Stanford Affordable Hearing Project
Process Design Report
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1 Introduction

This report examines the procedures for understanding a patient’s hearing loss, fitting them with an appropriate hearing device, and counseling them in its use. We spoke with many audiologists and experts to gain insights into the strengths and weaknesses of existing procedures for screening, diagnosis, treatment, and counseling. We also investigated some recent technological innovations with the potential of substantially improving these processes.

This report maps out how these new technologies can be used to create a streamlined and efficient process for screening, diagnosis, treatment, and counseling. The resulting procedures are of high quality while requiring substantially less time and labor – and thus cost – than current procedures commonly in use.
2 Efficient Screening and Diagnosis

2.1 Background

A relatively quick and simple screening process can separate those who need some sort of treatment from those who do not. Thus, rather than having all patients go through the time-consuming diagnostic evaluation, only those with hearing loss will continue with the process. After determining those who have hearing loss, the audiometric evaluation is necessary to assess the nature of the hearing loss to prescribe and provide treatment.

Traditional methods require a soundproof booth to perform an accurate audiometric evaluation and constant supervision by an audiologist or a hearing aid dispenser to administer the test. However, we plan to perform audiograms using an automated system, such as the Otogram, in which the patient interacts with a touch screen to perform their own audiogram. The Otogram requires neither constant supervision nor a soundproof booth, allowing an audiologist or dispenser to test multiple patients at the same time.

While most audiologists do use self-assessment questionnaires, we propose using several in order to more accurately judge what the patient expects, needs, and wants.

2.2 Proposed Procedure

A screening is a simple, short evaluation to determine whether or not a person has hearing loss. One possible procedure is to measure 25 dB and 40 dB pure tone thresholds and administer a self-assessment questionnaire. Typically, positive results of two of the measurements indicate hearing loss.

After the patient has gone through this first round of screening, an audiologist goes through the checklist for warning signs of a medical condition that requires referral to an ENT before receiving any form of hearing aid. If no signs are present, the patient can sign the waiver to forego the visit to a physician or ENT and proceed with treatment. The audiologist should also check the ears for wax and clean them, if necessary, before the audiological evaluation.

An audiogram consists of measuring a patient’s pure tone thresholds for air and bone conduction, Speech Reception Threshold, and Word Recognition Score.

To use the Otogram, an audiologist or an assistant first instructs the patient about the different tests and sets them up at the station. The technician places in the patient’s ears noise-attenuating earbuds, which present tones and words, and places against the patient’s forehead the bone-conduction “bow,” an instrument that presents tones through vibrations. During the test, the computer provides instructions through voice, pictures, and onscreen text.

Pure-tone air conduction and bone conduction tests present pure tones at varying frequencies and volumes. The user interacts with the Otogram touch screen upon hearing sounds, and the thresholds for each frequency are calculated. The pure-tone air conduction test determines how well the patient hears at different frequencies. The bone conduction test, when compared to the air conduction test, helps localize the source of patient’s hearing loss to the outer, middle, or inner ear, and is useful in determining whether or not a hearing device may be appropriate.

For the speech reception threshold test, the user is presented with a series of pictures on the screen that have two-syllable words with equal stress on both syllables. They hear a set of these words at decreasing volumes, and each time they hear that word, they press its picture on the
touch screen. The threshold is the softest point in which the patient is able recognize a word correctly 50% to the time. The test indicates the level of sound required for the patient to understand words and helps check the reliability of the pure tone air test. The interface is similar for the word recognition test, except that the one-syllable words are presented at a consistent, comfortable volume, and instead of having dissimilar words, the word recognition test sees how well the patient can discriminate between subtly different sounds like “hill”, “bill”, “chill”. The test indicates how well they can be expected to understand everyday conversation once fitted with a hearing aid.

Finally, tympanometry is done to detect disorders of the middle ear. A probe tip discharges varying sound and air pressure into the patient’s ear canal and a microphone on the tip measures how the sound is reflected off the eardrum. The test assesses the middle ear movement and helps determine if the hearing loss is conductive or sensorineural.

Throughout all these tests, the user wears microphones that pick up ambient noise, so the Otogram can monitor this noise and ensure that the tests are only done when it is below a given threshold. When the test is completed, the data from the test can be printed out or transferred to electronic medical records.

Because the system is automated, an audiologist can administer multiple audiological exams at the same time, staggering when each patient requires attention at the initial setup of the exam. Also, since no soundproof booth is necessary, multiple exams can be done in a confined space. The higher volume of people served would make the Otogram system more cost-effective than a large investment in soundproof booths and the personnel to perform the tests manually.

Self-assessment questionnaires are also important in determining how the patient’s hearing loss affects their life, what their needs are, and from what forms of treatment or help they could most benefit. Specific types of questionnaires include questions about difficulties the patient has in everyday life (e.g. Abbreviated Profile of Hearing Aid Benefit) to uncover implicit needs. Implication questions (e.g. Hearing Handicap Inventory for the Elderly) help describe how serious an effect hearing loss has on the patient’s quality of life. Need-payoff questions (e.g. Client Oriented Scale of Improvement) target the patient’s explicit needs—what type of treatment the patient wants and therefore benefit from the most.

These types of questions help assess patients’ motivation. To continue on from the diagnosis a patient must: 1) have no symptoms of serious medical conditions that suggest they should see an ENT, 2) be diagnosed with hearing loss appropriate for a hearing device, and 3) demonstrate motivation to get a hearing aid.
3 Efficient Treatment

3.1 Background

Dispensing hearing aids is typically a time-consuming process because hearing aids must be both physically and electronically customized to the patient. The patient often needs to schedule two to three visits with an audiologist. The time investment and labor required in these visits greatly increases the overall cost of buying a hearing aid.

One reason hearing aids are traditionally not dispensed in one visit is that the earmold for the hearing aid is typically made off-site. The audiologist takes an impression of the patient’s ear and then ships the impression to an earmold-manufacturing lab. It usually takes one to two weeks for the completed earmold to be sent back, after which the patient must return to the audiologist to receive the aid and have it programmed.

We plan to use alternatives to lab-made earmolds, specifically non-custom eartips for patients with high frequency hearing loss and instant earmolds for patients who require a custom-fit. Both options allow a hearing aid to be dispensed in one visit.

Another time-consuming part of the fitting process is measuring the patient’s loudness discomfort levels and verifying that the aid has been appropriately programmed for the patient using real ear measurement (REM). While REM is valuable, since it is an objective way to test how the aid affects the particular patient’s hearing, the equipment required is costly. Also, a significant amount of time is needed to present varying decibel levels of noise when doing REM. Therefore, we plan to use pair comparison within the programming software to confirm that the dynamic range of the hearing aid is comfortable for the patient rather than measuring loudness discomfort levels and then using REM to confirm the hearing aid operates within those levels.

3.2 Proposed Procedure

For patients with high frequency hearing loss, the appropriate non-custom eartip is chosen. For patients who require a custom-fit, an impression of the ear is taken using instant earmold material. Refining the ends of the impression creates the final mold. In California, this needs to be performed by an audiologist or a hearing aid dispenser. Using an instant earmold provides the benefits of a custom earmold without requiring the typical one- to two-week wait for the impression to be sent to a lab and the earmold to be sent back. Instead, the hearing aid can be dispensed in one visit. For the Microsound Pilot hearing aid, the audiologist or dispenser should find the best fit between the two sizes of the stock eartips and between the vented or non-vented options.

State law requires a licensed audiologist or hearing aid dispenser to be the person who programs the hearing aid to customize gain levels in each frequency band. The point of departure for most hearing aid programming comes from a default “first fit” determined by the hearing aid’s programming software from the patient’s audiogram. This first fit is typically derived from the NAL/NL1 standard, a pattern of gains for the different frequencies best suited for an average ear. Audiologists or dispensers then fine-tune the hearing aid’s programming to adjust for variations between patients.

It is important to program the hearing aid so the maximum output does not exceed the patient’s loudness discomfort level (LDL). While LDL’s can be measured and then verified through real ear measurements, this would not be time or cost-effective for our model. Thus, we suggest the audiologist have the programming software predict the LDL from the measured pure tone
thresholds. The calculated LDL is appropriate for approximately 70% of patients. The audiologist can then use pair comparison to fine tune the gain by, for example presenting “soft” and “loud” dB of noise to the patient while wearing the hearing aid until the patient says it is inaudible or uncomfortably loud.

Doing too much fine tuning in the initial visit can be counterproductive as the patient often has not had enough experience in wearing and using the hearing aid to provide adequate feedback for its adjustment. Too much tweaking can thus be frustrating and tiresome for the patient. Therefore, a mere 10 to 15 minutes of programming is often all that should be necessary in an appointment to get the hearing aid programmed to be comfortable enough for the patient to use.

The rest of the appointment should be focused on counseling and education so that the patient knows how to properly use and care for the aid.

In a follow-up visit, the audiologist should readjust the programming after finding out how the patient has been using the hearing aid and how successful the experience has been. The programming can then be fine tuned in response to this discussion. The audiologist is also available in this visit to provide a refresher course on care for and cleaning the hearing aid.
Hearing aid fitted to patient

Choice between non-custom earpiece or instant earmold

Technician selects non-custom earpiece of appropriate size and type (5 min)

Technician makes instant earmold (10 min + 20 min curing time)

Audiologist or technician attaches hearing aid to programming equipment and enters patient’s audiogram for software to calculate initial “first fit” program (5-10 min)

Patient tries on the hearing aid and tests the first fit. Based upon patient feedback, the audiologist fine-tunes the patient’s program. (5-10 min)

Patient continues with counseling
4 Effective Counseling

4.1 Background

A crucial component in the success of a patient's use of a hearing device is the ability of the audiologist to understand and address the impact of hearing impairment on the patient's daily life. A patient needs much more than just the hearing device. He needs realistic expectations of what his hearing improvement will be, and he needs to learn important communication strategies. Counseling provides the needed knowledge and guidance to patients as well as their family and friends.

Effective counseling needs to address a number of topics. Part of the counseling process is independent of the type of device (assistive listening device or hearing aid); part of the process after the device is chosen is specific to the device. Below are the topics to be covered in the counseling process:

1. General overview of hearing loss: Patient learns about the various causes of hearing loss and gains perspective on his situation.
2. Case history: Patient conveys his primary concerns, previous and present noise exposure, family history of hearing loss, and progression of hearing loss.
3. Understanding one's own specific hearing loss: After the audiogram is completed, the audiologist shows the patient his results in graphical form against that of someone with normal hearing. The patient will learn what common sounds he cannot hear, and how an assistive listening device (ALD) or hearing aid can help.
4. Understanding options and trade off's of hearing devices: Patient learns the benefits and trade offs of ALDs vs. hearing aids.
5. Adjusting patient expectations: Patient learns that hearing will improve by a slow process and not immediately upon obtaining the device. Patient is given realistic expectations for hearing with the device, understanding that hearing will never be perfect.
6. How to use and maintain the device: Patient is instructed in how to properly clean and store the device, as well as how to put it on, take it off, and change its batteries.
7. Communication strategies for patient: Patient learns the various other strategies such as gesturing and lip reading that will increase their overall success in communication. Follow-up group counseling sessions and classes are highly encouraged to cover this topic in greater detail.
8. Communication strategies for family and friends: Patient is given supplementary material (DVD and/or pamphlets) to take home to give to family and friends. The materials will educate them about accommodating and being considerate of the patient.
9. Scheduling a follow-up visit: For patients who choose a hearing aid, a follow up visit will be necessary for any necessary adjustments of their hearing aid.
10. Giving option of group counseling sessions: All patients are given the resources for pursing group counseling sessions (5 to 10 people) regarding communication and technical issues.

4.2 Proposed Procedure

We propose to use a DVD as a cost-effective way to provide information and instruction. These DVDs will contain a comprehensive selection of hearing-related topics and will have audio and closed captioning in the languages of the major populations we anticipate serving. Topics on the DVD include:

- How does the ear function? What is hearing loss?
- How to use your hearing device
• Adjusting to your hearing device
• How to clean and maintain your hearing device
• Wearing schedule
• Psychological impacts
• Communication techniques
• Auditory training
• Other supplementary amplification technologies

Part of the DVD may be viewed at the time of the patient’s visit to give them the opportunity to ask questions. A copy of the DVD will be given to the patient to be able to refer to as needed. If the patient does not have access to a DVD player, they will be given the location of the nearest local library with a player. The purpose of distributing a DVD is to cut down on the counseling time by covering topics that do not need to be addressed in person, to reduce the number of follow-up visits by providing a source of answers to basic troubleshooting questions, and to maintain patient knowledge by having a ready source of content available on one disc.

We have also explored the potential for group counseling sessions. Such procedures can be more time-efficient, and oftentimes more beneficial to the patient, due to the value of patient-to-patient interaction. Group sessions are particularly suitable to the introductory topics, as well as those discussing product maintenance and communication strategies.

The complete counseling procedure flow chart:
Initial screening

Patient has hearing loss

Audiogram (Otogram)

Patient counseled about specific hearing loss

Candidate for amplification

Explanation of assistive listening devices and hearing aids

Assistive listening device chosen

Assistive listening device fitted to patient

Hearing aid chosen

Hearing aid fitted to patient

How to use device
Cleaning, maintenance, batteries

Communicating with device
Options for group counseling

DVD and pamphlet given to patient with information on how to use and communicate with device, including information for family

Referral to MD

Possible medical problem