ORIGINAL RESEARCH

Traveling an Audiologist to Provide Otolaryngology Care Using Store-and-Forward Telemedicine

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Abstract

This project increased access to otolaryngology services by having an audiologist travel to remote Alaska and communicate with an otolaryngologist using store-and-forward electronic consultation. The audiologist was instructed to effectively image appropriate parts of the otolaryngology exam and create telemedicine cases that included clinical histories, images, audiograms, tympanograms, otoacoustic emission testing and/or other documents. The otolaryngology consultants reviewed new referrals as well as follow up cases and made treatment and triage recommendations. Over a 57 month period, 54 trips were made to 14 villages providing 197 clinic service days. The 1,458 patient encounters resulted in referral for surgery or special diagnostic testing 26%, referral for monitoring 23%, starting of medications 19%, referral to regional ENT clinic 15%, and referral to another specialty 5%. Approximately 27% patients did not need to see the otolaryngologist and were triaged out of the specialty clinic. The total cost to run this project was $141,114. Travel was prevented for 85% encounters, resulting in travel cost avoidance in airfare of $496,420. These services were provided at a significantly lower cost and with fewer burdens to the patients when compared to the standard referral system. An audiologist that travels to remote locations and uses store-and-forward telemedicine can rapidly deliver otolaryngology services. This model is a proven mechanism of efficient healthcare delivery that may be expanded to other specialties.

Key words: *audiologist, otolaryngology, store-and-forward, telemedicine*

Introduction

Delivering specialty care to patients in remote areas of Alaska is challenging. With 586,000 square miles and a population density of 1.1 persons per square mile,[1] the distance that separates patients and providers creates a significant obstacle. Seventy-five percent of Alaskan communities are not connected by a road to the nearest hospital. The Alaska health system relies heavily on traveling patients great distances, usually by air, to see a provider. The system is successful, yet burdened with high travel costs, frequent missed appointments, and imperfect triage, leading to situations where medical conditions may worsen while patients wait to gain access to the appropriate provider.

Since 2002, store-and-forward telemedicine has been steadily integrated into the care delivery plan at the Alaska Native Medical Center (ANMC), a tertiary referral center in Anchorage, Alaska. ANMC is able to receive telemedicine "cases" from more than 200 sites in rural Alaska. These cases may originate in a small village clinic by a community health aide or in a rural hospital by primary care physician, midlevel provider, or audiologist. This project takes this concept a step further, by having an audiologist travel to remote regions of the state and empowering her with telemedicine access to the otolaryngology department at ANMC.

Otolaryngologists and audiologists have a history of collaborating in the care of patients with ear and hearing problems. Telehealth has many potential uses for audiologists, including enhancing communication and care planning with otolaryngologists.[2] This potential has been realized in Alaska, where audiologists based at rural hospitals use store-and-forward telemedicine to electronically transmit clinical histories, hearing assessment data, and images of the tympanic membrane (TM) to otolaryngologists for consultation. These audiologists and ANMC have used telemedicine for hearing aid medical clearance, postoperative follow-up, medical management of ear and hearing problems, and referral for surgical procedures.[3]

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The State of Alaska realized the need for audiology access in rural areas, and in the 1970s attempted to address this need by sending audiologists to remote villages to offer some services and to refer patients to otolaryngologists when necessary. While successful in improving access for rural patients, this program eventually ceased due to difficulty in justifying costs, recruiting audiologists, and providing specialist support.

In view of the need for audiology and otolaryngology services in remote Alaska and the successful experience of hospital-based audiologists acting as telemedicine "case originators," a traveling outreach project was envisioned. This project was designed to train audiologists in the use of telemedicine and to send them to remote villages to provide hands-on audiology services and telemedicine otolaryngology services by rapid case review and communication with a distantly located otolaryngologist.

Methods

This project focused on two regions of western Alaska. Village clinics were included if they desired participation, had accurate listing of referrals from primary care providers, had wide area network connectivity, and did not have regular access to audiology and otolaryngology services.

The audiologist received training on use of the AFHCAN tConsult software (Alaska Native Tribal Health Consortium (ANTHC), Anchorage, AK) and carts that included a video otoscope, digital camera, and document scanner. The video otoscope consisted of an AMD/Welch Allyn 300S Imaging and Illumination Platform (AMD Telemedicine, North Chelmsford, MA) with Solarc lamp as an EPSON Perfection 1240 or 1250. The audiologist also used an Interacoustic Audio Traveler AA222 audiometer (with built-in tympanometer) (Interacoustics, Eden Prairie, MN) and a Biologic AuDX Portable otoacoustic emission (OAE) testing unit (Natus, San Carlos, CA).

The audiologist was trained to perform a sufficient ear-nose-throat (ENT) examination. Guidance was provided on acquiring a history and presentation of audiologic data relevant to the patient complaint. For TM imaging, instructions included patient positioning, proper operation of the video otoscope, image capture, and standards for acceptable images. For the digital camera, instructions included appropriate techniques of facial, oral, and oropharyngeal imaging.

The audiologist was scheduled to see patients for several days in a week, and each appointment was planned for 30 minutes. For each encounter, the audiologist reviewed the referral information and took a clinical history based on ENT guidelines. Video otoscope images were taken of the TMs and digital camera images were taken of the oral cavity, oropharynx, face, or scalp as needed. Audiologic diagnostic tests including audiograms, tympanogram, acoustic reflexes, and OAEs were performed at the discretion of the audiologist. Chief complaint and clinical information were entered directly into the AFHCAN tConsult software. Video otoscope images were saved as 24-bit color Joint Photographers Expert Group visually lossless images with 640 × 480 pixel resolution, and typically compressed at a 13:1 ratio. Paper documents such as audiograms, tympanograms and clinic notes, labs, etc., were scanned and saved as Portable Network Graphics (PNG) compressed image files.

All data and images were transmitted to the otolaryngology department at the ANMC. Cases were viewed on a standard laptop computer using the AFHCAN tConsult software. Responses were transmitted back to the audiologist and included recommendations for medications, surgery, follow-up, or referral to other specialties. The audiologist worked with the village clinic staff to carry out the recommendations. All telemedicine cases were archived in the software (to facilitate follow-up) so that they were retrievable by the village clinic, audiologist, or ANMC staff. Patients requiring surgery were contacted directly by the ANMC staff and arrangements for surgery at ANMC were made.

Table 1. Clinic Visits by Site

VILLAGE CLINIC	NO. OF TRIPS	NO. OF CLINIC SERVICE DAYS	NO. OF PATIENT ENCOUNTERS
A	15	57	380
B	4	15	98
C	3	13	104
D	5	19	139
E	2	4	45
F	1	2	8
G	2	8	50
H	1	3	25
I	1	2	16
J	3	11	70
K	4	12	100
L	8	31	252
M	3	14	121
N	2	6	50
Total	54	197	1,458

Summary statistics for the clinic visits conducted at each village by the traveling audiologist. (Note: The actual time spent at a village may be longer that the number of actual "clinic days" due to early arrival or late departure from the village clinic).

Table 2. Clinic Visits by Length of Trip

LENGTH OF TRIP (DAYS)	NO. OF TRIPS	% OF TRIPS	NO. OF PATIENTS	% OF PATIENTS	PATIENTS/DAY
1	2	4%	16	1%	8.0
2	10	19%	175	12%	8.8
3	11	20%	255	17%	7.7
4	14	26%	417	29%	7.4
5	16	30%	562	39%	7.0
6	1	2%	33	2%	5.5
Total	54	100%	1,458	100%	

Summary statistics for the length of each clinic visit conducted by the traveling audiologist, as measured by the number of actual days of service delivery at the village clinic (does not include travel time or days of nonservice—e.g., weekends).

Table 3. Clinical Caseload

PATIENTS/ DAY	NO. OF CLINIC DAYS	% OF DAYS	NO. OF PATIENTS	% OF PATIENTS
1	8	4%	8	1%
2	11	6%	22	2%
3	8	4%	24	2%
4	17	9%	68	5%
5	10	5%	50	3%
6	24	12%	144	10%
7	17	9%	119	8%
8	22	11%	176	12%
9	25	13%	225	15%
10	23	12%	230	16%
11	13	7%	143	10%
12	7	4%	84	6%
13	7	4%	91	6%
14	4	2%	56	4%
15	0	0%	0	0%
16	0	0%	0	0%
17	0	0%	0	0%
18	1	1%	18	1%
Total	197	100%	1,458	100%

Summary statistics for the caseload (cases/day) conducted by the traveling audiologist.

The audiologist recorded the duration of encounter, tests performed (e.g., audiogram, tympanogram, OAE), and insurance coverage. The audiologist also selected one or more of seven treatment decisions resulting from the encounter: Medications started, Referred to regional otolaryngology clinic for in-person evaluation, Scheduled for return appointment/ongoing monitoring, Surgery or special testing (computed tomography, magnetic resonance imaging) recommended at ANMC, No further evaluation or follow-up needed, Refer to other specialty and/or Unnecessary case archived without sending.

Project costs were calculated for the audiologist. These included the salary and benefits, airfare, lodging, and per diem for each clinic performed. Estimated "travel costs avoided" were calculated based on the round trip airfare to the nearest regional hospital where otolaryngology and audiology specialty services were customarily offered. For children, travel costs included airfare for the required adult escort. Costs for patient lodging, per diem, and loss of time from employment were not included in the estimate.

Results

The audiologist made 54 trips to 14 different remote villages providing 197 clinic service days over the 57-month period (*Table 1*). The trips varied in duration from 1 to 6 clinic days of service, with the most common being 4–5 clinic days accounting for 56% of all the trips (*Table 2*). Overall, 94% of all clinics were 2–5 days in duration, fitting well within the work week at the site.

Patients ranged in age from 1 to 81 years old, with a mean of 17.9 years and a median age of 10 years. One third (33%) of the patients were 5 years old or younger, and 71% were under 18 and would have required a parent or guardian in the event travel was needed for care. Patients were representative of a disadvantaged population with

approximately 50% covered by Alaska State Medicaid, 28% with no coverage, and 19% with third-party coverage.

A total of 1,458 patient encounters were completed during the 197 clinic service days (*Table 3*). One to 18 patients were seen each day, with an average caseload of 7.4 patients per day. Higher case loads of 12 or more occurred on 10% of the service days and accounted for 17% of the patients. The mean patient encounter time was 34.9 minutes. Shorter appointments (15–20 minutes) and longer appointments (60 minutes) each accounted for 18%.

The vast majority of patients received services related to ear- and hearing-related problems. Almost all patients had audiological testing by receiving tympanometry (89%), audiometry (69%), both (67%), or OAE testing (8%). OAE testing was performed mostly on 2–3-year-olds, with 40% of this age group receiving OAE testing.

Treatment plans or clinical intervention resulting from the audiology encounter and store-and-forward otolaryngology consultation are illustrated in *Figure 1*. While the audiologist had access to telemedicine otolaryngology for all patients, 27% of the encounters were "Unnecessary" and did not require telemedicine to resolve the clinical issue at hand. For these cases, the audiologist could resolve the clinical problem independently, such as a hearing aid adjustment. This percentage also included those patients whose problems had resolved since the time of the initial referral. It also included patients referred to the wrong specialty (for example, a patient with a vision problem referred to Otolaryngology rather than Ophthalmology).

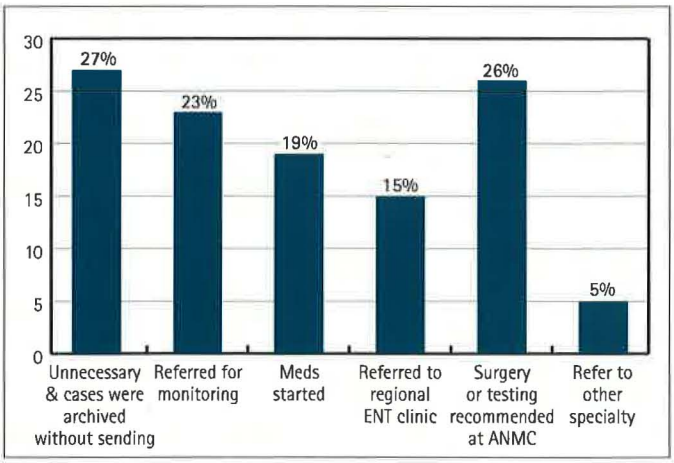

Fig. 1. Treatment plans: The clinical intervention resulting from the traveling audiologist using store-and-forward telemedicine with an otolaryngologist for 1,458 patient encounters. ENT, ear-nose-throat; ANMC, Alaska Native Medical Center.

Twenty-three percent were "Referred for Ongoing Monitoring" and the otolaryngologist recommended repeat examination or testing. A typical case would be one of serous otitis media, where a repeat set of TM images would be requested in 4–6 months to determine whether spontaneous resolution would occur or whether myringotomy and ventilation tube placement should be considered.

Nineteen percent of patients had "Medications Started," most commonly topical ear drops or oral antibiotics.

Fifteen percent were "Referred to Regional ENT Clinic" for an in-person examination. This included cases where more information was needed from a direct in-person examination; the store-and-forward telemedicine case was insufficient to address the clinical question posed. It also included telemedicine encounters that clearly indicated that an outpatient procedure, such as mastoid bowl debridement, was required. Five percent needed to be "Referred to Another Specialty" because of an issue recognized by the otolaryngologist.

Twenty-six percent were able to have "Surgery or Testing Recommended" solely based on the information contained in the store-and-forward telemedicine case. The surgeries scheduled ranged in complexity from tympanostomy tube placement and adenotonsillar surgery to tympanoplasty and mastoid surgery. For these patients, the first face-to-face encounter with the consulting surgeon was the preoperative visit on the day before surgery.

Overall, 67% of the patients seen had a treatment plan developed as a result of the encounter: medications prescribed, a referral made for surgery, or follow-up appointment scheduled for ongoing monitoring of a clinical problem.

The total cost to run this project was $141,114. Approximately 75% of this cost was in hourly charges for the audiologist (including travel hours and direct patient care hours); the remaining 25% was absorbed by costs for travel, lodging, and per diem. Travel was saved for 1,239 (85%) of the 1,458 patients; the other 219 patients were referred to the regional clinic. Most of the patients for whom travel was saved were less than 18 years old (802 or 65%); for these cases, the travel costs for an escort were included. The sum of patient travel costs avoided for the 1,239 patients was $496,420, with a mean value of $401 saved per patient encounter. Of interest, the highest airfare for travel from village to regional hospital that was avoided was $786. Overall, the net project savings was $355,305, which yields a return on investment of 250%.

Discussion

The shortage of physicians and other healthcare workers in Alaska is an ongoing and well-documented problem. Most of the state is designated as a Health Professional Shortage Area.[4] The shortages include

physicians as well as nurses and allied health professionals.[5] The ratio of physicians to population is below the national average (2.05 MDs per 1,000 population in Alaska versus 2.38 U.S.), and Alaska has the sixth lowest physician-to-population ratio in the nation.[6] Forty-nine percent of Alaska's physicians are primary care providers, versus 28% for the rest of the U.S. This lack of access to medical care, particularly specialty care, creates a powerful motivation to develop innovative ways to extend the reach of physicians into rural Alaska.

In this project, an audiologist with additional training in telemedicine techniques was successful in delivering care to rural patients and was able to provide a higher level of service by establishing a link with distant specialists. In this way, a type of "specialty care" was provided to these patients despite the patient never leaving their village or the specialist their office. It is remarkable that only 16% of the patients required a subsequent face-to-face encounter with an otolaryngologist. The fact that the majority of patients could be diagnosed, treated, or effectively triaged speaks to the power of combining clinical information, images, and communication between healthcare providers. These results support previous reports that noted the potential uses of telemedicine in enhancing communication between providers caring for ear- and hearing-related problems.[2,7] Additional tools now being trialed such as store-and-forward video clips and on-demand video teleconferencing may further improve the efficacy of a nonphysician health professional as an extender of specialty services.

Part of the efficacy may be due to the experience of ANMC otolaryngologists in the subspecialty of otology and the use of telemedicine. Due to the high prevalence of ear disease in the Alaska Native population[8] and the fact that all of the otolaryngologists involved in this study had at least 2 years of experience consulting on store-and-forward telemedicine cases, our staff was particularly comfortable using the this modality to diagnose and treat patients with ear disease.

In those cases where binocular microscopy was required, instrumentation of the ear was needed, or a more in-depth interview and examination was requested by the consultant, a face-to-face encounter was still necessary. When using telemedicine to deliver care, the option for a traditional in-person encounter must always be present, even if it is not often chosen as an option. A provider must never feel forced to make a decision based on less than the needed information. Otolaryngologists with less otology experience or less familiarity with telemedicine may have required more in-person examinations than did our group.

It came as a surprise that 27% of patients seen by the audiologist did not result in a case sent to the otolaryngologist. This was due in large part to the number of problems that practicing audiologists handle independently, such as those related to hearing aids. For many of these cases, the referring provider could have sent the patient directly to Audiology rather than ENT. This points out the inherit inefficiency of managing a patient queue, as many of the patients had been on waiting lists for the regional otolaryngology clinic for months. As has been noted by other authors, prolonged wait times and large patient queues lead to much inefficiency, including inappropriate or wasted appointments, which occurred in some cases in this project.[9,10] Store-and-forward telemedicine allows for efficient triage by subject matter experts. This increases the likelihood that a patient will be managed by the appropriate provider, using the best resources, modality, and time frame.

The dramatic cost savings result from avoidance of airplane travel from village to regional hospitals. The cost savings are a conservative estimate, as we did not include patient lodging, per diem, time away from work, or other societal costs. It is also difficult to estimate the cost savings related to earlier diagnosis, and/or reduced morbidity/mortality. Obtaining the consultation from a specialist earlier rather than later helps decrease the number of visits to the local primary care provider—visits that tend to recur as patients wait in a queue.[11] Anecdotally, there were several patients with severe otologic problems diagnosed at an earlier stage for which high-level care, significant disability, and associated costs were avoided (*Fig. 2*).

Finally, for ANMC, this project resulted in substantial savings related to the consultant's time. Using the traditional model of outreach clinics, it would have taken approximately 70 provider days

Fig. 2. Image of a cholesteatoma: An asymptomatic cholesteatoma found during an audiology clinic. After consultant review, the patient was triaged for surgery. Left undetected, irreversible morbidity is likely.

to offer 1,458 appointments, taking into account travel to and from the clinic. An otolaryngologist typically spends about 6 minutes on the computer (mean time) reviewing and responding to a store-and-forward case.[12] For most ear conditions, the telemedicine encounter is equivalent to an in-person examination.[13,14] Therefore, this model of delivering care markedly increases the efficiency and productivity of the consultant. Using telemedicine, the physician spends less time consulting and does not spend time on inappropriate referrals, as they have been screened out. For the participating clinics, the effect of adding these "additional" 1,458 appointments significantly decreased wait times for otolaryngology and audiology services. For the consulting otolaryngologists, this was a relatively easy way to increase the capacity to offer their service, a step noted by other authors as being critical in improving access and decreasing delays for care.[15]

The project also reveals that the costs and savings are distributed in such a way that incentives to expand a successful project such as this are lacking. The costs of this project—audiologist's salary and benefits, travel, equipment, training, network—were all borne by the Alaska Tribal Health System at a variety of locations and levels. The most substantial and notable cost savings were realized by Alaska State Medicaid, who would have otherwise paid the travel costs for almost half of the patients. There is currently no means by which the cost savings enjoyed by one agency can be reinvested to expand a program funded and administered by another.

Disclosure Statement

No competing financial interests exist.

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