear disease and can improve access to care, reduce wait times, and decrease travel-associated costs for patients.[20-22] Smith et al[23] found that in a pediatric population, a telehealth-enabled screening service improved access to specialist care in the community and resulted in fewer outpatient and surgical appointments at a tertiary center.

The objective of this study was to evaluate the feasibility and efficacy of mobile teleotolaryngology combined with videoconferencing and facilitated by a nonotolaryngologist physician in adult patients attending a general otolaryngology outpatient clinic. This technology has the potential to enable populations currently challenged by reduced access to specialist otolaryngology care to receive such care.

Methods

This was a prospective comparative study that was conducted between November and December 2016 in the otolaryngology outpatient clinic of the Ziv Medical Center in Safed in Northern Israel. All patients aged 18 years and above attending the clinic for a doctor's appointment were eligible to be included in the study. Study population included patients referred by family physicians or otolaryngologists from the community, patients after hospitalization, and pre- and postoperative examinations. Postoperative examinations were included although seemingly in these cases the diagnosis is clear. It was felt that in many cases these are visits that could be rendered unnecessary and the operative diagnosis is normal postoperative status, as opposed to a complication requiring further intervention. Demographic data were collected. All diagnoses were included. Patients were approached individually by the first author (R.Y.) after office registration while waiting for their appointment. Due to the cultural diversity of the population, it was deemed inappropriate to use a script to introduce the study. After recruitment, all participants received a full explanation from one of the investigators and signed an informed consent. Patients refusing to sign informed consent were excluded.

The telehealth encounter was conducted prior to the scheduled visit in a separate dedicated room in the outpatient clinic. In addition to the patient, a final-year medical student and a supervising otolaryngology resident were also present in the room. A full history of the presenting problem was taken during a video conference with 1 of 2 remote specialist otolaryngologists (S.B., P.G.) that was conducted using the freely available, web-based, real-time communication application software Skype, version 6.19 (Microsoft Inc, Redmond, Washington, USA), which we ran on a 13-inch, mid-2012 Mac book pro (Apple Inc, Cupertino, California, USA). Due to security and privacy considerations, no recordings of the remote consultations were made. Images were captured using an LG G2 D802 32GB smartphone (LG Electronics Inc, Seoul, South Korea) with a built-in 13-megapixel camera with autofocus, macro mode, and zoom functions and video (1080p@60fps), HDR, and stereo sound. A Clearscope smartphone endoscope adaptor (Clearwater Clinical Ltd, Ottawa, Ontario, Canada) coupled the smartphone to a standard 4-millimeter, 0° angle, 175-mm rigid endoscope (Jedmed, St. Louis, Missouri, USA). A portable battery-powered LED light source (Karl Storz, Tuttlingen, Germany) was used. The focused examination was conducted by a final-year medical student supervised by an otolaryngology resident, according to the specifications of the remote specialist otolaryngologist. The final-year medical student performing the examination simulated a nonotolaryngologist general physician who would have been trained and authorized to use the diagnostic equipment previously described. Supervision of the medical student was required by the institutional ethics committee. Video images of the areas (external auditory canal and tympanic membrane, nasal cavity, mouth, and oropharynx) specifically requested by the remote otolaryngologist were streamed live using the freely available, web-based application Vysor, version 1.0.0.8, which enabled us to mirror the screen of the smartphone to the computer using the share screen option in Skype. The remote otolaryngologist could offer guidance during the acquisition of the video images. Results of hearing tests and other relevant documents were transmitted via the video conference. Internet connection was obtained using the public Wi-Fi network of Ziv Medical Center. Following the telehealth encounter, the patient and the remote otolaryngologist were asked to rate their satisfaction with the encounter on a visual

analogue scale (VAS), ranging from 1 for not satisfied at all to 10 for highly satisfied. The remote specialist otolaryngologist was requested to formulate a diagnosis and rate the level of certainty of this diagnosis using the same VAS. In addition, the remote otolaryngologist was asked to assess whether the encounter could have taken place as a remote encounter, thus enabling the patient not to travel to the hospital.

Subsequently, the patient proceeded to the scheduled face-to-face encounter with a staff otolaryngologist who was either a specialist otolaryngologist or a resident otolaryngologist supervised by a specialist. None of the health care professionals participating in the remote encounter took part in the face-to-face encounter. Diagnoses from the telehealth encounter and the face-to-face encounter were compared. Although treatment was not assessed in this study, all treatment was given according to the face-to-face diagnosis.

Institutional ethics committee approval was obtained (Ziv Medical Center Ethics Committee Reference No. 0046-16-ZIV), and all procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation and the Declaration of Helsinki.

Statistical Analysis

Descriptive Statistics

For categorical variables, summary was provided giving sample size, absolute, and relative frequencies. For continuous variables, summary was provided giving arithmetic mean (M) and standard deviation (SD). Pearson's chi-square was applied for testing the correlations between the study's different categories of patients for the categorical parameters. Kruskal-Wallis nonparametric tests were applied to measure the differences between the 3 groups. *P* values of 5% or less were considered statistically significant. The data were analyzed using SPSS, version 24 (SPSS Inc, Chicago, Illinois, USA).

Results

Forty-eight patients participated in this study. The overall participation rate was 4.9% of all patients attending the clinic during the study period. No data were collected regarding those who were not requested to participate in the study or those who refused to do so. Table 1 summarizes the participant demographics. All patients completed both remote and face-to-face consultations. Of the 48 participants, 22 (45.9%) had otologic complaints, 16 (33.3%) had rhinologic complaints, and 10 (20.8%) had complaints involving the neck, pharynx, or larynx. Thirty-one (64.6%) of the visits were regular consultations not related to recent or planned surgery, 10 (20.8%) of the visits were for postoperative care, and 7 visits (14.6%) were for preoperative evaluation. Table 2 summarizes the agreement between diagnoses, patient and physician satisfaction with the remote visit, level of confidence in diagnosis, and proportion of preventable hospital visits in different categories of patients (ear, nose and sinuses, pharynx, larynx, and neck). All visits with disagreement regarding diagnosis were designated as visits that could not have been prevented.

Table 1. Demographic Data of Participants.

Age (y, M ± SD)	42.5 ± 18.0
Gender, No. (%)	
Male	24 (50.0)
Female	24 (50.0)
Ethnicity, No. (%)	
Jewish	31 (64.6)
Other	17 (35.4)

Discussion

Despite Israel being a relatively small country, several subpopulations including prison inmates, soldiers, those in remote rural locations, and the physically disabled still suffer from limited access to specialty care. Telehealth has the potential to solve this problem. Otolaryngology has been found to be a field that is compatible with telehealth consultations.[10-23] Biagio et al[24] found that a telehealth facilitator with limited training can acquire high-quality video-otoscopy recordings in children for asynchronous diagnosis. Substantial agreement was found between diagnoses made from video-otoscopy recordings and those from onsite otomicroscopy.[24,25] In a recently published study, Kohler et al[26] have shown that electronic consultations in an otolaryngology practice can lead to decreased wait times and added value for primary care physicians and patients.

The very few reports of the use of mobile technology for tele-endoscopy[7-9] have been mainly technical in nature, demonstrating the high quality of images obtained in this fashion. This is the first study to evaluate the feasibility and efficacy of mobile teleotolaryngology facilitated by a non-otolaryngologist physician in adults attending a general otolaryngology outpatient clinic.

In the otology group, the concordance rates were highest, followed by the rhinology group, and lowest in the pharynx and neck group. The overall high concordance rates stem, in our opinion, from the ability of the remote physician to take a full medical history directly from the patient through video conferencing. In addition, the physical examination images were acquired in real time, and the remote physician was able to guide the performance of the examination.

Table 2. Concordance Between Diagnoses, Patient and Physician Satisfaction With the Remote Visit, Level of Confidence in Diagnosis, and Proportion of Preventable Hospital Visits in Different Categories of Patients.

	Total	Ear/Vestibular	Nose/Sinuses	Neck and Pharynx/ Larynx	P^a
Patients, No. (%)	48	22 (45.9)	16 (33.3)	10 (20.8)	
Age (y, M ± SD)	42.5 ± 18.0	44.1 ± 20.4	34.2 ± 11.7	52.0 ± 16.3	.075
Preventable visit, No. (%)	24 (50.0)	15 (68.2)	8 (50.0)	1 (10.0)	.009
Concordance between diagnoses, No. (%)	38 (79.2)	19 (86.4)	13 (81.3)	6 (60.0)	.329
Patient satisfaction (1-10, M ± SD)	9.5 ± 0.9	9.7 ± 0.7	9.3 ± 1.2	9.5 ± 0.7	.379
Physician satisfaction (1-10, M ± SD)	8.7 ± 1.3	8.6 ± 1.3	8.9 ± 1.0	8.5 ± 1.5	.873
Confidence in Skype diagnosis (1-10, M ± SD)	8.3 ± 1.4	8.4 ± 1.5	8.4 ± 1.2	7.9 ± 1.8	.732

[a]Differences between the 3 study groups.

The cost of the smartphone endoscope adaptor used in this study was approximately 400USD. This enabled us to construct a cost-effective device for the acquisition of images. All software used for image transfer and for video conferencing was free of cost.

It is interesting to note that despite these generally high concordance rates, the proportion of visits that could have been prevented was significantly lower than expected. This results from 2 main limitation of the telehealth encounter. The first limitation is the occasional necessity to perform a diagnostic and/or therapeutic procedure, such as cerumen removal. The second limitation is the lack of ability to perform a hands-on physical examination and thus obtain tactile information. This was especially evident in cases of cervical masses, where tactile information is of paramount importance.

It is of note that we used a rigid endoscope only. The smartphone endoscope adaptor can also be coupled to a flexible endoscope that could facilitate laryngeal examination. In this study, many of the patients with laryngeal complaints could not be examined, resulting in a low rate of preventable visits. The rigid endoscope was easily used by a nonotolaryngologist with minimal training and with almost no learning curve. It is possible that the use of a flexible endoscope might require more rigorous training.

As has previously been demonstrated by Smith et al,[18] patient feedback regarding telehealth consultations is overall very positive. In this study, patient and physician satisfaction were high in all groups of patients.

In several cases in this study, medical documents and images, for example audiograms, were shown to the remote physician through video conferencing using the computer's built-in web camera. It is obvious that an infrastructure enabling the remote physician to view medical records, prior test results, and especially imaging needs to be in place. In addition, issues of patient confidentiality and information security need to be addressed.

In this study, the remote examination simulated an examination performed by a nonotolaryngologist general physician, such as might be found at remote locations such as prisons or military bases. The final-year medical student performed the examination under the supervision of a resident and required only very brief instruction to perform the examination satisfactorily. It is not inconceivable that in the near future, technology enabling patients to perform ear self-examination at home or parents to examine children's ears will exist and thus widen the scope of teleotolaryngology. Indeed, such technologies for the acquisition and transmission of otoscopy images by parents already exist.[27]

There are some limitations to this study. The study was conducted in 1 medical center. The participants were culturally diverse, with an average age of 42.5 years and did not include children. For these reasons, our results may not be generalizable to a wider population. The mix of patients in our outpatient clinic is predominantly otologic due to the nature of our practice and the subspecialties of our physicians. It is conceivable that with a different mix of patients, the results would have been different. Enrollment in the study was voluntary, and therefore participation may have been biased toward patients with strong negative or positive feelings regarding telehealth. Patient and remote otolaryngologist satisfaction were measured by a single question and therefore may be less reliable. Recruitment was performed intermittently during the study period, and therefore the overall participation rate was relatively low. Due to the fact that no data were collected regarding those not approached or refusing to participate, we cannot be sure that the results were not biased toward a certain subgroup. The telemedicine consultation was conducted at the outpatient clinic, immediately prior to the face-to-face encounter, and as such might not have been perceived by the patients as a "true" telemedicine encounter. However, we believe that the conditions of the test reliably simulated the conditions of a telemedicine encounter. Finally, due to budgetary limitations, this was a pilot study with a restricted number of participants.

Conclusions

We found high rates of concordance between the diagnosis reached by the remote physician and the face-to-face physician in otologic patients. Concordance rates for nose and

sinus patients were moderate, and for neck/pharynx/larynx patients they were low. Patient satisfaction with the remote encounter was also high, as were the satisfaction of the remote physician with the telehealth encounter and the level of confidence in the accuracy of the diagnosis. Overall, 50% of the encounters were defined as visits in which the patients' arrival at the hospital was unnecessary. In the otology group, 68.2% of the visits could have been rendered unnecessary. This is the first study to examine the feasibility and efficacy of mobile teleotolaryngology combined with video conferencing and facilitated by a nonotolaryngologist physician in adult patients attending a general otolaryngology outpatient clinic. We conclude that smartphone-based, synchronous telehealth consultations facilitated by a nonotolaryngologist physician can be used effectively as an alternative to a general otolaryngology outpatient clinic visits, especially for otologic patients. This has the potential to substantially reduce patients' waiting times and travel costs without compromising the quality of medical care.

Declaration of Conflicting Interests

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