

Providing the Best Audiological Care and Creating Sustainability in Peru

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ABSTRACT

International humanitarian programs are one way for individuals within low-income countries to access hearing health care. Faculty and students from the Idaho State University (ISU) Audiology Program have traveled to several locations within less developed countries over the past 15 years. Most recently, the ISU Audiology Program has partnered with Idaho Condor Humanitarian to provide hearing health care services to Peruvian indigenous people. The humanitarian expedition provides medical, dental, and audiology services to rural villages surrounding Cusco, Peru. Each year the ISU Audiology team gathers data on the hearing health care needs of the Peruvian people and fits donated hearing aids. The ISU Audiology team navigates a variety of barriers associated with limited resources to provide quality hearing health care focused on best practice guidelines for the people of Peru. This article highlights the specific needs of the people served, which the team identified and prioritized, as well as initiated a plan for continuing to develop follow-up care and sustainability.

KEYWORDS: humanitarian, Peru, hearing health care, sustainability, best practice

A sustainable health care system including hearing health care is something typically accessible within the United States and other developed high-income countries. At times patients may have to wait longer than they would prefer to see physicians or specialists or pay more than anticipated for services; however, for all intents and purposes, the option of health care, specifi-

cally hearing health care, is readily available. In contrast, what if general health care was not accessible and specialty care was not even an option? Patients in less developed countries experience this on a day-to-day basis. For example, when a child or an adult develops an ear infection in a remote village in Peru, patients and caregivers have very limited avenues to seek out

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medical help. Home remedies may be administered or traditional medicine of the culture may be searched out and used when modern medical treatment is not available. However, research^{1,2} has shown chronic middle ear dysfunction, when left untreated or without proper monitoring, can lead to permanent hearing loss and other complications. Modern intervention would dictate a child with hearing loss, acquired or congenital, would be fit with amplification within weeks, if not days, after diagnosis in the United States when audiotologically appropriate. Early intervention is essential and would begin immediately to avoid a delay in communication development. In contrast, this is not the typical intervention pathway for children who experience middle ear dysfunction and other audiotological ailments in villages of countries that are less developed. Congenital hearing loss is being undiagnosed and conditions that cause acquired hearing loss are being untreated in both children and adults, greatly affecting hearing outcomes.

BACKGROUND

International humanitarian programs are one way for individuals within low-income countries to access hearing health care. As reported by Stringer,³ the traditional model for international humanitarian programs is for foreign professionals to travel to a country with minimal resources for a short period of time, volunteer their expertise in providing direct services, and temporarily alleviate health care needs in a specific community. However, this model is not sustainable as hearing health care is an ongoing need especially when amplification and other technologies are utilized for intervention. Sustainability is possible for humanitarian programs; however, it may not look the same for each international community. To create a sustainable humanitarian program, groups must connect with local communities, communicate with all stakeholders, learn from past experience, and build the program based on the needs of the patients and the community requiring hearing health care.

Faculty and students from the Idaho State University (ISU) Audiology Program have traveled to several locations within less developed countries over the past 15 years. Most recently, the ISU Audiology Program has partnered with

Idaho Condor Humanitarian to provide hearing health care services to the Peruvian indigenous population. Idaho Condor Humanitarian is a nonprofit organization based in Pocatello, Idaho. ISU Audiology has traveled with Idaho Condor Humanitarian for the past 4 years with a goal of providing the best possible audiotological care and creating sustainable hearing health care for the population served. However, creating sustainable hearing health care in an area that has little to no access to medical care is a difficult task. One thing that can be used to help establish sustainability is past experience. Faculty at ISU have gained this experience while participating in medical expeditions which provided audiotological services in Guatemala, Uganda, and Ecuador.

PAST EXPERIENCE

Guatemala. The experience in Guatemala was with a well-established and highly organized international medical expedition group. Since 2003, this medical group and an audiology team traveled annually to the urban town of Antigua, Guatemala. Services are provided from a local hospital. Additionally, other humanitarian groups visit this location annually. Essential hearing health care is provided by trained audiotological providers at least twice a year at this location. The audiology clinic within the Guatemalan hospital includes a quiet location with a sound-treated room, permanent audiology equipment, trained onsite staff, and maintained medical files. Additionally, local hospital staff and volunteers have been trained to help with amplification troubleshooting, schedule biannual appointments for established patients, and identifying individuals within the community in need of hearing health care.

The sustainable program started as most humanitarian programs do, with an initial evaluation of health service needs within the community. With donations of equipment, volunteers, space, and time, the permanent audiology clinic was established over several years. This would be an excellent model for sustainability; however, this model does not fit the needs of Peru. In Peru, the medical expedition moves to different villages each day over a period of a week. Each year, new villages are selected for the expedition and only occasionally the expedition returns to a previous

village. Therefore, the experience gained during the Guatemala medical expedition demonstrates one way of creating sustainability; however, it is not a model that can be applied currently in Peru.

Uganda. The experience in Uganda was limited to one medical expedition traveling to an orphanage outside the capital city of Kampala. The medical expedition had established a good and presumably feasible goal: screen each child to determine who required further audiological evaluation. However, once on site, the group quickly learned that the goals of the expedition were not aligned with the primary needs of the staff and children at the orphanage. Although hearing health care was a need for many children at the Uganda orphanage, it was not the highest priority. At the time of the medical expedition, the children were also completing end of year examinations. Good performance on the examinations was required for students to continue their education, which naturally made attending class a priority. Students did not want to leave class for extended periods to have a hearing evaluation, or return to the clinic for intervention. This experience highlighted the need for extensive, preexpedition communication with all stakeholders, especially the intended population to be served. Over the course of 5 days, 138 hearing screenings and 16 full audiological evaluations were completed. Cerumen management was provided to 35 individuals and one hearing aid was fit. Plans were made to return to the Ugandan orphanage; however, due to the instability of the government at that time, the return trip was canceled.

Ecuador. The experience in Ecuador encompassed one successful expedition with a well-established and organized international expedition group. The medical and audiology team traveled to Ambato, Ecuador, and provided services in the local municipal hospital. Over a period of 5 days, 135 hearing evaluations were performed and 48 hearing aids were fit. In an effort to create sustainability, the audiology team prepared for a second expedition the following year. As the return trip was in the planning stages, the Ecuador government determined medical expeditions were not in the best interest of the country. The government would not allow the group to return. This experience again highlighted the need for international groups to

work with all stakeholders, including the government of the intended humanitarian expedition country.

PERUVIAN HEALTH CARE SYSTEM

The total population of Peru in 2018 was estimated at just over 31 million with close to 78% of citizens residing in an urban city. The remaining 22% lived in rural communities and had limited access to modern health care.⁴ In 2002, the Peruvian government created the Coordinated Decentralized National Health System in an effort to work toward providing comprehensive health care to all Peruvians. According to the Pan American Health Organization⁵ (PAHO) "The health system is structured according to a pluralistic model, with both public and private service providers, and is organized by specialized functions." In 2015, the PAHO⁵ estimated the ratio of health care providers to citizens was only 17.6 per 10,000 persons in rural areas. Many of the Peruvian citizens residing in rural environments receive comprehensive health insurance through Seguro Integral de Salud. According to PAHO,⁵ "Seguro de Salud provides health care to the poor and extremely poor population through the Ministry of Health's network of services. Members receive the services covered under the Essential Health Insurance Plan, together with some additional benefits covered through a special solidarity fund for the treatment of cancer and other high-cost diseases." However, the individuals in these rural villages often live hours away from the nearest health care facility and have limited options for transportation.

As with any aging population, hearing health care remains a significant need. The PAHO⁵ states, "Between 2000 and 2015, the population over 64 years of age grew from 1,235,855 (4.8%) to 2,043,348 (6.6%) of the total population... and life expectancy at birth rose from 70.5 to 74.1 years. In the latter year, 80.8% of older women and 68.0% of older men had some type of chronic health condition, and 45.8% had some type of disability.... Difficulties in the use of arms and legs (33.3%) and impairments of vision (13.4%) and hearing (13.4%) were the leading forms of disability."

However, aging is not the only cause of hearing loss in Peruvian citizens. The PAHO⁵

reported, "In 2015, the Ministry of Labor received 435 reports of occupational diseases, of which 26% were related to noise-induced hearing loss or deafness. That same year, the Ministry of Energy and Mines received 6,708 reports of occupational diseases related to mining, of which noise-induced hearing loss or deafness accounted for 95.2%." Additionally, limited access to health care often results in untreated infections of the outer and/or middle ear.⁶ This could result in fluctuating temporary or permanent hearing loss for both children and adults. In addition, there is no universal newborn hearing screening program in Peru and children born with hearing loss are often not identified until later in life.

Based on the ISU Audiology team's expeditions to Peru and a search of online medical clinics, there are limited options for hearing health care. The capital, and largest city in Peru, Lima, has a hospital that provides audiologic services including cochlear implants; however, reaching that hospital would require a minimum of 24-hour bus ride one way from most of the villages that surround Cusco. A handful of otorhinolaryngology specialists and hearing aid dispensers have clinics in Cusco; however, this would still require a 2- to 3-hour trip for most individuals residing in surrounding villages where transportation options are not easily accessible.

Another aspect of Peruvian culture that guides provision of hearing health care on medical expeditions is the strong family bonds and loyalty to caring for elderly family members. Family is one of the most important and sacred aspects of the Peruvian culture.⁷ As a result, approximately 50% of people in Peru live with extended families. Over the past 4 years, ISU Audiology has observed this first hand, when young adults bring their elderly parents or grandparents to audiology clinics. They request their elderly family members receive services above their own needs. This emphasizes the loyalty to caring for elderly family members.

CURRENT EXPERIENCE: IDAHO CONDOR HUMANITARIAN

Idaho Condor Humanitarian,⁸ a well-established nonprofit organization, travels to Cusco,

Peru, and surrounding villages to provide medical, dental, surgical, and audiological services. According to their Web site,⁸ "Idaho Condor Humanitarian, Inc. is a national non-profit organization dedicated to providing cost-free medical care to the indigent of Peru. The organization is built on the idea that a collective of caring people can affect positive changes on individuals, communities and nations."

Member of the Idaho Condor Humanitarian group have been traveling to Peru for the past 10 years. Each year, a team of health care professionals, interpreters, and student volunteers trek to remote villages to create temporary clinics. Although Idaho Condor Humanitarian is an American-based nonprofit organization, it works closely with local Peruvian physicians to determine which villages are in need of additional health care. The Peruvian physicians also help maintain good public relations between the citizens of Peru and the humanitarian expedition. For example, the Peruvian physicians will meet with the Mayor of each village to discuss the services offered by the medical expedition and obtain permission to come to the village. Idaho Condor Humanitarian also works closely with other government officials to seek the necessary approvals for traveling in-country for the purpose of providing medical services. The local government will then announce the dates of the expedition and each village that will be visited. As a result, some individuals will travel from surrounding areas hours away to come to a village where Idaho Condor Humanitarian is providing services. The Seguro Integral de Salud is also provided information regarding the expedition and may refer patients to come see the "American doctors." Over the past 10 years, Idaho Condor Humanitarian has maintained an outstanding track record of caring for the citizens of Peru, while respecting the customs and traditions, and involving local officials when planning each expedition.

In 2016, Idaho Condor Humanitarian invited faculty and students from the ISU Audiology Program to participate in their annual expedition. Two audiologists and a third-year audiology graduate student set out to establish the need for audiology services and to lay the foundation for future trips. Along with medical and dental professionals, the audiology team traveled

to six different villages and provided hearing health care services to approximately 159 people. Audiology services included otoscopy, tympanometry, cerumen removal, and minimal hearing screenings due to limited access to quiet-test environments in each village. Even though hearing aids were unable to be fit on this inaugural trip, the need for amplification was evident.

ISU Audiology was invited to return for the 2017 expedition. The team consisted of two audiologists, three graduate students, and one volunteer. The team provided much needed hearing health care as well as fit 25 hearing aids. Even though hearing aid orientation was covered and a 1-year supply of batteries was provided, the audiology team recognized that follow-up care was necessary, but unavailable. Creating a plan for follow-up care, particularly for individuals receiving a hearing aid, was the primary focus for future expeditions.

ISU Audiology recently completed their fourth expedition to Peru with Idaho Condor Humanitarian. The team consisted of four audiologists and three graduate students. Each year, the team gathers data on the hearing health care needs of the Peruvian people and fits donated hearing aids. The team has identified and prioritized specific needs of the people served as well as initiated a plan for continuing to develop follow-up care and sustainability.

Student involvement. The goal as university faculty and audiologists is to expose students to working in less-than-ideal environments with limited resources. A goal to foster cultural awareness, interprofessional collaboration, critical thinking, and an attitude of service was also put in place. One of the audiology students who volunteered during an expedition summarized her experience as follows⁹:

This experience was life changing for me—as a student and as a future clinician. I learned what it was like to work under limited conditions, often with no running water, limited electricity, and only the supplies we could carry on an airplane. It really showed me how much good can be accomplished with determination, ingenuity, and a good base of audiological knowledge. We made do with what we had, and most importantly, provided care to individuals who needed it.

Student involvement is important in our humanitarian work; however, it also creates its own challenges. Supervising students of varying levels of experience is difficult in a fast-paced remote clinic. Students who may feel confident in a university clinic may be unsure of this new role and responsibility when the clinic suddenly becomes a room with a simple desk and chair, no sound booth, no clean surface, and no electricity.

Close supervision is necessary, as the primary goal always remains to provide the best care to the patients, whether in Idaho or in Peru. Typically, students become more confident throughout each clinic day, and by the end of the week they are “creating” our clinic space with ease, setting up each workstation, and interacting comfortably with our patients. By the end of the expedition, our students have gained valuable experience related to cultural awareness, critical thinking, flexibility, creativity, and interprofessional collaboration.

Idaho Condor Humanitarian expeditions include a variety of other medical professionals and our collaboration with these providers is crucial. We are conscientious to follow the appropriate line of care when a potential medically treatable problem is identified. One of the advantages of sharing the clinic space with the full medical team is that a consult with another provider is just a few steps away. Recruiting an otolaryngologist or other ear, nose, and throat (ENT) specialty provider, possibly a physician assistant, has become a future goal due to the high number of middle ear diseases and other pathological conditions encountered during each trip.

AUDIOLOGY BEST PRACTICE IN PERU

Audiologists are obligated to provide the best possible hearing health care services using the guidelines set forth by the national organizations.^{10,11} The professional practice guidelines or best practices help hearing health care providers use the appropriate procedures for the diagnosis and treatment of hearing and vestibular disorders in accordance with evidence-based practices. When providing audiologic care within the United States, the professional practice guidelines are easy to follow and allow the provider to optimize patient outcomes. Typically, each

audiologist has the resources needed to perform and provide evidenced-based, quality patient care. However, when traveling to other areas of the world, audiologists may not have the resources needed to provide the same standard of care. For example, the audiologic assessment may not be completed in a sound-treated room and the audiologist must choose the quietest place possible to obtain the necessary audiometric information. Furthermore, portions of the basic assessment, bone conduction and speech testing, are eliminated due to the testing environment. This creates challenges since the type of hearing loss and other factors needed to adequately treat the patient remain unknown. This is only one example of how best practices are modified when resources are limited. On each expedition, the ISU Audiology team navigates a variety of barriers associated with limited resources to provide quality hearing health care for the people of Peru.

Expedition preparation. To overcome the limitations while keeping best practices in mind, the audiology team prepares and plans extensively for the expedition. Adequate preparation allows the providers to consider the potential problems and devise solutions prior to arriving in-country. For example, irrigation is one strategy used during cerumen management; however, the running water available at each village is cold and would be uncomfortable for the patient. Instead of utilizing cold water for irrigation, the audiology team packs an insulated bag to transport hot water from the hotel to the village every day. When the need for cerumen management arises, the hot water is adjusted to the appropriate temperature. In addition, packing lists and inventory spreadsheets have been crucial components of the preparation phase that ensure the team is adequately prepared for each expedition.

Documentation. Another limitation to providing best practices is the ability to document and track patient data. Over the last 4 years, the audiology team has modified and streamlined the documentation process. Prior to 2019, spreadsheets were used to record the procedures performed, test results, and treatment provided for each patient. This tracking system was inefficient, difficult to use, and time consuming. For the most recent expedition, a new documentation and tracking system was

implemented. Basic patient information and audiologic results were documented through a survey program created within Qualtrics and allowed documentation to be completed through the corresponding Qualtrics application on any team member's cellular phone or tablet. Each day, the information was gathered through the offline feature of the application and then uploaded at the end of the day once Wi-Fi was available. Using this method, the process was streamlined for accuracy and efficiency.

Otoscopy. Completing otoscopy is within the scope of practice for an audiologist and is a necessary component of the assessment process. This allows the audiologist or audiology student to examine the outer ear, ear canal, and tympanic membrane. Professional practice guidelines serve as a guideline for the outer ear exam during each expedition to Peru. In this case and with careful preparation, the audiology team has all the resources needed to follow the best practice guidelines. Each provider packs and uses standard otoscopes, while at least three video otoscopes are also available for use during the clinic days. All providers follow strict infection control policies and procedures. Otoscopy is completed on all patients seen by the team with the exception of a few children and those with microtia or complete atresia.

For the 2019 expedition, the audiology team completed an otoscopic examination on 459 ears. A total of 94 ears were identified as partially occluded or occluded with cerumen. Along with the occluded ears, other pathological conditions were noted. Many individuals had scarring, cloudy eardrums, retraction pockets, and perforations. Others had more serious conditions such as drainage, fungus, foreign objects, granulated tissue, infection, and possible cholesteatomas. When a serious condition was identified, the patient was referred immediately to the medical team for evaluation and treatment. In addition, an in-country ENT specialty physician referral was provided to those who needed specialized otologic care. Fig. 1 depicts pictures captured using a video otoscope. The pictures display a few of the pathological conditions seen throughout the expedition. Out of all of the pathologies present, perforations were the most common pathology noted.

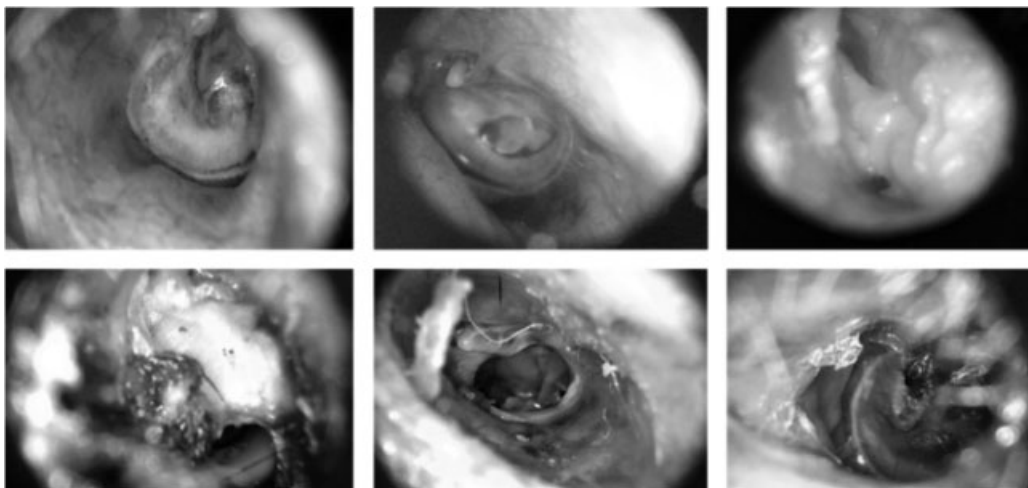


Figure 1 Pathologic conditions captured with a video otoscope during the 2019 medical expedition.

Tympanometry

Tympanometry is an objective measure to assess middle ear function and is an important feature of the evaluation process. Tympanometry helps identify any potential pathological conditions relating to the outer ear, eardrum, and middle ear. When used in conjunction with otoscopy, it is possible to accurately identify perforations, cerumen occlusion, and middle ear disease. Similar to otoscopy, tympanometry is performed on each patient unless there are extenuating circumstances such as atresia or patient refusal.

Each year, an Interacoustics Titan is used to provide a diagnostic assessment of middle ear function. Most patients seen in 2019 had normal middle ear function in both ears; however, several patients had abnormal results. Fig. 2 shows the specific tympanometric types collected over a 2-year span. When compared with the previous data, there is a high percentage of patients who have normal middle ear function or stiff middle ear systems. It is uncertain as to the cause of the tympanograms. Equipment limitations in relation to the high altitude may be a contributing

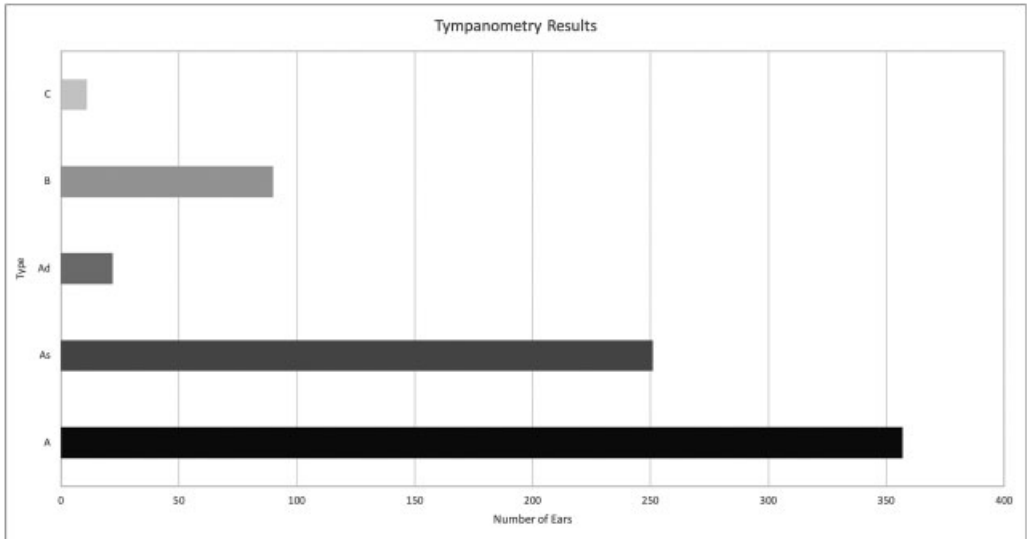


Figure 2 Types of tympanograms collected over a 2-year span, 2018–2019.

factor; however, further exploration is needed on this topic. Patients who have flat tympanograms are either referred to the medical team or to an ENT in Cusco depending on the information gained from otoscopy and case history.

Cerumen removal. In the United States, it is within the scope of practice in most states to remove cerumen for the purposes of evaluation, custom earmold impressions, and the treatment of hearing loss. Three main strategies are utilized to remove cerumen: irrigation, manipulation, and suction. The audiologist must choose the best strategy or combination of strategies for safe and successful removal. The strategy used depends on the consistency of cerumen. In some cases, the wax is impacted with a solid consistency and an over-the-counter solution, such as carbamide peroxide, may be necessary to soften the wax prior to removal. Audiologists should have over-the-counter products, such as oxymetazoline, available to stop bleeding if needed. Finally, strict infection control protocols are followed to prevent the spread of harmful pathogens. All reusable tools are cleaned, decontaminated, and disinfected prior to use on another patient and all tools are cleaned in an ultrasonic system with a disinfectant cleaner at the end of the day.

While in Peru, best practices for cerumen removal are followed and tympanometry is always conducted prior to removal regardless of the

strategy used. On the most recent expedition, wax removal was needed in 94 ears and was removed successfully in the majority of cases. In those individuals in whom the wax could not be fully removed, over-the-counter wax softeners and flushing bulbs were provided with instructions. If possible ear pathology was noted after cerumen management, the patient was referred to the medical team for evaluation and treatment. The number of patients in need of cerumen removal has increased over the last 4 years. This may be due to an increase in the number of patients seen each year and the villages' awareness of the audiologic services provided. Fig. 3 illustrates changes in cerumen management over the last 4 years.

Distortion product otoacoustic emissions. Distortion product otoacoustic emissions are a useful tool for evaluating cochlear function. When in Peru, the Interacoustics Titan is used to assess outer hair cell function in younger patients or those who cannot perform standard behavioral testing. A standard diagnostic protocol is used while in Peru.

Behavioral audiometry. Pure tone thresholds, air and bone conduction, are the gold standard for establishing the degree, type, and configuration of a hearing loss. Within the United States, patients are typically evaluated in a sound-treated room and are required to

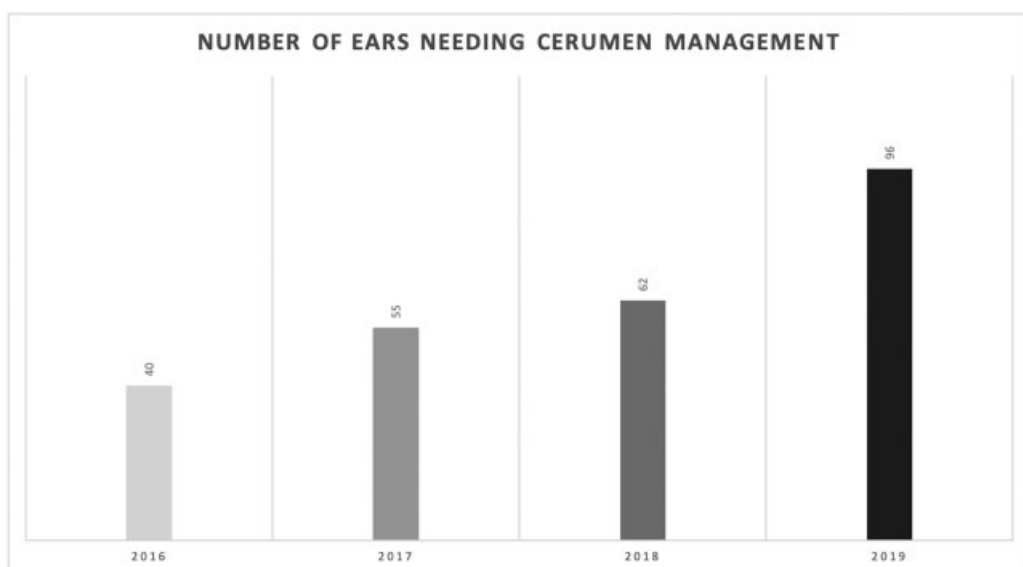


Figure 3 The changes in cerumen management provided during the medical expedition from 2016 to 2019.

provide a behavioral response when a sound is detected. When performing the hearing test, the audiologist assesses hearing acuity for a variety of frequencies including those outside the typical speech frequencies. Patients are encouraged to respond to all sounds no matter how soft or how loud. The thresholds are used to determine whether or not a hearing loss is present and helps guide the audiologist toward treatment strategies. However, while in a less-developed country with limited resources, a hearing health care provider must adapt to the surroundings to gather the necessary information as it relates to hearing sensitivity. Even though the basic procedure for determining thresholds is similar, other confounding factors may influence the results. The test environment, equipment issues, inability to determine the type of hearing loss, language barriers, and cultural differences all contribute to challenges experienced throughout the assessment process. The astute audiologist must find ways to overcome each issue to obtain the most accurate threshold information. If the room noise is too loud, hearing thresholds are likely elevated, especially in the low frequencies. If a patient has a hearing loss and could benefit from hearing aids, the elevated thresholds will influence the hearing aid fitting, resulting in over amplification and reduced hearing aid benefit.

One of the most significant confounding factors identified in Peru is the test environment, which affects threshold determination, frequencies tested, and the ability to determine the type of hearing loss. In Peru, each day is a new experience with a new village. Upon arrival at each village, the expedition leaders must examine the location or building provided for the medical and dental teams. The audiology team must try to find a quiet room or space away from noise sources. On an average day, the team contends with patient noise from the medical team, equipment noise from the dental team, music from a loudspeaker, and music generated from the National Police of Peru Band who entertains the villagers while waiting for medical, dental, or audiologic care. To compensate, the audiology team seeks a room away from the noise sources and completes biological checks for each portable audiometer. The thresholds obtained during a biological check are compared with the known

thresholds of that audiology team member. If needed, correction factors for each frequency are applied. Not only does the test environment affect accurate determination of hearing thresholds but limits the frequencies that can be tested as well. According to best practices, the audiologist should find thresholds for 250 to 8,000 Hz including the interoctave frequencies. Testing all frequencies is ideal but may not be possible due to the test environment encountered during each clinic day. The lowest and highest frequencies, although useful, are typically not evaluated and omitted from the audiogram. To compensate, the audiologist evaluates the frequencies primarily responsible for speech understanding. Fortunately, the “speech bananas” for English and Spanish are quite similar; however, the speech frequencies necessary for the native Peruvian language, Quechua, are not well documented. Quechua is the native language and also refers to the indigenous ethnic groups in South America, especially in Peru.

A noisy test environment eliminates a valuable component of audiometric testing, bone conduction. However, assessing bone conduction in the absence of a sound-treated room leads to elevated thresholds and the conductive component is likely underestimated. In Peru, bone conduction thresholds are not evaluated at this time; therefore, this test does not assist in distinguishing between a conductive or mixed hearing loss versus a sensorineural hearing loss. The audiology team members consider the tympanometric results to help determine the type of hearing loss and treatment options.

Another factor that likely influences hearing thresholds is the language barrier and cultural differences. At times, the audiologist and student question the accuracy of the pure tone audiogram due to the instructions provided. In small villages surrounding Cusco, two languages are spoken, Spanish and Quechua. Therefore, instructions must be translated from English to Spanish and then Spanish to Quechua. Even though the audiology team has a designated English to Spanish translator, it is difficult to maintain a consistent translator who can convey the necessary information from Spanish to Quechua. Hence, the patient may or may not respond when the tone is heard or they may wait until

it is louder prior to responding. If the patient waits to respond, then the thresholds are elevated and inaccurate. To help solve this issue, the audiologist uses verbal instructions as well as demonstrates the task while using a tone of sufficient intensity. In addition, the audiologist may use a hand-over-hand approach to help train the patient to the task. Finally, pure tone testing is not an everyday task for the patients seen in the villages. Many villagers live in remote areas and a hearing test is a new concept, let alone a new experience. Providing instructions in multiple modalities and patience has proven to be the most effective method of obtaining accurate hearing thresholds.

Despite all the factors that influence pure tone thresholds and the challenges in obtaining accurate hearing information, the people of Peru are affected by hearing loss and there is a need for audiologic services. Within the last 2 years, the majority of patients reported difficulty hearing in one or both ears and, when tested, had a measurable hearing loss that could be treated with amplification. Out of the 438 patients seen during the 2018 and 2019 expeditions, 211 participated in a hearing test. The average pure tone thresholds for the speech

frequencies indicated a mild or greater hearing loss in one or both ears. Fig. 4 shows the average hearing loss in the right and left ears from the data gathered in 2019, while Fig. 5 shows the average hearing loss from 2018. Unfortunately, the audiometric data from 2017 could not be included in the averages, as two of the audiology teams' equipment bags were lost in Peru at the end of that expedition, both of which contained the audiograms.

Fitting hearing aids. From data collected and our observations over the last 4 years, hearing loss is prevalent and the effects of hearing loss are noticeable in each village. The patients and loved ones report communication difficulties that affect quality of life. Family members describe scenarios of isolation when a parent or grandparent can no longer hear or when the hearing loss is caused by trauma or a medical condition. Many of the patients seen during each clinic day have hearing loss in both ears and the majority could benefit from hearing aids or other assistive listening devices. Unfortunately, only a limited number of hearing aids are available and the team must determine who receives a hearing aid and who does not. For most team members, this is the hardest decision made on the expedition.

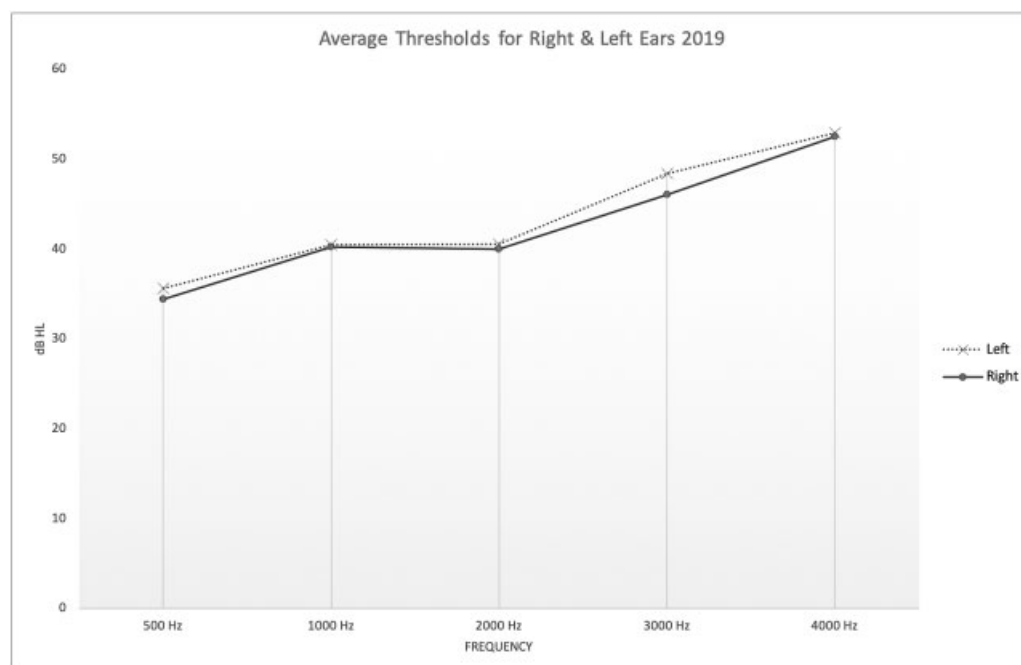


Figure 4 Average hearing loss in the right and left ears ($n = 107$) from the 2019 medical expedition.

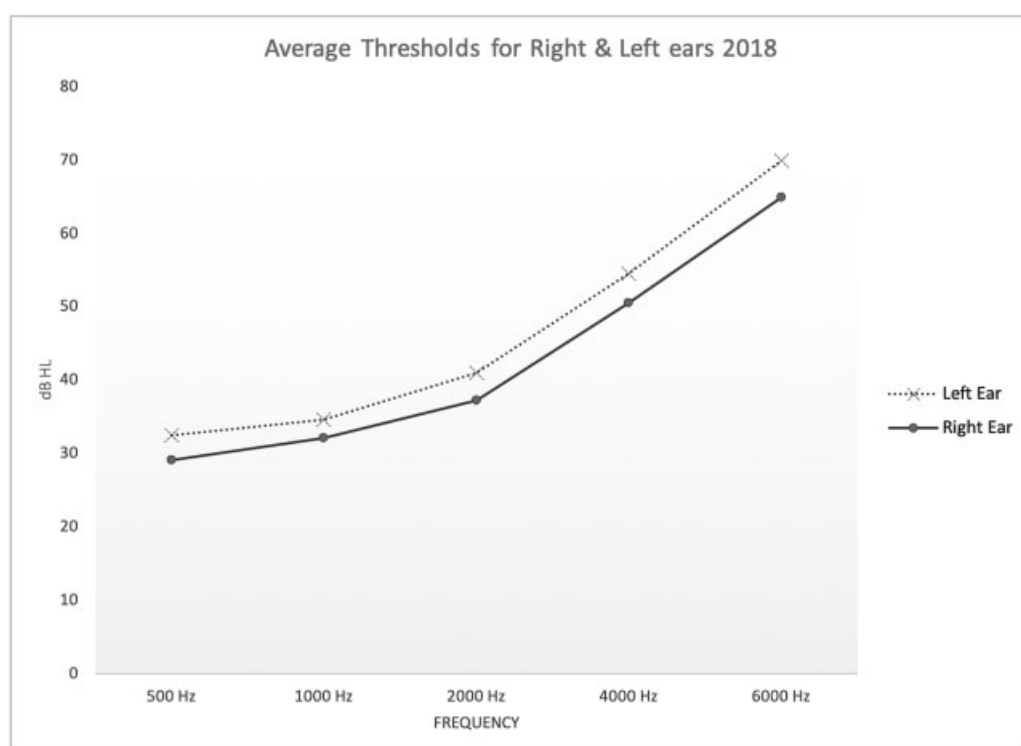


Figure 5 Average hearing loss in the right and left ears ($n=104$) from the 2018 medical expedition.

Furthermore, adult patients are fit unilaterally even if a bilateral hearing loss is present to provide amplification to as many individuals as possible. If a pediatric patient is identified with a hearing loss and the family is unable to travel to Cusco, he or she will be fit bilaterally.

Prior to the first clinic day, the team establishes a base criterion for fitting hearing aids. The criterion varies significantly from the standard practices seen within the United States and is based on the degree of hearing loss in the better ear, age, dexterity, family support, and cognition. First, the patient must have a mild hearing loss or greater with a pure tone average of 40 dB HL at 2000, 3000, and 4000 Hz in the better ear to be considered a hearing aid candidate. Second, the patient's age is considered and, finally, the patient must display adequate dexterity along with the ability to understand the care and maintenance of the device if there is no family support. If family support is available within the household, then a hearing aid may be considered even in the presence of reduced dexterity and limited capability to independently maintain the hearing aid. Although the criterion for fitting a

hearing aid is less than ideal, it is a necessary component when resources are limited.

The hearing aid selection and fitting process differs when compared with standard practices. The patients can only be fit with the instruments available; however, the audiologist chooses the most appropriate hearing aid to achieve maximum benefit when considering the hearing loss and communication difficulties reported during the brief case history. For the fitting, a custom earmold is made, if needed, and the hearing aid is programmed to the hearing loss using the manufacturer's standalone software on a laptop. Even though the audiology team subjectively assesses hearing aid benefit, objective measures to verify the hearing aid fitting are unable to be performed due to equipment issues. Subjective assessment includes a validation process using an interview to determine hearing aid benefit perceived by the patient. Adjustments are made depending on the initial information provided by the patient and responses to the hearing aid benefit interview. Finally, hearing aid orientation is provided either in a one-on-one setting or in a group using available translators. If family

members accompany the patient, they are invited and encouraged to take part in the hearing aid orientation process. The content is typically limited to the use, care, and function of the hearing aid as well as realistic expectations. Along with the hearing aids, patients receive cleaning tools and a 1-year supply of batteries. Fig. 6 shows the number of hearing aids fit within the last 3 years.

Follow-up and ongoing care for each hearing aid fitting, although necessary, is not currently available and one of the many pitfalls of providing audiologic treatment in Peru. The audiology team recognizes that follow-up care is an integral component for hearing aid use and optimal benefit. Creating sustainability is the primary goal of future expeditions. Furthermore, hearing aids are not the only solution or option for providing those with hearing loss access to sound.

Due to the limited opportunities for follow-up care and some of the inherent challenges related to traditional behind-the-ear hearing aids, other amplification options may be beneficial for some patients. Considerations for future expeditions include bone conduction devices and pocket talkers. Due to the high number of

patients with suspected conductive hearing loss, a softband or adhesive sticker bone conduction device could be a viable option. This would eliminate the need for an earmold and tubing, which often are components in need of replacement. Pocket talkers or similar hearing-assistive technologies may be beneficial for individuals who lack the dexterity or support to effectively use traditional hearing aids. Many of the patients who could benefit from hearing aids have limited experience with modern technology and may be unable to troubleshoot common issues related to traditional hearing aids. The simplicity of pocket talkers or similar devices could still meet the listening needs of these individuals without the complexity of more advanced technologies. Additionally, the cost for these types of devices is significantly less than hearing aids, making it feasible to either purchase more devices or obtain additional devices through donations.

CREATING SUSTAINABILITY

Over the last 4 years, audiology has become a valuable component of the Idaho Condor Humanitarian expedition. An audiology clinic

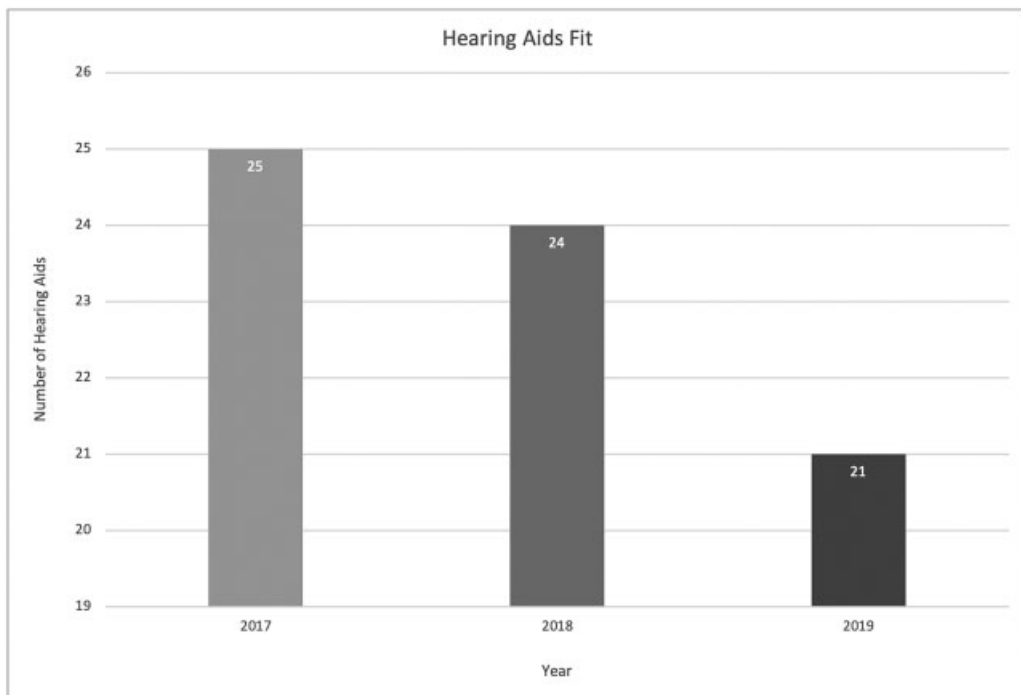


Figure 6 The number of hearing aids fit during the medical expedition from 2017 to 2019.

director was appointed and added as a board member and meets with the board on a monthly basis. This allows for representation, influence for future expeditions, and support of the audiology team's goal of sustainability.

The ISU Audiology team and Idaho Condor Humanitarian advisory board have identified three factors that will help create sustainability and better meet the needs of the patients. First, the team would like to select a few villages each year where the team will return the following year. This will provide the opportunity to establish a comprehensive follow-up clinic during the expedition. Next, the team has identified the need to connect and communicate with local hearing health care professionals in Cusco to discuss opportunities for collaboration. This will create pathways for follow-up for some patients with transportation access to Cusco. Finally, key individuals within each village will be identified and trained to provide basic follow-up care for those who were fit with a hearing aid or other amplification device.

CONCLUSION

Even though there are many challenges to providing services outside the United States, many of those challenges may be solved by adequate preparation and making good clinical decisions while keeping the best professional practice guidelines in mind. Even with the best planning and preparation, it is inevitable that unforeseen challenges which need to be addressed will arise and possible preventive measures could be put in place to avoid or reduce those challenges. If asked to define one characteristic necessary for an audiologist interested in pursuing humanitarian work, the answer would most likely be "flexibility." Humanitarian expeditions usually come with limited resources, less-than-ideal clinic environments, and language/cultural barriers. When limited resources are available, difficult choices must be made, but keeping best practice guidelines at the forefront of decision making will allow the audiologist to make appropriate decisions using solid clinical judgement. By including students in this experience, we hope to move the profession forward by modeling best practice even in the presence of challenges. Students also help seasoned audiologists think outside the box

and come up with innovative ideas to address challenges and sustainability.

A truly sustainable humanitarian hearing health care program requires perseverance and patience; it will not happen overnight. Although the expeditions to Peru may still not be considered fully sustainable, they have each provided the framework and necessary pieces to continue building a sustainable program. At times, the path to best practice and sustainability for a humanitarian program may look different from what is used in the United States; however, they are achievable with the right mindset and support.

CONFLICT OF INTEREST

Institutional support was provided by Idaho State University to the authors for travel to Uganda, Ecuador, and Peru during humanitarian expeditions discussed in the manuscript. No financial support was received for this research. No financial support was given by companies of the equipment and products listed in this manuscript. Nonfinancially, the authors are members of the Coalition for Global Hearing Health and two of the authors currently serve as active board members of Idaho Condor Humanitarian. Parts of this manuscript were presented during the 10th Annual Conference of the Coalition for Global Health Hearing.

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