Journal of Nursing & Interprofessional Leadership in Quality & Safety

Volume 1
Issue 1 *Fall*

Article 1

2016

The Future of Healthcare Delivery: IPE/IPP Audiology and Nursing Student/Faculty Collaboration to Deliver Hearing Aids to Vulnerable Adults via Telehealth

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Cover Page Footnote
This project was supported in part by: Center for Medicaid/Medicare Services (CMS) Delivery System Reform Incentive Payment (DSRIP) Project: IPE/IPP Telehealth Model for Addressing Unmet Hearing Healthcare & Hearing Aid Needs. Texas Regional Health Partnership 6. Grant Number: 085144601.1.15 - RHP6 University of Texas System (STARS) Educational Program Development grant The Authors acknowledge and wish to thank the following individual for their key support in the project: UTHSCSA Center of Excellence in Communication Sciences and Disorders: Michelle Ramirez IT: John Garcia, Scott Tucker, Scott Calhoun, Mark Rogers, Kelly Parker EPIC EMR and database networking: Kris Johnson, Andrew Krececk, Dr. Tim Barker, Patricia Harper, Travis Strong Facilities and Office of Risk Management: Ray Martin, Gail Madison-Brown UTHSCSA Nursing Clinical Enterprise and Employee Health Clinic: Yvonne Bustos, Priti Doshi, Patrick Kinnamon University Health System: Primary source of audiology patient referral: Dr. Michelle Tejeda, Dr. Jerome Evans, Dr. Allyson Womak Willford Hall Audiology: Dr. Benigno Sierrairizarry Otometrics (Ron Dusek) & Hansaton (Dr. Jerry Yanz , Kristen Ashwell, & Robert Eastman)

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Introduction

Currently over 30 million people in the United States, or 13% of the population 12 years or older, have hearing loss in both ears, and this number is largely related to compounded effects of noise exposure and longer life expectancy (National Institute on Deafness and Other Communication Disorders [NIDCD], 2016). Approximately 8.5% of adults aged 55 to 64 years, 25% aged 65 to 74 years, and 50% 75 years and older have disabling hearing loss (NIDCD, 2016), which is identified as the third most prevalent chronic health condition in older adults (Collins, 1997).

Approximately 20% of individuals who might benefit from hearing aid use actually use them. On average, hearing aid users wait approximately 7 to10 years after their initial diagnosis to be fitted with their first set of hearing aids (Davis, Smith, Ferguson, Stephens, & Gianopoulos, 2007). A nationwide survey of nearly 4,000 adults with hearing loss who were not wearing hearing aids found that their significant others showed significantly higher rates of depression, anxiety, and other psychosocial disorders (Kochkin & Rogin, 2000). The survey reported positive benefits of amplification and that hearing aid use positively affected quality of life for both the hearing aid wearer and his or her significant other. More recently, Lin et al. (2011) reported a strong link between degree of hearing loss and risk of developing dementia. The authors reported that individuals with mild hearing loss were twice as likely to develop dementia as those with normal hearing, those with moderate hearing loss were three times more likely, and those with severe hearing loss had five times the risk.

Although early intervention has proven effective in mitigating the negative effects of hearing loss (Walling & Dickson, 2012), early treatment is threatened by person shortage. Too few audiologists are being trained to meet current demographic demands, and hearing aids in the current delivery system are financially out of reach for many who need and want them. Longer life expectancies and the rapidly growing aging population are expected to further strain the limited hearing health care workforce. These concerns, along with the recent addition of the Affordable Care Act (Public Law 111-148, 2010), have motivated the health care workforce to pursue changes to the current service delivery model for audiology and other health care services to increase efficiency and effectiveness as well as lower cost.

Several models and services are in practice. The American Speech-Language-Hearing Association (ASHA) describes *Telepractice* as the application of telecommunications technology to the delivery of speech language pathology and audiology professional services at a distance by linking clinician to client/patient or clinician to clinician for assessment, intervention, and/or consultation (Brennan et al., 2010), The term *telepractice* was adopted rather than the frequently used terms *telemedicine* or *telehealth* to avoid the misperception that these services are used only in health care settings. Other terms, such as *teleaudiology, telespeech,* and *speech teletherapy,* may be used in addition to *telepractice*. Services delivered by audiologists and speech-language pathologists are also included in the broader generic term *telerehabilitation* (Rushbrook & Houston, 2016).

Teleaudiology, or the remote delivery of audiology services via telecommunication technology, provides one potential solution for reducing the personnel shortage in audiology. Specifically, teleaudiology allows the audiologist to connect virtually to the patient regardless of geographic distance, and this technique essentially expands the reach of the professional. For example, local teleaudiology hubs staffed by facilitators can remotely connect to an audiologist, potentially hundreds

of miles away, who takes remote-computer control of digital audiometric equipment and hearing aid fitting software.

The teleaudiology model was successfully pilot-tested in the Veterans Administration Health Care System (VA) and proved useful in meeting the needs of the VA population (Dennis, Gladden, & Noe, 2012). Campos and Ferrari (2010) described the successful use of telehealth in hearing aid delivery in their Brazilian-based investigation. McCaslin and Tharp (2015) devised a model for development and implementation of telepractice audiology, and Swanepoel and Hall (2010) provided a systematic review of telehealth application in audiology. However, in the United States (U. S.), telepractice has not been adopted by the non-VA hearing health care systems as a common practice for audiologists' delivery of hearing aids.

The Affordable Care Act promotes inter-professional education (IPE) and inter-professional practice (IPP) as "a team-based system that rewards collaboration and quality with the goal of improving population health" (Public Law 111-148, 2010). In addition, a growing number of professional degree program accrediting agencies require the inclusion of IPE/IPP curriculum and clinical experiences for program reaccreditation. This approach provides health care students with innovative team-based learning experiences in preparation for practice in the team-based healthcare system of the future. In addition, the IPE/IPP approach to education and training recognizes the relevance of the knowledge/skills of professionals from other professional disciplines.

An IPE/IPP approach was taken in the present initiative. Healthcare personnel in several departments within a large academic medical center setting in the southwest undertook a project using telepractice to replicate the VA model for hearing aid delivery. The resulting healthcare team were from communication sciences, nursing clinics and clinical or simulation centers, and a doctor of audiology program, Because the project initiative targeted audiology and nursing students, an IPE/IPP approach provided a broader supply of qualified faculty capable of meeting the teaching, scholarly research, and technological needs of academic programs that have mutual learning and practice outcomes.

The report, *The Future of Nursing: Leading Change, Advancing Health* (Institute of Medicine [IOM), 2011), recommended that Centers for Medicaid and Medicare Services (CMS) support the development and evaluation of models of payment and care delivery that use nurses in an expanded and leadership capacity, where such use is to improve health outcomes and reduce costs. This also serves as objectives of this IPE/IPP teleaudiology hearing aid service delivery demonstration project. A nurse-based clinic and a simulation center leadership and staff provided the space and infrastructure for the first four years of this project initiative. The IPE/IPP teleaudiology project was developed in response to the CMS Medicaid 1115 Waiver Delivery System Reform Incentive Payment (DSRIP) Program (Gates, Rudowitz & Guyer, 2014) to stimulate innovation in health care delivery, increase access to health care for at-risk populations with effective patient outcomes, and reduce per capita costs of health care delivery, aims promoted in IOM's report, *Crossing the Quality Chasm: A New Health System for the 21st Century*. (IOM, 2001). Tele-health was recognized by CMS as one of the potential modes of health care delivery that could help achieve these objectives for both primary and specialty health care

Goals of the Project

The goals of this project were to target vulnerable, hard of hearing populations, to address their unanswered hearing aid needs, and to promote interprofessional education and practice solutions for this critical healthcare challenge. This project received a 5 year DSRIP award, which has funded the personnel required for delivery of the project. The equipment and hearing aids required for the project were purchased through a university-based grant for support of the development of innovative academic and clinical programs.

Methods

The IPE/IPP project partners included audiology faculty and staff; nursing administrative, faculty, and clinical staff; nursing students; and Doctor of Audiology program faculty and students. Referrals of vulnerable hard of hearing patients needing hearing aids came from community stakeholders, such as public health systems, a military center facility, audiology clinics; faculty practices, a refugee health center, and other community-based audiologist and hearing aid dispensers. In this project, the teleaudiology hearing aid services were offered at no charge to patients.

Prior to the start of the project, personnel in EPIC electronic medical records (EMR), in collaboration with the project principal investigator (PI), created a new "tele-audiology" department within the existing EPIC EMR system. The teleaudiology system included digital flowsheets, which enabled documentation of audiometric, hearing health history and hearing or communication handicap data. Data collection tools were the Hearing Handicap Inventory for the Elderly-Screening (HHIE-S) (Lichtenstein & Hazuda, 1998; Ventry & Weinstein, 1983), International Outcome Inventory for Hearing Aids (IOI-HA) (Cox & Alexander., 2002; Cox, Alexander, & Beyer, 2003), Glasgow Profile for Hearing Aid Benefit (GHABP) (Gatehouse,1999; Gatehouse, 2000), and Psychosocial Impact of Assistive Device Scale (PIADS) (Saunders & Jutai, 2004). Interview-style surveys were used to collect pre and post hearing aid fitting data, which were entered into the EPIC flowsheets. Other important data captured included daily hearing aid use. "Smart sets" were used to facilitate patient visit documentation at the initial hearing aid fitting, 30 to 45-day clinic visit, and 6-month follow up as well as follow up telephone calls to assess progress of patients in the use of their new binaural hearing aids. A licensed Vocational Nurse and a senior administrative assistant were invaluable in assisting with patient triage and follow up phone calls.

In both the audiology and nursing educational programs, a 5-hour IPE course with an IPP clinic time slot was developed for the project and held once per week. Using secure Cisco A/V conferencing, the audiology and nursing students and their faculty virtually met together to share the knowledge and skills associated with their respective roles of teleaudiologist provider and tele-audiology nurse facilitator. Course content dealt with delivery of hearing health care services and hearing aids to vulnerable hard of hearing patients. The course curriculum consisted of instructional articles, slide shows, and videos covering topics such as interpretation of basic hearing tests and immittance results, otoscopy, ear anatomy and physiology, tympanometry, and specific hearing aid technology.

Audiology students and supervising faculty were located at Doctor of Audiology department in a southwest city (City 1). Nursing Students and their supervising nursing and audiology faculty and the patients were based at a nursing center, or later in the project, at a medical arts center in in a separate Southwest city (City 2) located about 80 miles from Doctor of Audiology program (City 1).

Nursing students, and their supervising faculty (nurse and audiologist) and the patients in City 2 interacted with the audiology students and their supervising audiology faculty in City 1 via secure Cisco Systems A/V conferencing. Patients were referred by audiology clinics which provided the hearing evaluations and were then directed to the teleaudiology clinic for subsequent hearing aid fitting and follow up services. Nursing students, and their supervising faculty (nurse and audiologist) and the patients in City 2 interacted with the audiology students and their supervising audiology faculty in City 1 via secure Cisco Systems A/V conferencing. The audiology students and faculty in City 1 took control of the lap top computer in City 2, which was equipped with Otometrics products, an Otosuite/NOAH computer-based AURICAL hearing aid fitting audiometer with integrated real ear probe microphone measurement system, MADSEN Otoflex 100 tympanometer, and AURICAL Otocam300 video otoscope.

Referring audiologists or hearing aid dispensers identified the patients. Participant criteria were: 1) hearing loss in the mild to severe range; 2) no active ear pathology; 3) patient-perceived hearing handicap, and 4) desire to receive help confounded by financial limitations that prevented them from obtaining hearing aids. Some patients had coverage through Medicaid, Medicare only, or the county's public financial assistance program. Others were underinsured with no hearing aid benefits or uninsured (self-pay) and not able to afford hearing aids. All but two of the patients reported that they were first-time hearing aid users.

Patients were required to have a hearing evaluation from a licensed audiologist or hearing aid dispenser within one year of the hearing aid fitting and to bring their audiogram to the initial appointment at the teleaudiology clinic. Case history information was collected from each patient, which included information about duration of hearing loss, hearing loss etiology, perceived hearing symmetry, previous history of hearing aid use, and presence of tinnitus, vertigo, otalgia, otorrhea. Students collected Information via an interview-style survey administered by the students both pre and post hearing aid fitting. After the initial intake with case history completion, the students in both cities collectively determined the hearing needs of the patient.

Prior to the start of each teleaudiology clinic, the protocol was to establish the Cisco Systems video conference link and secure remote desktop access. The GotoMyPC remote computer control software allowed the computer operator in City 2 to access the computer in City 1 and then to navigate the computer-based Otometrics equipment and hearing aid programming software.

Video otoscopy was performed by the nursing students and interpreted by both the audiology and nursing students and faculty using the Otometrics Otocam. Patients identified with perforations of the tympanic membrane, total cerumen occlusion of the external auditory canals, significant hearing loss asymmetry, ear pain or drainage, or vertigo previously undiagnosed or treated were referred for further medical intervention. These patients were required to have, if necessary, or waive, if unnecessary, medical clearance prior to proceeding with hearing aid fitting. Video otoscopy was completed for all patients prior to the hearing aid fitting, and exam photos were saved to the patient's electronic medical record.

Audiogram information and video otoscopic images were entered into the NOAH database software. For each appointment, one of the Doctor of Audiology program students (City 1) conducted the survey portion of the appointment with the patient and administered the HHIE-S, the GHAPB questionnaire, the IOI-HA and the PIADS (at 6 months) via video conference. Simultaneously, another Audiology student programmed the hearing instruments for the patient's individual needs. If available, other audiology students were responsible for note taking and general records management for each

patient. Audiology students rotated tasks so that each student had an opportunity to practice a variety of skills. The nursing students located in City 2 took measurements of the dimensions of the pinna for selection of the thin tube length and earbud size and type (open, closed, power, tulip) and, with input from the patient, selected the color of the hearing aids (bronze, black, grey or beige) to be dispensed. They also completed a listening check of the hearing aids to determine proper functioning and to help the audiologist identify the serial numbers of the left and right aids during the programming process.

The hearing aid manufacturing partner was Hansaton (Plymouth, MN). The hearing aid model used for the teleaudiology project was the Sorino, a mini behind the ear (BTE) with a mid-level digital circuit. The devices were fit with slim tubes and domes to avoid invasive procedures, such as ear impressions. Hearing aids were programmed to fit the patients' hearing loss as measured on their audiograms using the Hansaton software and Connex Programming Device. All hearing aids included a 3-year warranty and 3-year one-time unit loss replacement warranty, with a replacement fee charged to the patient if the hearing aid was lost or irreparably damaged. Only one patient required replacement of a hearing aid during the project, and the person saved money over several months to pay for the replacement aid. The audiology students performed remote programming of the hearing instruments, while the nursing students reviewed the owner's manual, educated the patient on hearing aid parts, battery type/insertion/removal, and use of the push button volume control.

Real ear probe microphone measurements were completed using the remote desktop access connected to probe microphone measurement equipment in City 1 to ensure that appropriate amplification targets were met and that the maximum power output settings across the frequency range of the hearing aid accommodated patient loudness comfort. The audiology/nursing student team completed calibration of the probe tube microphone/real ear system; the nursing student placed the real ear probe tubes, and the video otoscope was used as a camera to provide the audiology student visual confirmation of the probe tube placement.

Both nursing and audiology students collaborated to orient the patient and their family members on the care and maintenance of the hearing aids. At the conclusion of the visit, the patients received discharge instructions and hearing aid support materials. Nursing students accompanied the patients to clinic check out. Patients were scheduled for a follow up appointment to the clinic within 30-45 days of the initial fitting appointment. Patients received 6-month follow up phone calls to determine a need for hearing aid re-programming and fit modification. If the patients did not need a clinic follow up visit, 6-month follow up HHIE-S, IOI-HA and PIADS surveys were completed over the telephone. All registration, scheduling and progress notes for each teleaudiology clinic patient visit were documented in the EPIC electronic medical record.

Results

Patient Outcomes

The IPE/IPP tele-audiology project has delivered hearing health care services, including bilateral (only two patients fit monaurally) digital Hansaton Sorino mini-BTE hearing aids fit with thin tubes and open/tulip/closed ear buds to 181 patients over 29 months of the project. During that time period, 205 total patients were referred to the teleaudiology clinic, although some of these patients did not show for their appointments and others needed further medical referral prior to hearing aid fitting. Over 90% of these patients, as assessed by either patient teleaudiology clinic visits or

telephone follow up, successfully wore their hearing aids. Success indicated reported daily use of the hearing aid, and in most cases, was confirmed via hearing aid data logging at the 30/45 day follow up clinic visit. Patients also revealed dramatic and significant changes in the outcome measures, which demonstrated aided hearing handicap reduction (as assessed via the HHIE-S), improvement in communication abilities in various listening situation (as assessed via the GHABP), general improvement in communication abilities (as assessed via IOI-HA), and improvement in psychosocial function (as assessed via the PIADS).

In addition, the Visit-Specific Satisfaction Instrument (VSQ-9), a nine item instrument that focuses specifically on satisfaction with a visit to a physician or other health care provider was used (Rubin, Gandek, Kosinskik, McHorney, & Ware, 1993). For this IPE/IPP tele-audiology project, the mean patient satisfaction score for 28 months was 91.22% (range 75-100%). Areas assessed by the VSQ-9 of less than 100% reported patient satisfaction included: "how long you waited to get an appointment", "convenience of the location of the office," "length of time waiting at the office to be seen by the health care professional", and "getting through to the office by phone". The vast majority of patients reported 100% satisfaction with the "time spent with the health care professional", "explanation of what was done for you", "technical skills (thoroughness, carefulness, competence) of the health care professional you saw", "the personal manner (courtesy, respect, sensitivity, friendliness) of the health care professional you saw", and "the visit overall".

Student Outcomes

During the project, 21 nursing students received teleaudiology facilitator education and supervised practicum. The majority of the students were in their last semester of a baccalaureate nursing program, with several in a nursing graduate program. Once receiving their degrees, their goals typically were to practice in the hospital as well as the community while continuing with graduate nursing studies. Likewise, 15 Doctor of Audiology students, in the second or third year of their program, completed at least one semester of the elective IPE/IPP teleaudiology clinical practicum. Six students have registered for two or more semesters of the teleaudiology clinical IPE/IPP experience, bringing the total to 21.

Following are quotes that highlight the learning experience of the nursing and audiology students:

> **Nursing Student Quotes –**
> *"Today was one of the most rewarding experiences I have had during nursing school. We were able to utilize several different forms of technology to help improve the quality of life for several different hearing impaired patients…Providing free hearing aids to patients and removing the financial barrier to receiving this wonderful gift is simply astounding…I learned more than I ever could have asked for, and they even included us in conducting the initial exam for one of the new patients…One patient expressed sincere gratitude for being able to hear her children on the phone and see her grandchildren perform in plays…It is a wonderful service and a fairly easy process. I am extremely grateful I got to spend time there today".*
>
> *"I learned so much from the tele-audiology clinic today. I was amazed at the work we can do via videoconference…We brought in the patients; they spoke to the patients from (City 2). We had the hearing aids here (City 1) and they were programmed in (City 2), fitted for the patient here (City 1), and the*

patient took them home today! I am astonished! This was the coolest thing I have seen in a long time. How amazing technology is that we can serve our vulnerable populations in this capacity!"

Audiology Student Quote –

"Teleaudiology has been an invaluable experience for me so far, it has been such a pleasure to help out individuals with their hearing health. Seeing patients come through the door with reluctant looks, then leaving with a pair of hearing aids and smiles on their faces with excitement about their new devices... has been wonderful! Being able to share my knowledge and educate patients and nursing students is experience unlike any that I would receive in a classroom. I am happy to be a part of it at (City 1)."

Patient Anecdotes

Numerous patients stated that the hearing aids provided through the clinic, "have given me my life back", "have given me a new life", and "have made me feel like a part of my family again". One patient under the age of 65 years expressed during the hearing aid fitting and counseling process that she had always wanted to be a nurse and believed that her own health challenges, including hearing loss, provided insights that could be beneficial to her future patients. Despite significant bilateral hearing loss, she had never worn hearing aids and was uniformed regarding the process to obtain a BSN degree. With excellent aided outcomes by the end of the initial fitting session, she expressed interest in meeting with a nursing admissions advisor, which we arranged that same day. Following her meeting with the admissions advisor, the patient had a printed plan for the prerequisite courses to apply to a BSN nursing degree program that she would need to take at a community or four-year college of her choice. She left the teleaudiology clinic amazed at her ability to hear with her new hearing aids, and happy with the academic plan to pursue her dream of becoming a registered nurse.

Another patient in his mid-70's stated in his teleaudiology follow up appointment that he had recently been hired as a crossing guard at his neighborhood school and was excited to once again be employed. He stated that he would not have been able to apply for this job prior to obtaining hearing aids, as he could not have heard the children and important traffic noises. He now could hear the children talking when they were behind him.

Discussion

This article described an innovative, collaborative IPE/IPP teleaudiology project whose health care workforce included 21 nursing and 21 audiology students with 1 nursing and 3 audiology faculty that targeted vulnerable, hard of hearing populations to address unanswered hearing aid needs and promote interprofessional education and practice solutions for this critical healthcare challenge. Currently in the fifth year of this five-year project, 205 patients have been referred to the teleaudiology clinic. Of those referrals, 181 patients total to date have been fitted with digital hearing aids, and all but two received binaural hearing aids.

Patient satisfaction data revealed that the patients were satisfied with the teleaudiology mode of digital hearing aid and hearing health care service delivery. Patients reported significant hearing handicap reduction, with some patients going from a maximum pre-aided hearing handicap score of 40 (severe handicap) to a post-aided self-perceived hearing handicap score of 0 (no handicap), as well as communication and quality of life improvement secondary to their hearing aid use. The experience

provided IPE/IPP pre-service exposure to cutting edge technology and an innovative delivery system for future members of the healthcare workforce.

Critical factors that created barriers to smooth, efficient, and effective delivery of telehealth services included technology malfunction and Internet connectivity issues. Students were challenged to adapt and problem-solve in real time when an equipment malfunction occurred, or an intermittent Internet signal prevented the two sites from connecting. While this required the development of problem solving skills, this real time activity also demonstrated the need for excellent collaboration and ongoing communication between professionals at each site, in addition to having a relationship with the information technology departments. The connectivity problems occurred primarily during the first year and were minimal to non-existent through the remaining years of the project.

A second critical factor in the teleaudiology program was a high no-show rate secondary to the life challenges of vulnerable and impoverished populations. Transportation can be extremely difficult, and often involve an arduous bus ride to make an appointment. In addition, this vulnerable population has a higher rate of multiple chronic diseases than in the population at large, which results in hearing health becoming a lower priority when other conditions are life threatening and resources are limited. Despite reminder calls that were implemented in an attempt to mitigate missed appointments, no-shows continued to be a challenge to our clinic. These issues demonstrate the multiple barriers that vulnerable populations face in getting to health care appointments, even though the service is free. Finally, language fluency among clinicians is essential for effective communication. Family and student interpreters were used for patients speaking Spanish as well as Arabic, Farsi, Mandarin, or Tagalog.

Numerous elements are critical to ensuring the success of any IPE/IPP project. We identified eight key factors, which include the following: (1) funding for the purchase of needed equipment, electronic medical records and IT support, and needed faculty full-time equivalency; (2) high level administrative support (University presidents, deans, and department chairs); (3) generous space acquisition and infrastructure support, (4) enthusiastic interest of faculty members in each of the participating professional disciplines to include the IPE/IPP curricular content and clinical experience in their teaching; (5) flexibility to adapt the IPE/IPP course content and clinic experience into existing courses without the need to create new courses that require extensive curricular review and approval; (6) institutional recognition of the importance and rigor of IPE/IPP in considerations for promotion and tenure of faculty who make a significant commitment to IPE/IPP program development and delivery; (7) interest among students from various disciplines to participate in IPE/IPP curricular experiences, and (8) availability of times built into the university course schedule that are reserved for IPE/IPP course delivery and protected as such by departments desiring to participate in IPE/IPP.

Conclusion

By working in an interprofessional team, students learned effective communication skills, expanded their knowledge base across disciplines, and provided patients with more comprehensive care that improved quality of life. Lessons learned thus far have included a number of factors influencing the uptake of hearing aids in the population served, including extra-audiological health priorities, transportation difficulties, and the presence of a translator at each appointment.

The project's outcomes demonstrated that patients were positively impacted through this approach, which supports CMS reimbursement of telehealth for audiology and hearing aid service

delivery and a CMS hearing aid benefit for all who need and want hearing aids. When following the protocol used in this initiative, it would be possible to support Medicare eligible vulnerable patients in the future purchase of hearing aids and payment of audiologists for professional services related to hearing aid fitting and follow up.

Finally, the project revealed an ideal partnership and interprofessional, complementary practice and education model for audiologists and nurses. With 3.3 million nurses in the U.S., and their commitment to serve rural populations, the expansion of nurse-managed clinics with nurses trained in specialized teleaudiology places nurses as ideal facilitators for this model. Recognition that most states have rural and underserved populations, and nurses willing to serve, sets the stage to replicate this model throughout the U.S. Nurses with specialized audiology training can link patients where they live to academic partnerships, where barriers to hearing healthcare are removed and successful outcomes can be achieved. When underserved populations are linked to hearing health experts and audiologists through community and academic consortiums, diverse populations with hearing loss can achieve their full potential.

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