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EVALUATION OF THE LASH PROGRAM AT TOWSON UNIVERSITY'S HEARING AND BALANCE CENTER

by

Kaitlin E. Berry

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THESIS APPROVAL PAGE

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Jennifer Smart		5/2/2017
Chairperson, Thesis Committee Signature	Jennifer Smart, Ph.D.	Date
		5/2/2017
Chairperson, Thesis Committee Signature	Elise Smith, Au.D.	Date
Tricia Ashby, AuD		5/2/2017
Committee Member Signature	Tricia Ashby, Au.D	Date
Janet V DeLany	Janet DeLany	May 16, 2017
Dean of Graduate Studies	Janet DeLany, D.Ed	Date

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Abstract

Evaluation of the LASH Program at Towson University's Hearing and Balance Center

Kaitlin Berry

It is estimated that over 360 million people have hearing loss worldwide, making it one of the most prevalent chronic health conditions (WHO, 2015). Hearing aids are the most common form of treatment for hearing loss. However, less than a fourth of individuals with a diagnosed hearing loss use hearing aids (Kochkin et al., 2010). Low rates of hearing aid use have been associated with lower levels of education, income, and financial support (Bainbridge & Ramachandran, 2014; Nieman et al., 2016).

Numerous programs and foundations exist that provide financial assistance for hearing aids for low-income individuals that have hearing loss. Studies on existing low income program have found that these programs were successful at providing hearing aids to low-income individuals but that follow-up appointments were necessary to address patient's concerns and monitor long-term outcomes of hearing aid benefit (Freitas & Costa, 2007; Iwahashi, Jardim, & Bento, 2013).

The purpose of this study was to conduct a retrospective chart review of 100 patients that have received hearing aids and services through the LASH program at the TU-HBC. Information regarding patient population characteristics (i.e., age, gender, hearing loss) and program outcomes were recorded from the patient charts.

This study revealed that a majority of the patients seen through the LASH program qualified for reduced service fees, which suggests that the program is reaching the target population. A total of 23 participants were lost to follow-up and there was a wide range in the duration between the fitting and first follow-up appointment. About

half of the participants required at least one repair. These findings suggest the need for a better follow-up protocol to monitor long-term use. Overall, the amount of revenue the TU-HBC generated from participating in the program was as expected, which indicates that participation in the LASH program is not detrimental to the clinic financially.

Future research should focus on gathering more detailed information regarding patient demographics, comparing outcomes of LASH patients to patients with private pay or insurance, and include subject questionnaires to get a better understanding of the patient's personal experience with the hearing aids.

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Chapter 1

Introduction

Hearing loss is one of the most commonly diagnosed disabilities that affects more than 360 million people worldwide (Carkeet, Pither, & Anderson, 2014; WHO; 2015). Hearing loss can negatively impact a person's ability to communicate, which can lead to difficulties with their relationships, careers, and self-esteem (Chia, Wang, Rochtchina, Cumming, Newall, & Mitchell, 2007; Dalton et al., 2003). The impact that a hearing loss has on an individual varies based on the type, degree, and configuration of the loss.

An audiological evaluation is conducted by a licensed audiologist to diagnose a hearing loss. The evaluation typically consists of behavioral pure tone audiometry, speech audiometry, and immittance testing (Baiduc et al., 2013). Once a hearing loss is diagnosed some form of medical, surgical, and/or amplification intervention is typically recommended (Lasak et al., 2014). The most common treatment option for hearing loss is hearing aids. However, only 25% of individuals with hearing loss that could benefit from a hearing aid use one (Kochkin et al., 2010).

To improve our understanding of why hearing aids remain underutilized by individuals with hearing loss, it is important to identify the barriers and factors that contribute to their use. Studies have shown that lower rates of hearing aid use are associated with lower levels of education, income, and financial support (Bainbridge & Ramachandran, 2014; Nieman et al., 2016). Financial concern is a common reason why people don't use hearing aids (Kochin, 2007). Hearing aid prices range from $1000-$3000 per aid and there are additional costs such as earmolds, batteries, repairs, and office visits that make them financially out of reach for many individuals (Ingrao, 2011; Caccamo, Voloshchenko, & Dankyi, 2014).

There are numerous programs and foundations that provide hearing aids to low-income individuals. Some examples of large foundations include Starkey's Hear Now program, the Veterans Administration (VA), and the Lion's Association for Sight and Hearing (LASH). While these programs help alleviate the financial constraints of hearing aids, there are other factors that contribute to a person's success with the devices, such as previous experience, follow up visits, maintenance, counseling, and patient satisfaction (Kochkin et al., 2010). Follow-up appointments are necessary to address these factors and monitor long-term outcomes of hearing aid use (Freitas & Costa, 2007; Iwahashi, Jardim, & Bento, 2013). Currently, no research has been conducted to investigate the long-term outcomes of the LASH program at Towson University's Hearing and Balance Center (TU-HBC).

The purpose of this study was to conduct a retrospective chart review to identify the outcomes of patients that have received hearing aids and services through the LASH program at the TU-HBC. Information regarding patient population characteristics (i.e., age, gender, hearing loss) was recorded. The number of follow-up visits, hearing aid type, monaural or binaural fitting, adjustments and repairs, quality of life, and billing information was recorded and analyzed to assess outcomes over a two-year period of time.

Chapter 2

Literature Review

Hearing loss is one of the most prevalent health conditions affecting people of all ages, genders, races, and socioeconomic classes worldwide (Carkeet, Pither, & Anderson, 2014). The World Health Organization (WHO; 2015), reported that over 360 million people have a disabling hearing loss, which accounts for about 5% of the world population. Hearing loss often results in communication difficulties and is associated with cognitive and physical decline (Dalton et al, 2003). It affects a person physically, but can also negatively impact their overall quality of life by affecting their personal relationships, self-esteem, and social interactions (Chia, Wang, Rochtchina, Cumming, Newall, & Mitchell, 2007; Dalton et al., 2003). The effects of hearing loss vary based on the type, severity, and etiology. (Dalton, 2003). Persons with identical hearing losses may be impacted differently. In order to develop the best treatment plan to address the detrimental side effect of hearing loss, it is important to understand its type, degree, and etiology.

Obtaining an accurate diagnosis from a licensed audiologist is essential in guiding what treatment options are available. Once the type, degree, and etiology of the hearing loss are known the audiologist can begin considering treatment options. Hearing loss is typically classified as congenital or acquired. However, in cases where the cause of the hearing loss is unknown it’s considered idiopathic (Prosser, Cohen, & Greinwald, 2015). Congenital hearing loss is present at birth as the result of genetics or complications during pregnancy and/or delivery (Kenna, 2015). Acquired hearing loss, on the other hand, can occur at any stage of life and may be caused by a variety of different factors

(Kenna, 2015). Some common causes of acquired hearing loss include noise exposure, ototoxicity, and aging (Kenna, 2015; Lasak, Allen, McVay, & Lewis, 2014). The diagnosis of hearing loss occurs after a comprehensive audiological evaluation has been performed. It consists of subjective and objective tests (Baiduc, Poling, Hong, & Dhar, 2013).

Diagnosis of Hearing Loss

In order to comprehensively evaluate the auditory system, a battery of tests is needed to look into each part of the system. There are both subjective and objective tests. Patient participation is required in subjective tests, which includes behavioral and speech audiometry (Baiduc et al., 2013). Objective measures utilize physiological measurements that don't require patient participation (Baiduc et al., 2013; Lasak et al., 2014). In populations where behavioral tests cannot produce reliable results, objective tests can be used to obtain information regarding the status of the auditory system (Lasak et al., 2014). Examples of objective tests commonly used include otoacoustic emissions (OAE), which test the function of outer hair cells in the cochlea, and the auditory brainstem response (ABR) that measures neural firing from the auditory nerve up to the level of the brainstem (Baiduc et al., 2013; Lasak et al., 2014). Routine clinical assessments generally consist of both subjective and objective tests, with the core being the behavioral assessment (Baiduc et al., 2013).

In behavioral puretone audiometry, the patient responds each time they hear a puretone signal that is delivered via insert earphones, supraural earphones, or a bone oscillator to determine their hearing thresholds (Baiduc et al., 2013). The standard test frequencies include inter-octaves from 250-8000 Hz (Baiduc et al., 2013). Testing through insert or supraural earphones determines air conduction thresholds (Baiduc et al., 2013). Bone conduction thresholds are established by using a bone oscillator to bypass the outer and middle portions of the ear and deliver the stimuli more directly to the cochlea (Baiduc et al., 2013). Results from air and bone conduction testing are reported on an audiogram that allows us to diagnose the type of loss. An audiogram is a graph that has the test frequencies labeled across the x-axis and the intensity (dB HL) across the y-axis (Baiduc et al., 2013). In addition to puretone testing, speech audiometry is often conducted during audiologic testing.

Speech audiometry can help aid in the diagnosis of hearing loss. Speech recognition testing gives the audiologist an estimate of a patient’s threshold for speech by having them repeat two-syllable spondee words (i.e., “baseball”, “airplane”, “hotdog”) as the intensity is decreased (Baiduc et al., 2013). The intensity at which the patient is able to repeat 50% of the words is considered their speech recognition threshold (SRT), which serves as a crosscheck to puretone testing and as a baseline for word recognition testing (Baiduc et al., 2013). Another speech test commonly performed is word recognition testing. Patients repeat monosyllabic words at a comfortable level that is typically 40 dB SL above their SRT (Baiduc et al., 2013; Lasak et al., 2014). The percentage of words the individual is able to correctly repeat is considered their word recognition score (WRS) (Baiduc et al., 2013). The results of behavioral and speech audiometry are analyzed along with immittance test results to create a picture of how the outer, middle, and inner ear are working together (Baiduc et al., 2013).

An important part of the audiological evaluation is immittance testing. It commonly consists of tympanometry and acoustic reflex testing, which helps objectively confirm the type of hearing loss. Tympanometry provides information regarding the status of the middle ear (Baiduc et al., 2013). The volume, static compliance, and middle ear pressure are measured and displayed on a tympanogram (Baiduc et al., 2013). A classification scheme is used to describe tympanograms, where type A is considered normal, type B is flat, and type C indicates negative pressure (Baiduc et al, 2013). Type B and C tympanograms indicate abnormal middle ear function suggesting a conductive pathology (Baiduc et al., 2013). Acoustic reflex testing analyzes the reflex of the stapedius muscle. In normal healthy ears, the reflex occurs bilaterally in response to an intense impulse sound (Baiduc et al., 2013). Since the reflex occurs bilaterally, the results can be used to identify if there is a lesion along the reflex pathway (Baiduc et al., 2013). The results from these subjective and objective tests are analyzed together to classify the type, degree, and configuration of the hearing loss.

Classification of Hearing Loss

Type of Hearing Loss. There are three different types of hearing loss: sensorineural, conductive, and mixed. The most common type is sensorineural hearing loss (SNHL), which includes both sensory and neural causes of hearing loss or combined types (Muller & Barr-Gillespie, 2015). Sensory hearing loss occurs when there is damage to the sensory structures in the cochlea, such as the hair cells and the organ of corti (Baiduc et al., 2013; Muller & Barr-Gillespie, 2015). Noise-induced hearing loss is an example of a sensory loss that results from hair cell damage caused by exposure to intense noise (Lasak et al., 2014; Muller & Barr-Gillespie, 2015). Hearing loss is considered to be neural when the damage occurs along the auditory pathway beyond the cochlea (Baiduc et al., 2013). Auditory neuropathy spectrum disorder (ANSD) is an example of a neural hearing loss that occurs when outer hair cells are intact, but there is dys-synchronous firing along the auditory nerve (Hood, 2015). In general, hearing loss is reported as SNHL to encompass the losses that affect both sensory and neural structures. SNHL will be determined when the air and bone conduction thresholds are within 10 dB HL of each other and are outside normal limits (> 15 dB HL) **(** Baiduc et al., 2013)**.**

The second type is conductive hearing loss (CHL). CHL occurs when there is some dysfunction occurring in the outer and/or middle portions of the ear that prevents the sound from being properly transferred to the inner ear (Baiduc et al., 2013). Otosclerosis is a major cause of conductive hearing loss in adults that occurs when the stapes footplate becomes fixated preventing normal movement in and out of the oval window (Lasak et al., 2014). The audiogram will have normal bone conduction thresholds, but air conduction thresholds are in the range of hearing loss and at least 15 dB HL poorer than the bone conduction thresholds (Baiduc et al., 2013). The third type of hearing loss contains features of SNHL and CHL.

The last type is mixed hearing loss (MHL). MHL has features of both CHL and SNHL, indicating impairments occurring in the outer and/or middle ear as well as the inner ear. A MHL may occur when someone with SNHL develops an ear infection with middle ear fluid. This results in a CHL on top of the pre-existing SNHL. Hearing loss is considered mixed when air and bone conduction thresholds are outside the normal range and there is an air bone gap of more than 10 dB (Baiduc et al., 2013). Hearing loss is not only categorized as one of these types, but it is also categorized by the degree.

Degree of Hearing Loss. In addition to type, hearing loss is also categorized by degree (i.e., severity) based on where the air conduction thresholds are located on the audiogram. There are many different degree categorizations that have been published that slightly vary from one another (Clark. 1981). Clark (1981) published categories for the degree of hearing loss in an attempt to set a standard for classification. This classification scheme is what the American Speech-Language-Hearing Association (ASHA) has posted on their website (ASHA, 2016). Table 1 shows the categories for degree of loss published by Clark (1981).

Table 1

Degrees of Hearing Loss

Degree of Loss	dB HL
None	<16
Slight	16-25
Mild	26-40
Moderate	41-55
Moderately severe	56-70
Severe	71-90
Profound	>90

Note: Adapted without permission from “Uses and abuses of hearing loss classification.” by Clark, J. G. (1981). *ASHA*, 23, 493–500.

Configuration of Hearing Loss. Hearing loss may also be categorized by configuration. The configuration describes the trend in the hearing loss from one test frequency to the next, reading the audiogram from left to right (Hannula, Bloigu, Majamaa, Sorri, & Mäki-Torkko, 2011). Certain configurations are associated with specific etiologies that can aid professionals in determining the possible cause of the hearing loss (Hannula et al., 2011). For example, a notch in the 3-6 kHz range is typically seen in patients with a history of noise exposure (Hannula et al., 2011). A sharply sloping high frequency SNHL is associated with aging (i.e., presbycusis) (Hannula et al., 2011; Lasak et al., 2014; Muller & Barr-Gillespie, 2015). When the hearing loss is only present in one ear it is considered an unilateral hearing loss (UHL), and when hearing loss occurs in both ears it is considered bilateral hearing loss (ASHA, 2006). The hearing loss doesn’t have to be the same in both ears for it to be a bilateral hearing loss. If the type, degree, and configuration of hearing loss are identical in both ears it is called a symmetrical hearing loss (ASHA, 2006). Table 2 lists the most common types of configurations.

Table 2

Common terms used to describe configuration

Term	Description
Flat	<5 dB change per octave
Gradually sloping	5-12 dB increase per octave
Sharply sloping	15-20 dB increase per octave
Precipitously sloping	≥25 dB increase per octave
Rising	>5 dB decrease per octave
Peaked/Saucer	≥20 dB loss at extreme frequencies
Trough	≥20 dB loss in the mid frequencies
Notched	≥20 dB at one frequency with complete or near complete recovery at the adjacent frequency

Note: Adapted without permission from Schlauch, R. S., & Nelson, P. (2009). Puretone evaluation. In J. Katz, L. Medwetsky, R. Burkard, & L. Hood (Eds.), *Handbook of Clinical Audiology* (6 ed., pp. 7-30). Baltimore, MD: Lippincott Williams & Wilkins.

Identification of the type, degree, and configuration of a hearing loss is essential to developing a treatment plan. For instance, the type of hearing loss will determine if medical treatment is necessary or if the person can proceed with amplification. The severity will determine what amplification options are available or if other communication devices, such as cochlear implants, should be considered.

Treatment and Management of Hearing Loss

There are a variety of treatment and management options available for people with hearing loss, which vary based on the type and etiology. Treatment may consist of some form of medical, surgical, or amplification intervention (Lasak et al., 2014). Hearing aids are generally recommended for the management of a hearing loss, as long as it is within the aidable range. There are alternative non-auditory modes of communication, such as visual languages that includes American Sign Language (ASL) (Gravel & O'Gara, 2003). In certain cases, a medical evaluation is necessary to identify or rule out certain causes of hearing loss.

Medical Intervention. The Food and Drug Administration (FDA) recommends that all patients obtain medical clearance from a physician stating that they are a good candidate for hearing aids. However, patients over the age of 18 years have the right to sign a medical waiver. The FDA established a set of criteria that warrants a referral to a physician (and does not permit the signing of a waiver) that includes:

> visible deformity of the ear, history of active ear drainage in the past 90 days, sudden or rapidly progressing hearing loss in the past 90 days, acute or chronic dizziness, unilateral hearing loss of sudden or recent onset within the past 90 days, significant cerumen or visible foreign object in the ear, ear pain, an audiometric air

bone gap of 15 dB or greater at 500, 1000, or 2000 Hz, and children under the age of 18 years old (Steiger, 2005, p. 38).

If any of the red flags mentioned above are identified during an audiological evaluation, the patient should be referred to the appropriate physician. Additional testing is warranted in cases where the hearing loss presents with characteristics indicative of a more serious medical condition (Weaver, 2015). The physician will determine if the patient requires medical treatment, which may include surgery and/or medication. For example, steroids are often prescribed in cases of sudden SNHL due to their potential to reverse or minimize the permanent effects of sudden SNHL (Terzi, Ozgur, Coskun, Erdivanli, Demirci, & Dursun, 2016). In cases of UHL imaging may be done to rule out the possibility of a vestibular schwannoma (Weaver, 2015). In many cases of CHL, surgery may be done in an attempt to fix or replace any impaired structures in the middle ear. For example, patients with otosclerosis often undergo a stapedectomy to replace the fixated stapes with a prostatitis (Redfors, Hellgren, & Möller, 2013). If medical treatment is not successful or is not an option, hearing aids may be recommended to help compensate for the remaining hearing loss (Redfors, Hellgren, & Möller, 2013).

Hearing Aids. Hearing aids are the most common choice for the management of hearing loss (Hampson, 2012; Weaver, 2015). Hearing aids contain a microphone that detects acoustic signals, an amplifier that increases the signal’s intensity, and a receiver that delivers the amplified signal to the ear (Hampson, 2012). Hearing aids come in a range of styles and power options that can be used to fit most configurations and degrees of hearing loss (Hampson, 2012).

Styles. The most common styles of hearing aids include behind-the-ear (BTE) and in-the-ear (ITE) products (Hampson, 2012). BTE products are worn behind the ear with a tube that can be coupled to a custom earmold (Hampson, 2012). There is a slim tube option that connects to an earpiece that is less occluding than a traditional earmold and is often referred to as “open-fit” (Hampson, 2012). Receiver-in-the-ear (RITE) hearing aids are similar in style to BTEs except the receiver portion is placed in the end piece that sits directly in the ear canal (Hampson, 2012). ITE products are custom made and sit entirely in the ear. Custom ITE products are made from a casting of the patient’s ear. They come in a variety of sizes with the smallest, invisible-in-canal (IIC), to the largest, which is called a full shell (Hampson, 2012). The severity and type of hearing loss, personal preference, and dexterity issues contribute to which hearing aid is most suitable for an individual (Hampson, 2012). In some cases, traditional hearing aids aren’t an option and other amplification strategies are used (Weaver, 2015).

Alternative Options. In cases of single sided deafness (SSD) in which one ear is unaidable, a contralateral routing of signal (CROS) system may be used. With a CROS, a device similar to a BTE is worn on the non-hearing ear that takes the signal picked up by the microphone and transmits it to a receiver worn on the hearing ear (Weaver, 2015). If there is a hearing loss in the working ear, a system with bilateral microphones with contralateral routing of signal (BiCROS) is used. The concept is similar to the CROS, but the receiver is attached to a hearing aid that amplifies the signal before it is delivered to the hearing ear (Weaver, 2015). Transmitting the signal from the non-hearing ear to the hearing ear gives the person access to important signals from both sides (Weaver, 2015).

A bone anchored hearing aid (baha) is another alternative for SSD that delivers amplified sound to the better hearing cochlea through bone conduction (Lasak et al., 2014). It may also be used for patients who can't use traditional hearing aids, such as cases of atresia (Weaver, 2015). A baha device consists of a titanium abutment that is implanted on the side of the deaf ear with an attachable sound processor (Lasak et al., 2014). The sound processor converts the acoustic signal into vibrations that are transferred through the skull to the cochlea in the hearing ear (Lasak et al., 2014; Weaver, 2015). In addition to the baha, there are other surgically implanted devices used to give people with hearing loss access to sound.

Patients with severe to profound SNHL that receive minimal benefit from hearing aids may be candidates for a cochlear implant (CI) (Lasak et al., 2014). A CI is a device that is surgically implanted into head that stimulates the auditory nerve electronically to produce the sensation of sound (O'Donoghue, 2013). The internal components consist of a receiver coil and an array of electrodes placed along the cochlea. The external components include a microphone, speech processor and receiver (O'Donoghue, 2013). The microphone picks up the acoustic signal and sends it into the speech processor to be converted to a digital signal (O'Donoghue, 2013). The digital signal is sent to the transmitter that is aligned with the internal receiver coil (O'Donoghue, 2013). The receiver coil decodes the digital signal and sends electrical pulses to the electrodes along the cochlea, which directly stimulate the auditory nerve to produce the sensation of sound (O'Donoghue, 2013). While there is variety of amplification options available, they remain underutilized by people with hearing loss (Kochkin et al., 2010).

Prevalence of Hearing Aid Use

Despite the large population of individuals with hearing loss, only 25% of people who would benefit use hearing aids (Kochkin et al., 2010). Numerous studies have investigated the incidence of hearing aid use among adults diagnosed with hearing impairments (Bainbridge & Ramachandran, 2014; Nieman, Marrone, Szanton, Thorpe, & Lin, 2016). Bainbridge and Ramachandran (2014) examined the proportion of adults with hearing loss that used hearing aids in the United States. They wanted to determine if there was a relationship between hearing aid use and socioeconomic and demographic factors, health care utilization, and type of health insurance. The researchers obtained their data from the National Health and Nutrition Examination Surveys (NHANES) conducted in 2005-2006 and 2009-2010. The researchers identified 601 subjects as potential hearing aid candidates based on the criterion of having a PTA ≥ 35 dB HL in the better hearing ear or a self-report of difficulty hearing (Bainbridge & Ramachandran, 2014).

Bainbridge and Ramachandran (2014) interviewed participants to obtain the socioeconomic and demographic characteristics, health care utilization, and health insurance of the subjects. Age, gender, marital status, educational attainment, and family size were recorded for each subject. Poverty-to-income ratios (PIR) were generated for each of the subjects using the poverty thresholds set by the U.S. Census Bureau. Information regarding the number of health care visits over the past year, their last hearing test, and their insurance provider was also obtained. The researchers found that only 33% of the subjects reported using hearing aids. The 70-75 year olds had greater hearing aid use reported (41.1%) compared to the two other age groups ([70-74: 24.2%], [≥ 80: 33.6%]). Males had greater hearing aid use reported compared to females (38.2%

vs. 28.3%). Subjects with high PIRs were 28-66% more likely to report hearing aid use compared to those with the lowest PIRs. Subjects that had their hearing tested more recently were significantly more likely to report using a hearing aid compared to those who were tested more than 5 years ago. Having available financial support increased the likelihood of reported hearing aid use by 75%. These results indicated that overall hearing aid use is low and it is significantly lower in people with low PIRs, no recent hearing test, and no financial assistance (Bainbridge & Ramachandran, 2014).

Using the same sample population mentioned in the previous study, Nieman and colleagues (2016) examined hearing health care in adults to determine if any racial disparities existed. The same variables were analyzed as those used in the previous study except the researchers also included information on history of noise exposure. It is important to note that a recent hearing test was considered within the past four years and regular hearing aid use was defined as ≥ 5 hours a week for the past 12 months, which differed from the previous study. They found that the minority groups had lower education, income, PIRs, and rates of private insurance coverage compared to whites. Hearing aid use was more common in whites compared to the minority groups. Reports of noise exposure didn't vary by race. Recent hearing tests were more common in blacks and those with higher education. Poorer self-reported health was associated with lower rates of having a recent hearing test. They found that despite having a recent hearing test, hearing aid use was still low among blacks suggesting that access to hearing health care wasn't a barrier to hearing aid use for these individuals. Higher levels of education, PIR, and insurance coverage were associated with hearing aid use, which was consistent with the previous study (Bainbridge & Ramachandran, 2014; Nieman et al., 2016)

Helvik, Krokstad and Tambs (2016) found similar results while examining factors associated with hearing aid use in Norwegian adults. 11,602 subjects were selected from the Nord-Trondelag Hearing Loss Study (NTHLS), which was integrated as part of the Nord-Trondelag Health Study (HUNT). Audiometric testing was conducted for each patient bilaterally. Mean hearing thresholds were recorded for each of the following categories: low frequency hearing level (250- 500 Hz), medium frequency hearing level (1000-2000 Hz), and high frequency hearing level (3000-8000 Hz). Within each category, thresholds were averaged across frequencies for both ears. Information regarding hearing aid use, impact of hearing loss, marital status and education were obtained for each subject. The researchers found that despite 62% of the subjects having hearing loss, only 14% reported using a hearing aid. They reported that hearing aid use was associated with higher education, high and medium frequency hearing loss, and being more bothered by their hearing loss. Although the percentage of hearing aid use was lower in this study than the previous two, it is important to note that the sample used in this study included people with and without hearing loss (Helvik, Krokstad, &Tambs 2016).

The previous studies have shown that despite having a known diagnosis, the amount of hearing aid use remains low in individuals with hearing loss (Bainbridge & Ramachandran, 2014; Helvik, Krokstad, &Tambs 2016; Nieman et al., 2016). Hearing aid use is less prevalent among people with lower education, incomes closer to the poverty level, and no financial support (Bainbridge & Ramachandran, 2014; Nieman et al., 2016). Low hearing aid use is also associated with minorities and lower degrees of hearing loss (Helvik, Krokstad, &Tambs 2016; Nieman et al., 2016). Further studies have been done to investigate the reasons behind low hearing aid use in these populations (Kochkin, 2007; Kochkin, 2009; Kochkin et al., 2010).

Barriers to Hearing Aid Ownership

There are numerous factors that impact a person's decision to purchase hearing aids. The MarkeTrak VII survey investigated the main barriers that prevent adults with hearing loss from using hearing aids (Kochin, 2007). A survey was sent to 3000 non-hearing aid users that were identified as having a self-reported hearing loss. The survey contained 64 items across 11 categories. The subjects were asked to rate each item on a five-point scale as reasons for non-adoption of hearing aids. The top three categories most likely to impact the subjects' decision to purchase hearing aids were the degree of hearing loss (94%), minimization or lack of need (82%), and financial concerns (65%). It is important to note that the degree of hearing loss was self-reported by the subjects and may not reflect the true severity of their loss. If the subject is in denial of the severity of their impairment they are likely to state that the need for hearing aids isn't great enough to warrant purchasing them (Kochkin, 2007). To further investigate the financial barriers to adopting hearing aids, the researchers compared the average household income for the subjects who reported not being able to afford hearing aids to those that stated they could. They found significant differences in the average incomes of the two groups across all ages, which ranged from $2,100 up to $40,000. The researchers suggested that the significantly lower incomes of individuals that reported financial reasons as a barrier supports their claim that they can't afford to purchase hearing aids (Kochkin, 2007). Since many individuals cite financial reasons for not using hearing aids, it is important to investigate how much hearing aids cost.

With financial reasons being a widely reported barrier to hearing aid use, it is beneficial to know how much they typically cost. Marketrak VIII focused on the trends in hearing aid pricing (Kochkin, 2009). The researchers found that the average out of pocket cost for the consumer for a single hearing aid rose from $623 in 1989 to $1,601 in 2008 (Kochkin, 2009). Hearing aid prices vary by distributor, manufacturer, and technology level. Higher technology level hearing aids come with advanced features such as noise reduction, directional microphones, and multiple programs that help enhance the speech signal in more complex environments (Ingrao, 2011). Across most major manufacturers, an entry level hearing aid is less than $1000, mid-range is $1,000 to $2,500, advanced is $2500 to $3000, and a premium level is over $3000 (Ingrao, 2011). There are additional costs associated with hearing aids such as earmolds, batteries, repairs, and office visits that increase the financial burden (Carkeet, Pither, & Anderson, 2014). Even at the entry level of technology, hearing aids are too expensive for the majority of individuals who need them (Caccamo, Voloshchenko, & Dankyi, 2014).

Hearing Aid Programs for Low SES Adults

There is growing interest in establishing hearing aid programs that offer financial assistance for low-income individuals (Caccamo, Voloshchenko, & Dankyi, 2014). The cost, eligibility requirements, and the included services vary by program. Caccamo, Voloshchenko, and Dankyi (2014) evaluated the design and effectiveness of a hearing aid program in the Dominican Republic called EARs Inc. EARs Inc. aimed to establish a self-sustaining hearing aid delivery model that provides hearing aids to low income individuals in the Dominican Republic. The company established a contract with a hearing aid manufacturer to provide low-cost hearing aids. Participants in the program are asked to pay a small fee to help cover the cost of the hearing aids and follow-up services. Hearing aids are fit by trained hearing aid specialists or students under supervision. It is recommended that patients attend at least two follow-up appointments. When possible, repairs are completed using spare parts from donated hearing aids at no cost to the patient. The cost of batteries and other accessories are the responsibility of the patient (Carkeet, Pither, & Anderson, 2014).

The three major hearing aid programs available in the United States are: Starkey's Hear Now program, Veterans Health Administration (VA), and the Lions Association for Sight and Hearing (LASH).

Starkey's Hear Now Program. The Starkey Hearing Foundation provides hearing aids to those in need globally. Hear Now is a United States application-based program that provides hearing aids for low-income individuals. Eligibility is determined based on the applicant's income, assets, and hearing loss.

The following list of requirements is from the Hear Now 2016 application (Starkey Hearing Foundation, 2015). After contacting the organization to check their eligibility, the applicant needs to have their hearing tested by a hearing healthcare provider that works with Hear Now. A copy of the test results needs to be sent in with the application and must be less than 9 months old. The health care provider completes their portions of the application, which includes their recommendation of the type and number of hearing aids for the patient. The applicant must submit proof of income and their bank statements from the previous 6 months. The application fee is $125 for one hearing aid and $250 for two hearing aids (Starkey Hearing Foundation, 2015).

Each patient is fit with new “3 series” digital BTE or RITE hearing aids. The hearing aids come with a 1-year repair warranty, but they are not covered under loss and damage. The hearing healthcare professional waives their fitting fee and follow up services for the first year, but the patient is responsible for paying for their hearing test. If a patient’s application is denied, the money is returned. An application can only be submitted every 5 years (Starkey Hearing Foundation, 2015).

Veterans Health Administration (VA). The VA provides hearing aids for veterans enrolled in VA health care (U.S. Department of Veteran Affairs, 2016). Veterans that served in active duty qualify for VA health benefits. According to U.S. Department of Veteran Affairs (2016), veterans can enroll in person at any VA Medical Center or they can complete a 10-10EZ form online or by mail. Once enrolled, they will be referred to the Audiology and Speech Pathology Clinic for a comprehensive audiometric evaluation and hearing aid evaluation. The audiologist will determine whether they qualify for hearing aids or assistive listening devices. The make, style, and number of hearing aids selected for the veteran will be based on the test results. The evaluation, hearing aids, batteries, and repairs are free of charge. Some veterans may qualify for free wax guards and other accessories (U.S. Department of Veteran Affairs, 2016).

Lions Association for Sight and Hearing (LASH). The Lion’s Club provides hearing aids and glasses to low-income individual through its LASH program. The following information was obtained from the Lions Association for Sight & Hearing of Maryland, Inc. (2016). The LASH program in Maryland services individuals residing in Lion’s Club District 22A, which covers the clubs located in central Maryland. There is a non-refundable $25 application fee that needs to be approved to participate in the program. The application includes a LASH hearing assistance request form and documentation to provide proof of income. To be approved, the recipient's total household income cannot exceed three times the federal poverty guidelines. If the applicant is approved, they will be given a referral to Towson University's Hearing and Balance Center (TU-HBC), located in the Institute of Well Being (IWB). Referrals must be used within 30 days. When the patient is seen at the IWB, they will complete a Towson University application for reduced fee and have a hearing test. Patients are fit with either new Rexton BTE hearing aids or donated hearing aids that have been refurbished through Starkey's All-make repair lab. If the patient is fit with BTE hearing aids, impressions will be taken and the earmolds will be ordered. The hearing aids have a one year limited repair warranty. Services include hearing aids, earmolds, hearing aid fitting appointment, instructions on care and use, and follow up consultations. All services are provided by University staff and graduate clinicians at TU-HBC. The hearing aids and repairs are billed directly to LASH by the manufacturer. The earmolds are billed to TU-HBC, and the Lion's Club reimburses the clinic the full amount. LASH is also responsible for covering the cost of the hearing aid evaluation and the dispensing fee, which is paid to the clinic. The cost of the hearing aids varies depending on what hearing aids are fit and the patient's income. However, in most cases patients are only responsible for the application fee, which is paid to LASH, and the hearing test that is paid to TU-HBC (Lions Association for Sight & Hearing of Maryland, Inc., 2016).

Outcomes of Hearing Aid Programs for Low SES Adults

Financial barriers are not the only factor that contributes to a person's success with hearing aids (Kochkin et al., 2010; Kochkin, 2007). It has been shown that other factors such as hearing aid fit, previous use, follow up visits, maintenance and care, counseling, and satisfaction affect a patient’s success with hearing aids (Kochkin et al., 2010). Self-report measures, such as questionnaires, are commonly used to assess patient satisfaction with hearing aids (Prosser, Cohen, & Greinwald, 2015). An example of a questionnaire is the Client Oriented Scale of Improvement (COSI). The COSI is a quality of life (QOL) questionnaire administered to patients with hearing loss as a measure of self-perceived benefit from hearing aids (Emerson & Job, 2014). It is administered pre and post hearing aid fitting (Emerson & Job, 2014). The pre-fitting phase requires the patient to identify difficult communication situations that they would like improved with amplification (Emerson & Job, 2014). After being fit with the hearing aids, the questionnaire is revisited, and the patient is asked to rate the amount of benefit they received from amplification for each of the situations (Emerson & Job, 2014). Although hearing aid programs remove the financial barrier for patients, the COSI or other forms of self-reported measurements of benefit should be employed to monitor patient success with hearing aids (Prosser, Cohen, & Greinwald, 2015).

Iwahashi, Jardim and Bento (2013), investigated the effectiveness of hearing aids dispensed by a publicly-funded health service in Brazil. The sample consisted of 200 adults that were fit with bilateral digital BTE hearing aids over a one-year period. Each subject answered a set of open-ended questions regarding hearing aid use and completed the Satisfaction with Amplification in Daily Life (SADL) questionnaire. A visual inspection and listening check were performed on each hearing aid to ensure that they were a proper fit and in good working order. Otoscopy and audiometric testing was performed to assess any possible changes in hearing that may affect hearing aid use. Any counseling or program adjustments given during the appointment were classified as minor or major. The researchers found that only 68% of the subjects attended follow-up appointments during the first year. One year after being fit 76.5% were still wearing both hearing aids, 10.5% reported only using one hearing aid, and 13% were not wearing their hearing aids at all. The most common reason for not wearing both devices was sound discomfort (25.5%). Every subject required some form of intervention except for one (99.5%). Eighty-one subjects required major interventions with the most common being an adjustment of more than 5 dB in hearing aid gain. 118 subjects required minor interventions. The most common minor interventions included counseling regarding phone use (31.5%), maintenance and cleaning (28%), and on the benefits and limitations of hearing aids (22.5%). Adjustments of less than 5 dB of hearing aid gain (22.5%) were also commonly reported. The authors suggest that the 32% of subjects that did not return for any follow-up visits highlights the need to improve the protocol regarding long-term monitoring of these patients. Sound discomfort was the number one reason that subjects stopped wearing their hearing aids, which is usually alleviated through programming adjustments. The researchers suggest that if the patients were seen for routine follow-ups the necessary adjustments and counseling would be addressed sooner, which would lead to higher rates of long-term hearing aid use (Iwahashi, Jardim, & Bento, 2013).

Freitas and Costa (2007), found similar results in a group of 31 low-income patients that were fit with publicly funded hearing aids at the Federal University of Santa Maria. It is important to note that the sample was originally 37, but 6 subjects were lost to follow up. This was much lower than the drop-out rate reported by Iwahashi, Jardim, and Bento (2013) in the previous study, but it may be due to the small sample size. Each participant was interviewed to collect information regarding any complaints on use, batteries, earmolds, amplification characteristics, and access to a hearing specialist. Only 18 participants reported that they wore their hearing aids full time. This was lower than the previous study, but it may be due to the small sample size. Twenty-one (64.74%) of the participants had one or more complaints regarding their hearing aids. The most common complaints were that the sound was too strong (28.57%), sound was too weak (28.57%), and discomfort with binaural use (28.57%). Seven (33.3%) of the subjects had hearing aids that were not functioning or distorted. Despite the majority of participants reporting at least one complaint, there was no association with the number of complaints and the duration of use. The participants didn't vocalize their concerns regarding their hearing aids until they were probed by the interviewer. The researchers suggest that this reflects that participant's lack of self-advocacy regarding solving problems with their hearing aids. This supports the claim that long-term follow up appointments are necessary to identify and address any problems (Freitas & Costa, 2007; Iwahashi, Jardim, & Bento, 2013).

Statement of Purpose

While hearing aid programs have the potential to provide hearing aids to people who would not otherwise be able to access them, it doesn't guarantee successful use. The previous studies show the majority of patients that received hearing aids through funded programs needed follow-up services or were not satisfied with their devices, despite alleviating the financial burden (Freitas & Costa, 2007; Iwahashi, Jardim, & Bento, 2013). There should be long-term monitoring of appointments to prevent losing patients to follow-up (Iwahashi, Jardim, & Bento, 2013). Follow-up appointments are necessary to address patient concerns and make necessary adjustments to increase the likelihood of success (Freitas & Costa, 2007; Iwahashi, Jardim, & Bento, 2013). To date, no studies have been done to investigate the long-term outcomes of the LASH program at the TU-HBC. Thus, the purpose of this study was to conduct a retrospective chart review to identify the outcomes of patients that received hearing aids and services through the LASH program at the TU-HBC. Information regarding the number of follow-up visits, hearing aid type, monaural or binaural fitting, adjustments and repairs, years of experience, and quality of life were analyzed. To identify characteristics of the patient population, information regarding age, gender, and hearing loss were also recorded.

Chapter 3

Methods

Participants

This study was a retrospective chart review of 100 adult patients that participated in the Towson University's Hearing and Balance Center (TU-HBC) LASH program from August 2012 to December 2014. Patients signed an IWB federal privacy act notification form prior to their first visit at the IWB. This form states that their health information may be disclosed to researchers when their research has been approved by an institutional review board to ensure the privacy of their health information.

Materials and Procedures

Data Collection. The people that were fit with LASH hearing aids had their charts reviewed and the following was recorded on a separate data sheet: demographic characteristics (age, gender, hearing aid experience, medical clearance, and referral source), audiometric assessment (audiogram, speech recognition thresholds, and word recognition scores), hearing aids (fit, make, model, style, and acoustic coupling), appointment type (fitting, first follow up, and services performed at visits one and two), repair rates (frequency and type), and quality of life (questionnaires and patient reports) (Appendix A). Additionally, cost of services was reviewed (Appendix B).

All information regarding the participants' identities was kept confidential. Each participant was assigned an identification number that was used to track their information but de-identify them for data analysis only. The clinical charts remained in a HIPPA protected medical file at the TU-HBC. All data collection was conducted in a secure file area at the TU-HBC, which was designated by the IWB Director. The information obtained from the files in paper copy were kept in a locked research lab. Electronic copies of any data containing identifying information was kept on a password protected computer in a password protected file. One master list with patient names and matching identifying numbers was kept by the researchers in a password protected computer in a password protected file (passwords did not match).

Outcome Data.

Demographic characteristics. Demographic information including gender, age, hearing aid experience, medical clearance, and referral source of each participant was recorded. The age recorded was the patient's age at the time of the hearing aid fitting. For hearing aid experience, it was noted if the participant was an experienced or new hearing aid user. It was recorded whether the patient had to obtain medical clearance or if a waiver was signed. Referrals from the International Rescue Committee (IRC) were also recorded. This information was recorded from their file to a seperate data sheet (Appendix A part I).

Audiometric assessment. Audiometric assessments in the participant's chart were analyzed. Air and bone conduction thresholds, speech recognition thresholds, and word recognition scores were recorded. Air conduction pure tone thresholds at octaves from 250-8000 Hz were recorded along with the type of hearing loss (Appendix A part II).

Hearing aids. Information regarding the hearing aids fit for each participant was reviewed. Whether it was a monaural or binaural fitting was noted. The make, style, and acoustic coupling of the hearing aids were recorded. If an earmold was fit, the material and style were documented. If a dome was used, it was noted whether it was open or closed (Appendix A part III).

Patient appointment type. For the hearing aid fitting appointment, any counseling and real-ear measurements (REM) performed were recorded. The duration from the time of the hearing aid fitting and the first follow-up appointment was obtained for each patient. The number and reason for all follow-up appointments were noted. Reasons for follow-up appointments included program adjustments, counseling, repairs, routine maintenance, or other (Appendix A part IV).

Repair rates. The number of repairs was obtained. It was recorded whether the hearing aid could be repaired in-house or if it was sent out to the manufacturer (Appendix A part V).

Quality of life. Any Quality of Life (QOL) questionnaires in the file were reviewed and documented. Both pre- and post-fitting were included in the analysis. At the TU-HBC the COSI is typically administered at the time of the hearing aid evaluation and reviewed during the first follow-up after the hearing aids are fit. Results from any COSI questionnaires were documented. Reports and disposition notes from the first follow-up appointment were reviewed to analyze patient satisfaction with the hearing aids. If applicable it was classified as satisfaction or dissatisfaction with the sound quality, physical comfort, or volume of the hearing aids. There also was a category labeled “other” for additional patient reports (Appendix A part VI).

Cost of services. Information regarding TU-HBC’s cost for various services provided was obtained from the billing department in the IWB. Any billable services such as the audiometric evaluation, hearing aids, earmolds, repairs, and follow-up services were recorded for each participant. The amount billed, written-off, and reimbursed for the service were also recorded. Specifically, the amount billed to the insurance company or 3rd party payer and the reimbursement amounts was recorded. The responsible party (i.e., Medicare, the Lion's Club, or self-pay) was documented (Appendix B).

Statistical Analysis

Data from patient charts was recorded in Excel version 15.16. Descriptive analysis was conducted using Excel.

Chapter 4

Results

A retrospective chart review was conducted on 104 randomly chosen charts from LASH billing sheets dated from September 2012 to December 2014. Of the 104 charts initially chosen, four were not included because the patients were never fit with hearing aids.

Patient Demographics.

Out of the 100 charts used in this study, there were 35 males and 65 females. Ages ranged 18 to 96 years old (M=65.55, SD=19.23). The average age was 64.06 years (SD=17.86) for males and 66.35 years (SD=20.02) for females. IRC accounted for 14% of the total referrals (males=11.43%; females=15.38%) (Table 3). The majority of the subjects (61%) had no prior hearing aid experience and 39% were previous users.

Table 3

Patient Age and Referral Source

Referral Source	Males (n=35)	Females (n =65)	Total (n= 100)
IRC	4 (11.43%)	10 (15.38%)	14
Other	31 (88.57%)	55 (84.62%)	86

Note. The total number (n) for each referral source is displayed for each group. The percentage of each referral source for males and females is contained in the parenthesis.

Audiometric Results.

The majority of the patients had SNHL (n=84). There were 13 with MHL, and three with CHL. Medical clearance was required for all the patients with CHL, and for 11 of the 13 cases of MHL. The two participants with MHL that signed waivers had a history of stable MHL that didn’t required further medical evaluation. About half (n=40; 47.62%) of the patients with SNHL required medical clearance. Reasons for medical clearance in patients with SNHL included asymmetrical hearing loss, poorer than expect WRS, and referred with medical clearance. The number of participants that required medical clearance or signed a waiver for each type of hearing loss is displayed in Table 4.

Table 4

Medical Clearance Required by Type of Hearing Loss

Type of Hearing Loss	Medical Clearance	Waiver	Total
Sensorineural			84
Asymmetrical HL	27		
Poorer than expected WRS	5		
Referred with medical clearance	8		
Waiver		44	
Conductive			3
Clearance from ENT	3		
Waiver		0	
Mixed			13
Clearance from ENT	11		
H(x) Mixed HL		2	
Total	54	46	

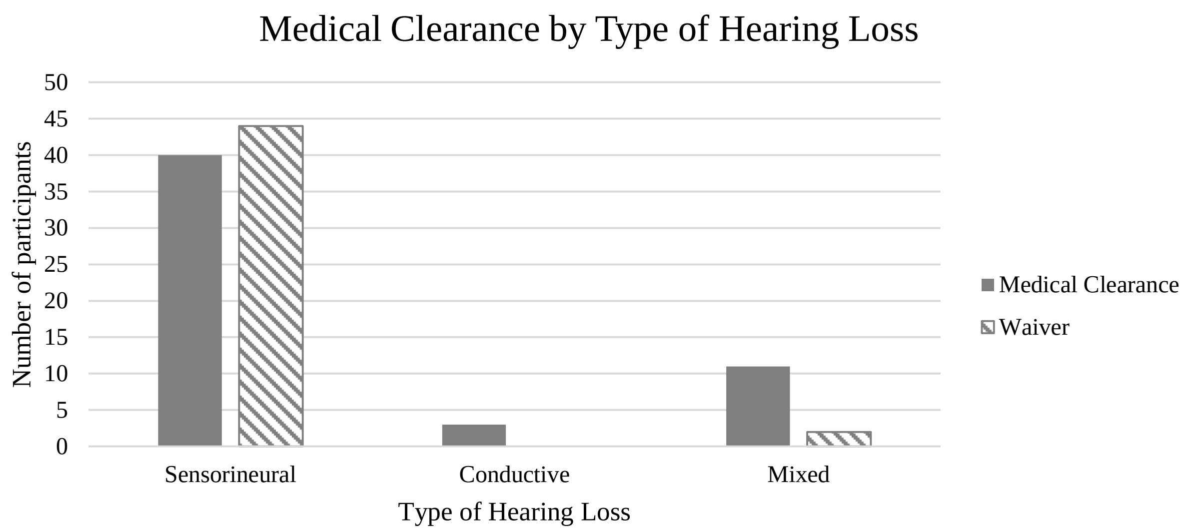

Figure 1. The number of subjects that required medical clearance or signed a waiver was recorded for each type of hearing loss.

Data for puretone air conduction thresholds were collected at 250, 500, 1000, 2000, 4000, and 8000 Hz for both ears. The average thresholds for each frequency are displayed in Figure 2. The mean thresholds increased as the test frequency increased, indicating that on average the subjects had poorer high frequency hearing.

The average PTA was 55.43 dB HL (n=100, SD=22.21) for the right ear and 55.91 dB HL (n=99, SD=22.61) for the left ear, which are on the borderline of the moderate to moderately-severe hearing loss range. The mean SRT was 48.76 dB HL (n=89, SD=21.88) for the right ear and 47.21 dB HL (n=89, SD=23.32) for the left ear. Speech audiometry wasn't obtained for 10 participants because English was not their native language. The average PTA and SRT can be seen in Figure 3. WRSs for both ears were obtained on 74 participants. The mean WRS was 70.85% (SD=23.69) in the right ear and 66.16% (SD=25.06) for the left ear. Binaural WRS was only obtained for 16 participants with an average of 73.5% (SD=21.40) (Figure 4). The average PTA, SRT, and WRS for each ear is displayed in Table 5. Table 6 displays WRS by category. For the left and right ears, most of the participants had a poor recognition WRS, 40.5% and 50% respectively. In the binaural condition, 37.5% (n=6) of the participants had a good WRS. It should be noted that some subjects only had functional hearing in one ear, therefore data was only available for one ear.

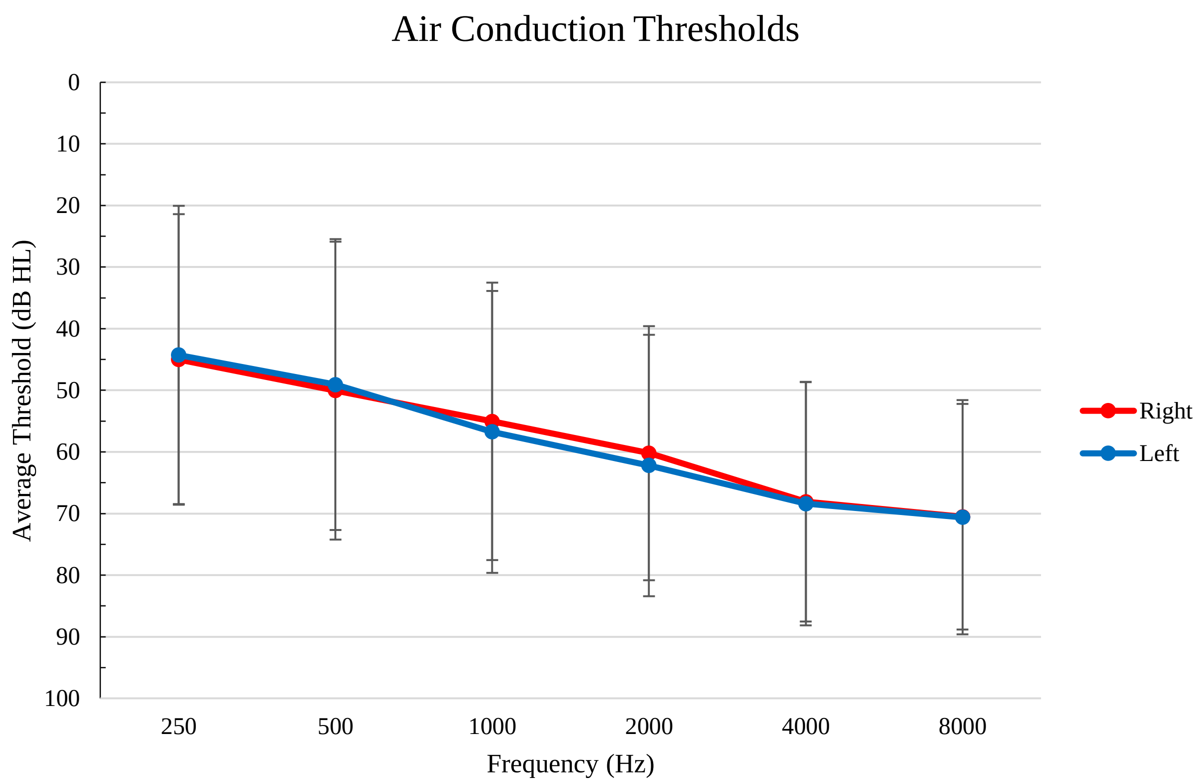

Figure 2. Frequency specific mean air conduction thresholds are displayed on the graph for each ear. The error bars represent the standard deviation for each.

Table 5

Audiometric Test Results

		n	*M*	*SD*
PTA (dB HL)	Right Ear	100	55.33	22.12
	Left Ear	99	56.10	22.23
SRT (dB HL)	Right Ear	89	48.76	21.88
	Left Ear	88	47.22	23.32
WRS (%)	Right Ear	74	70.85	23.69
	Left Ear	74	66.16	25.06
	Binaural	16	73.5	21.4

Note. The puretone average (PTA), speech recognition threshold (SRT), and word recognition score (WRS) for each ear was collected. If WRS was obtained binaurally it was recorded. The total number (n), average (M), and standard deviation (SD) for each is displayed above. The PTA and SRT are displayed in dB HL. WRS is displayed as a percentage (%).

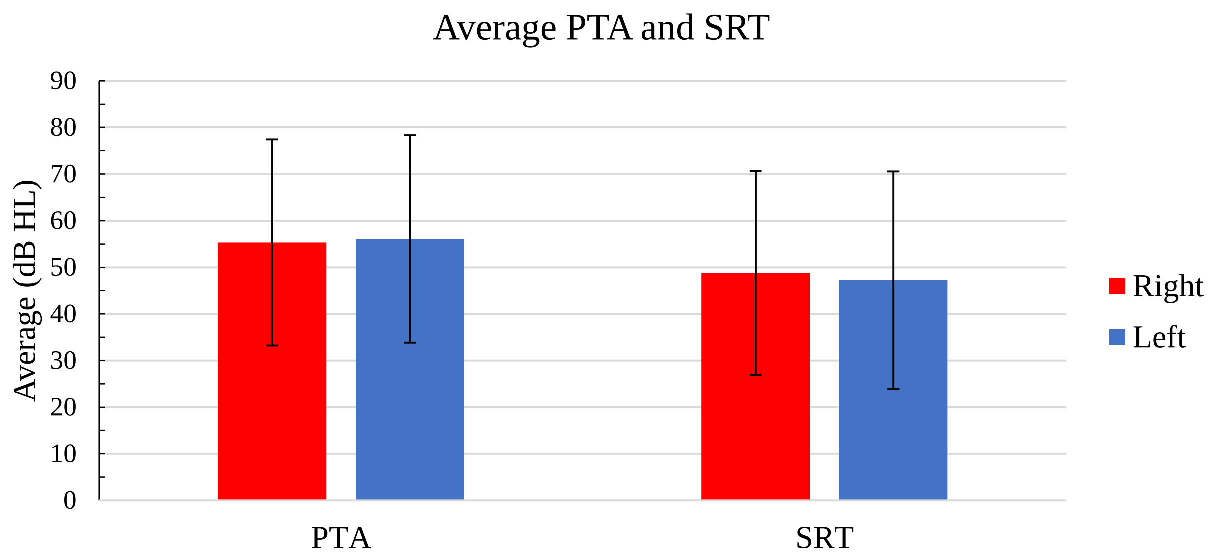

Figure 3. The mean puretone average (PTA) and speech recognition threshold (SRT) are displayed on the graph for each ear. The error bars represent the standard deviation. The averages for both PTA and SRT are expressed in dB HL.

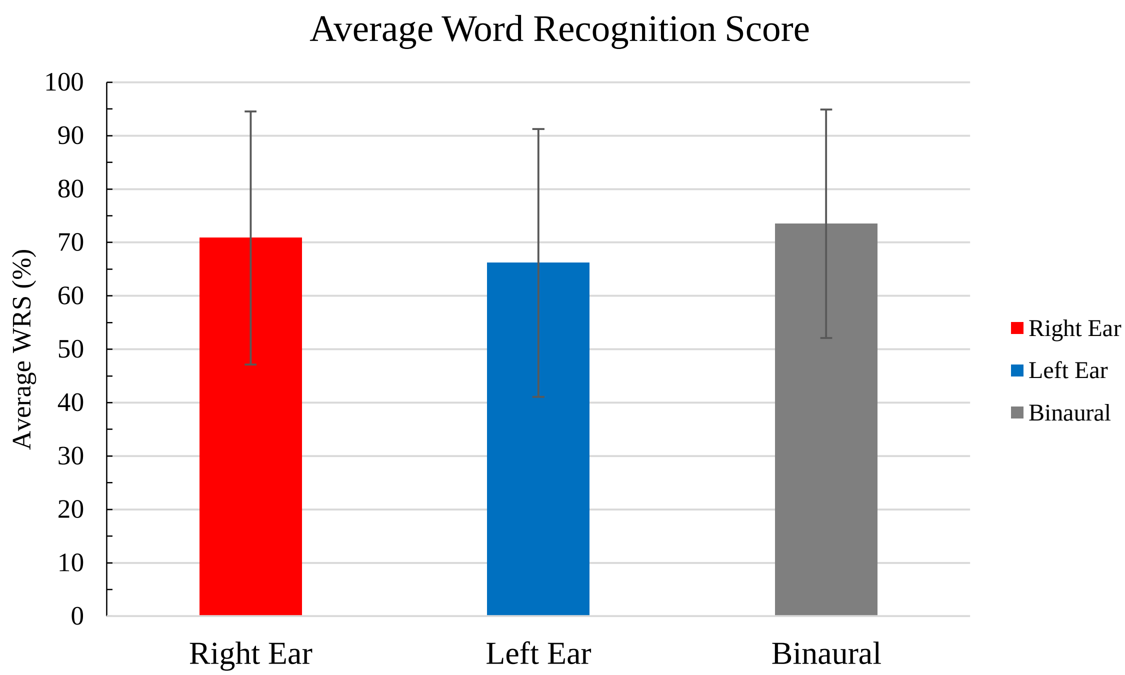

Figure 4. The mean word recognition score (WRS) is displayed on the graph for three different test conditions: right ear, left ear, and binaurally. The error bars represent the standard deviation for each. The averages for all three test conditions are expressed as a percentage (%).

Table 6

Classification of Word Recognition Scores

	Right Ear (n=74)	Left Ear (n=74)	Binaural (n=16)	Total (n=164)
Excellent	17 (23.0%)	14 (18.9%)	3 (18.8%)	34 (20.7%)
Good	19 (25.7%)	15 (20.3%)	6 (37.5%)	40 (24.4%)
Fair	8 (10.8%)	8 (10.8%)	2 (12.5%)	18 (11.0%)
Poor	30 (40.5%)	37 (50.0%)	5 (31.3%)	72 (43.9%)

Note. The number of participants for each category of WRS is displayed by test condition. The percentage of the total for each test condition is contained within the parenthesis.

Hearing Aids.

Eighty-nine percent of the participants were fit binaurally. Of the 11 monaural fittings, 2 had devices on the other ear (1 cochlear implant and 1 previously fit hearing aid). Thirty-nine subjects received Rexton hearing aids. Sixty-one participants were fit with hearing aids that were refurbished through Starkey. Refurbished hearing aids were from the manufacturers Phonak, Oticon, Widex, and Starkey. Eighty-six were fit with BTE devices and 14 were fit with RITE devices. Majority (n=70) of the BTE hearing aids were coupled to earmolds. The remaining 30% of all hearing aids were coupled to domes (BTE (open fit/slim tube)=16; RITE=14). Table 7 displays the hearing aid characteristics for all the subjects.

Table 7

Hearing Aid Characteristics

Variable		n
Experience		
	New	61
	Experienced	39
Fit		
	Binaural	89
	Monaural	11
Make		
	Rexton	39
	Refurbished	61
Style		
	BTE	86
	RITE	14
Coupling		
	Earmold	70
	Dome	30

The earmold style and material for the 70 subjects fit with earmolds are displayed in Table 8. The most common styles fit were full shell (n=25), skeleton (n=18), and half shell (n=15). The top three materials used were silicone (n=21), acrylic (n=18), and vinyl (n=15). The top three combinations of style and material used were silicone full shell (n=15), acrylic skeleton (n=10), and vinyl half shell (n=6). Figure 5 display the number of each earmold style by material type. Three participants were fit with a different style earmold for each ear bringing the total number of styles fit to 73.

Table 8

Earmold Style and Material

Style	Acrylic	Silicone	Vinyl	MGS	BS/AC	Total
Full Shell	4	15	4	3		25
3/4 Shell	1	2		1		4
Half Shell	3	1	6	4	1	15
Skeleton	10	4	1	1	2	18
Canal		1	4	4	1	10
Micromold	1					1
Total	18	21	15	12	4	

Note. The table displays the number of earmolds fit for each style and material combination.

The total columns represent the total number of earmolds fit for each style and each material.

MGS=medical grade silicone, BS/AC=body soft with acrylic canal.

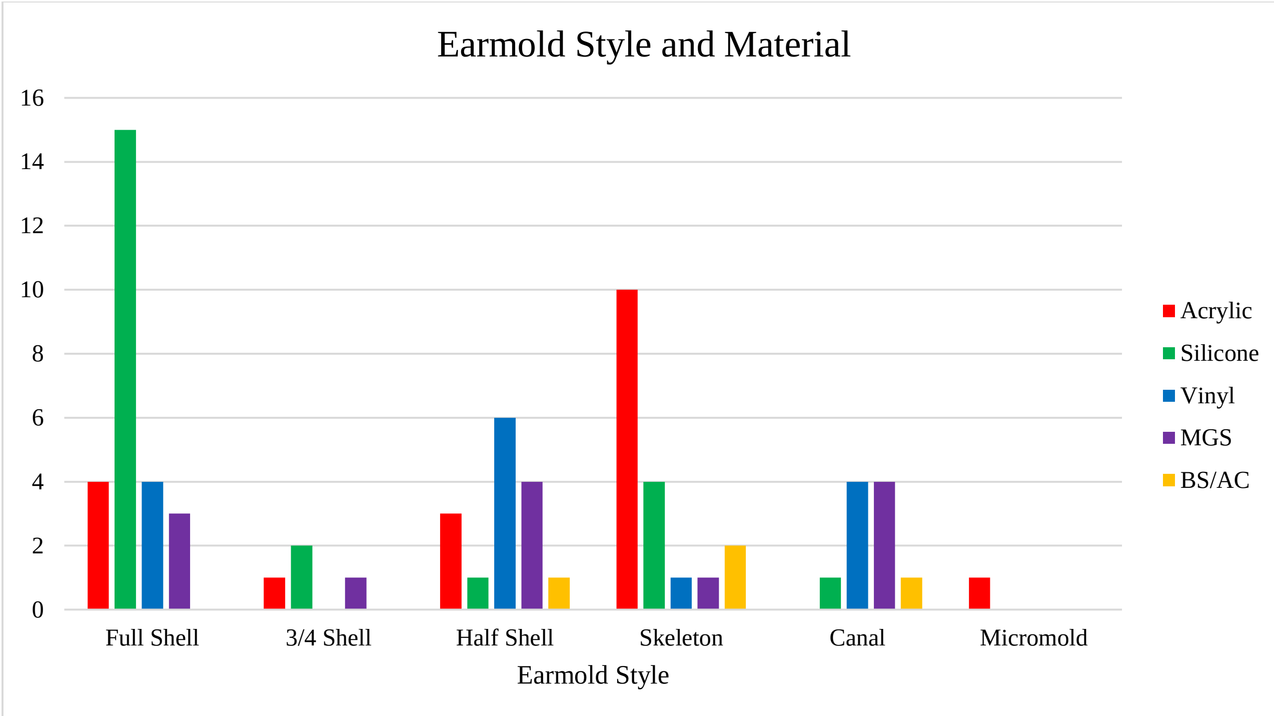

Figure 5. The number of earmolds fit for each style is displayed by material. The bars represent the material used. MGS=medical grade silicone, BS/AC=body soft with acrylic canal.

Appointments.

Real-ear measurements were obtained for 83 of the participants during the fitting appointment. Informational counseling was documented for 96 of the fittings, while affective counseling was only documented for 20 participants. The duration between the hearing aid fitting and the first follow-up appointment ranged from 3 to 360 days with an average of 61.61 days (n= 77, SD= 76.94). Twenty-three subjects were lost to follow-up after the fitting. The number of follow-up appointments ranged from one (n=77) to 14 (n=1) with the average number of appointments being 3.04 (n=77, SD= 2.60) during the 2-year period under review (Figure 6).

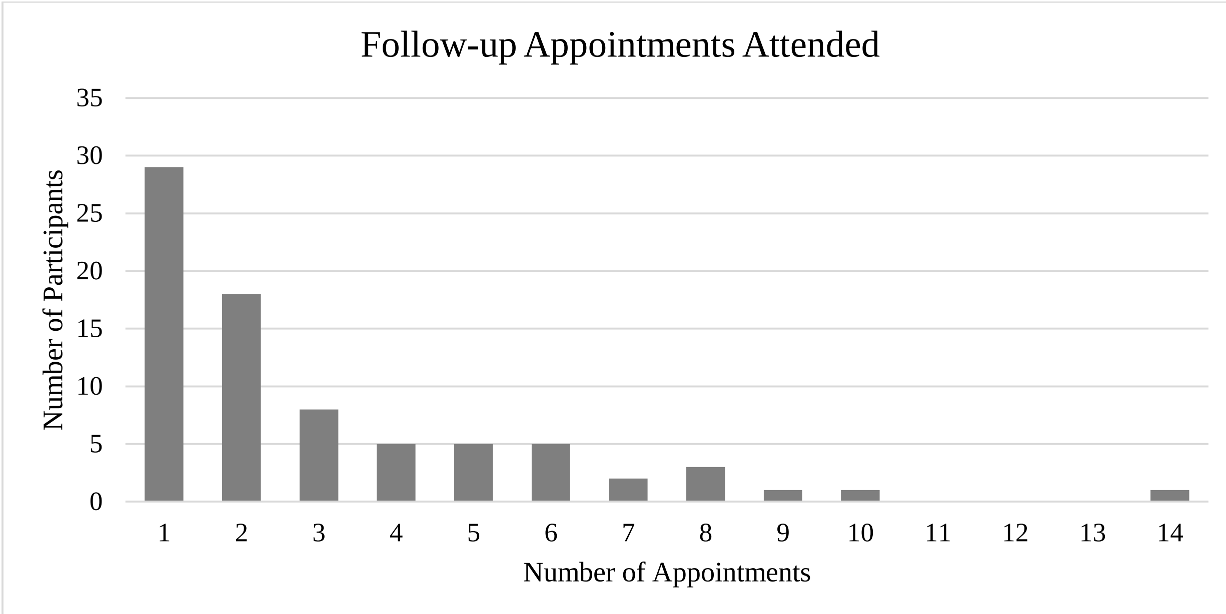

Figure 6. The bar graph displays the total number of follow-up appointments attended by participants in the two years after the hearing aid fitting.

The different services performed during the first two follow-up visits after the hearing aid fitting are displayed in Table 9. Many of the visits covered more than one type of service. Counseling was the most common service provided during the first two visits (n=49), followed closely by repairs (n=46), and programming (n=43). Programming adjustments were the top service performed at visit one (n=34), followed by counseling (n=31) and repairs (n=20). Repairs were the most commonly performed service for second visits (n=26). Routine maintenance included visits where the patient had no complaints regarding the hearing aids and the devices were cleaned and checked. These only made up a small number of the services performed for visits one and two (n=11). Services listed under other included re-evaluations, aural rehabilitation, earmold fittings, issuance of a second hearing aid, and one instance of returning the hearing aids.

Table 9

Services Performed During Visits 1 and 2

Service	Visit 1	Visit 2	Total
Programming	34	9	43
Counseling	31	18	49
Repairs	20	26	46
Routine Maintenance	8	3	11
Other	16	8	24

Repairs.

Forty-two of the participants required at least one repair over the 2-year period under review. Of the 42 requiring repairs, 6 (14.29%) had RITE devices and 36 (85.71%) had BTEs. A majority of the devices that required repairs were BTEs that were coupled to earmolds (n=30, 71.43%). There was a total of 83 repairs, 48 were completed in-house and 35 had to be returned to the manufacturer (Table 10). Of those repaired in-house, 24 were due to issues with the earmold and 24 were due to casing issues. Repairs classified under earmold included tubing changes and earmold modifications. Casing issues included replacing the tonehook, microphone covers, or battery doors. The percentage of repairs sent-out is displayed in Figure 7. The majority of repairs sent out were due to dead hearing aids (n=19, 54%). The second most common cause of repairs sent-out were due to distortion (n=11, 31%), which was followed by casing issues (n=3, 9%). A total of 2 hearing aids were lost and were covered under warranty (n=2, 6%).

Table 10

Total Number of Repairs

Type	n
In-House	48
EM	24
Casing	24
Sent Out	35
Distorted	11
Dead	19
Casing	3
Lost	2

Note. The total number of repairs complete in-house and sent-out are displayed in the table above. The reason behind device failure is also listed under each category of repairs. The total number of devices that were lost and replaced under warranty is listed. EM=earmold.

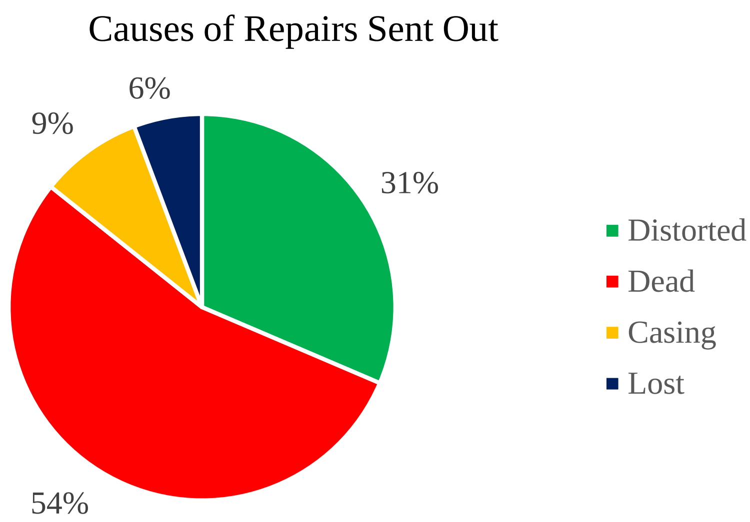

Figure 7. The percentage of the repairs sent-out are displayed in the pie-chart. The sections represent the percentage of repairs by cause of device failure.

Billing.

Services included in the total billing were the audiologic evaluation, hearing aid evaluation, hearing aid fitting, and other services such as batteries or repairs. The Lion's Club has their own account with Rexton, which they are billed directly through for patient's receiving Rexton hearing aids. The manufacturers' invoice costs for refurbished hearing aids were billed to the Lion's Club. The Lion's Club reimbursed the clinic the total cost of earmolds so it wasn't included in the analysis. The total amount of revenue generated from the participants in the program was $12, 272.91. This was less than half (32.18%) of the amount billed. A total of $25, 862.09 was written off for all the services. Table 11 displays the total amount billed, written-off, and reimbursed for services by the responsible payor. The breakdown of revenue generated from the Lion's Club, insurance, and self-pay is displayed in Figure 8.

Table 11

Total Amount Billed, Written-off, and Reimbursed for Services

Service	Billed	Written-Off	Reimbursed
Insurance			
Audiologic Evaluation	$6450.00	$3385.08	$3064.92
Self-Pay			
Audiologic Evaluation	$3930.00	$3397.01	$532.99
Other	$855.00	$0	$855.00
LASH			
HAE	$3000.00	$2084.50	$915.50
Dispensing fee	$23900.00	$16995.50	$6904.50
Total	$38135.00	$25862.09	$12272.91

Note. The table displayed the amount billed, written-off, and reimbursed for services for each responsible payor. All values are expressed in U.S. dollars ($). HAE=hearing aid evaluation.

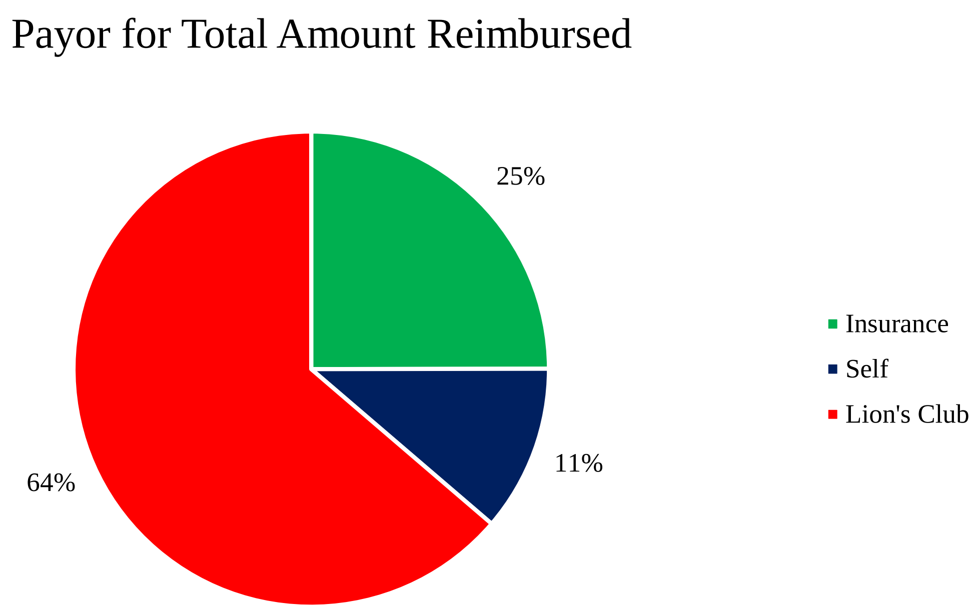

Figure 8. The breakdown of the total amount reimbursed by payor is displayed in the pie-chart. The sections of the pie-chart represent each responsible payor (insurance, self-pay, and Lion’s Club).

Insurance.

Audiologic evaluations are not covered by LASH. The cost of the evaluation was either billed to the patient or insurance. The only two insurances accepted at the TU-HBC are Medicare/Medicaid and BlueCross BlueShield (BCBS). The amount reimbursed for services varied by year for each company. Reimbursement rates were obtained from the billing department at the IWB and through Medicare's website. The average amount reimbursed by BCBS for an audiologic evaluation from 2012 to 2014 in Baltimore, MD was $59.80 (SD=0.01). Six participants had BCBS and the total reimbursed was $358.80. The average amount reimbursed by Medicare/Medicaid during this time period was $60.14 (SD=9.48). For the 45 participants with Medicare/Medicaid, the total reimbursed for audiologic evaluations was $2706.12. The total reimbursed by both insurance companies was $3064.92. It is important to note that some participants didn't undergo a complete comprehensive audiologic evaluation, which was reflected in the price billed to insurance.

Self-Pay.

Eighty-six participants qualified for reduced fees for services. Table 12 displays the costs for services for each reduced fee amount; it also displays the number of participants that qualified for each reduced fee amount. The diagnostic evaluation price is based on the amount billed for a comprehensive audiometric evaluation (air and bone conduction puretone audiometry and speech audiometry), tympanometry, and acoustic reflex testing. It should be noted that a comprehensive evaluation, tympanometry, and acoustic reflex testing weren't always performed. In some cases, only puretone testing was completed or tympanometry was conducted without acoustic reflex testing. The amount billed for these patients was altered based on what specific procedures were performed. If the patient didn't have an accepted form of insurance, they were responsible for paying for the audiologic evaluation. Other self-pay services included repairs, additional batteries, and dri-aid kits.

Table 12

Reduced Fee Pricing for Services

				Dispensing Fee ($)	
Reduced Fee	n	D(x) Evaluation ($)	HAE($)	Monaural	Binaural
None	14	125.00	30.00	150.00	250.00
$2	31	2.00	2.00	2.00	2.00
5%	6	6.25	1.50	7.50	12.50
10%	9	12.50	3.00	15.00	25.00
15%	10	18.75	4.50	22.50	37.50
20%	4	25.00	6.00	30.00	50.00
25%	1	31.25	7.50	37.50	62.50
30%	4	37.50	9.00	45.00	75.00
35%	7	43.75	10.50	52.50	87.50
40%	4	50.00	12.00	60.00	100.00
45%	3	56.25	13.50	67.50	112.50
50%	1	62.50	15.00	75.00	125.00
55%	3	68.75	16.50	82.50	137.50
60%	1	75.00	18.00	90.00	150.00
70%	2	87.50	21.00	105.00	175.00

Note. The table displays the pricing for various services based on reduced fee amounts. The number of participants that qualified for each reduced fee is displayed (n). The pricing values are in U.S. dollars ($). D(x) evaluation=diagnostic evaluation, HAE=hearing aid evaluation.

LASH.

The LASH program was responsible for covering the cost of the hearing aid evaluation, fitting fee, hearing aids, earmolds, and in some cases repairs. The Lion's Club was billed directly by the manufacturers for the hearing aids and repairs. The cost of hearing aids ranged from $0 to $525.94 (M= 272.96, SD= 144.63). LASH patients received a reduced fee for earmolds, which was $40.00 per ear. Earmolds are billed to the TU-HBC and the Lion's Club reimburses the clinic the full amount. There was only one instance in which a repair was covered by LASH that totaled $50.00.

The TU-IWB handled the billing of the hearing aid evaluation and dispensing fee. The amount billed to LASH for the hearing aid evaluation and fitting varied depending on whether the patient qualified for reduced fees. If the patient didn't qualify, LASH was billed the total amount for the hearing aid evaluation ($30.00) and dispensing fee (monaural=$150.00, binaural=$250.00). Reduced fees were set on a sliding scale based on the patient's income and total assets. Table 12 displays the reduced fee charges for hearing aid evaluations and dispensing fees. The total billed to LASH was $915.50 for hearing aid evaluations and $6904.50 for fitting fees. The IWB's total revenue from LASH totaled $7820.00. The total written-off for these services was $19080.00.

Chapter 5

Discussion

It is well documented in the literature that hearing aids provide a range of benefits to people with hearing loss (Kochkin et al., 2010). Unfortunately, the cost of hearing aids can often prohibit people from low SES backgrounds from accessing these benefits. This study focused on identifying the population characteristics and outcomes of patients enrolled in the LASH program at TU-HBC. The aim of the LASH program is to work with audiologists to provide hearing aids to low-income individuals that would otherwise not be able to afford them. To get a better understanding of what patients are being serviced through this program, patient demographics (gender, age, referral source, and hearing aid experience) and audiometric test results were analyzed. The following program outcomes were also analyzed: hearing aid characteristics (fit, make, model, acoustic coupling), follow-up appointments, services provided, and repairs.

Patient Demographics.

Gender. The majority of the reviewed charts were female patients (65%). The wide gender difference was not expected based on the National Health and Nutrition Examination Surveys (NHANES), which reported males more likely to use hearing aids than females by a narrow margin when the participants with hearing loss were queried (Bainbridge & Ramachandran, 2014). This difference may be due to the fact the NHANES survey consisted of *asking* adults with hearing loss if they'd wear hearing aids, whereas this patient population consisted of adults that were actively pursuing hearing aids.

Age. Ages ranged from 18 to 96 years old, with the average age of 64.06 for females and 66.35 for males. No patients were fit under the age of 18 because the LASH program is designed specifically for low-income adults. Mean age is expected because presbycusis is common in the elderly (Kaya et al., 2015).

Referral Source. The majority of the patients were referred directly by the Lion's Club or from other audiology and ENT practices in the surrounding area. A small percentage of the patients were referred to the TU-HBC by the International Rescue Committee (IRC; 14%). The IRC's aim is to "help refugees adjust to life in America by helping them obtain access to a home, shelter, food, health care, jobs, and an education for their children" (International Rescue Committee, 2017). IRC has offices located in 29 different United States cities that help refugees relocated from over 40 different countries (International Rescue Committee, 2017). Baltimore's IRC has specific programs aimed at helping refugees resettle, gain financial security, strengthen community ties, provide access to healthcare services, and educational opportunities for their children (International Rescue Committee, 2017).

Hearing Aid Experience. The majority of the patients in this study had no prior experience with hearing aids (61%). New hearing aid users may require more in-depth counseling since they are not familiar with the devices. It is also important to make sure new users have realistic expectations regarding their hearing aids. Both of these factors can potentially have a significant impact on the patient's overall success with hearing aids.

Audiometric Results.

Eighty-four percent of the patients had SNHL. Approximately half (47.62%) of the patients with SNHL obtained medical clearance. Reasons for medical clearance included having an asymmetrical hearing loss, poorer than expected WRS, and being referred with medical clearance. There were 13 instances of MHL and only three with CHL. Medical clearance was required for all cases of CHL and for 11 of the 13 MHL. The two patients that didn't require a referral had a history of stable MHL and were previously cleared for hearing aids. Referrals for medical clearance were consistent with the criteria established by the FDA (Steiger, 2005).

The average PTA was 55.43 dB HL for the right ear and 55.91 dB HL for the left ear, which are on the borderline of the moderate to moderately-severe hearing loss range. The mean thresholds were poorer in the higher frequencies that was consistent with the typical presentation of presbycusis (Hannula et al., 2011; Lasak et al., 2014; Muller & Barr-Gillespie, 2015). This is also consistent with Helvik, Krokstad, and Tambs' (2016) study, which found that hearing aid use was higher in individuals with more mid and high frequency hearing loss. The mean SRT was 48.76 dB HL for the right and 47.21 dB HL for the left. It should be noted that speech awareness thresholds (SAT) were obtained on a few non-English speaking patients instead of an SRT. SATs have the potential to reflect a supra-threshold that could have skewed the average SRT lower.

The average WRS was 70.85% for the right ear and 66.16% for the left ear. However, when WRSs were analyzed by category (e.g., excellent, good, fair, poor), half of the participants scores fell into the poor range. It is important to note that patients that have poor word recognition scores may not be considered good hearing aid candidates

(Lasak et al., 2014). Clinicians should be mindful of counseling patients on the limitations of hearing aids and consider referring them for cochlear implant candidacy testing (Lasak et al., 2014).

There were large standard deviations in all the audiometric test results analyzed. This is consistent with previous studies that investigated the audiometric variables in hearing aid users where a large range of audiometric configurations were also seen (Robertson, Kelly-Campbell, & Wark, 2012). Researchers found that audiometric test results had no correlation with the decision to use hearing aids, instead there are a variety of other factors that contributed to a person's decision to pursue hearing aids, with a major factor being self-perceived hearing difficulties (Robertson, Kelly-Campbell, & Wark, 2012). Studies have found that subjective hearing difficulties as measured by the Hearing Handicap Inventory for the Elderly (HHIE) were positively correlated with a patient's decision to continue hearing aid use (Maeda, Sugaya, Nagayasu, Nakagawa, & Nishizaki, 2016). Interestingly, there was no correlation between hearing aid use and amount of hearing loss found in this study. The authors summarized their study to state that in order to get a better picture of which patients will benefit from hearing aids, audiologists should use subject questionnaires, such as the HHIE, at the time of the hearing aid evaluation (Maeda et al., 2016). To date, it is not standard clinical practice at the TU-HBC to administer subjective questionnaires at the hearing aid evaluation or follow-up appointments.

Program Outcomes.

Hearing Aids. Eighty-nine percent of the patients were fit binaurally. Two of the patients that were fit monaurally already had devices for the other ear, so they were binaural users after the fitting. A study comparing patients with mild to profound hearing loss that were fit binaurally to those fit monaurally, found that the binaural group performed significantly better on speech perception tests (Most, Adi-Bensaid, Shpak, Sharkiya, & Luntz, 2012). When fit binaurally, patients can utilize intensity and timing cues to better localize where a sound is coming from (Bryne, 1981). Binaural amplification also results in an increase in the signal-to-noise ratio, which can decrease listening effort in noise (Bryne, 1981; Noble & Gatehouse, 2006). These two factors combined are some of the reasons why binaural amplification is routinely recommended for people with hearing loss in both ears.

Hearing Aid Make. Through the LASH program new Rexton hearing aids or refurbished hearing aids of various makes and models may be selected. Most of the patients were fit with refurbished hearing aids (61%). The new Rexton hearing aids that are available to LASH are considered a basic level of technology. Many of the refurbished hearing aids have more advanced technology levels that have features that could provide more benefit in complex listening environments (Ingrao, 2011). Such advancements include directional microphones, wireless capabilities, and noise reduction which works to increase the signal-to-noise ratio making it easier to hear in noisy environments (Kerckhoff, Listenberger, & Valente, 2008). Rexton Targa Plus hearing aids have some of these features such has directional microphones, noise reduction, feedback cancelation, and multichannel programming (Rexton Inc., 2007). However, there are additional benefits to the higher level technology in the refurbished aids that may explain why more clinicians in the TU-HBC fit patients with refurbished aids over requesting new Rexton hearing aids.

Hearing Aid Style. BTEs accounted for 86% of the hearing aids fit and the remaining patients were fit with RITEs (14%). ITE hearing aids were not available to patients through the LASH program. The large amount of BTEs fit is likely due to the fact that RITE devices are still considered relatively new technology (Hampson, 2012). Additionally, Rexton only provided BTE hearing aids to LASH. BTEs also have a wider fitting range so they can be fit to a range of severities of hearing loss (Hampson, 2012).

Acoustic Coupling. Most of the BTEs fit were coupled to earmolds (n=70). The remaining BTEs (n=16) were attached to slim tubes that were coupled to domes. All of the RITEs (n=14) were coupled to domes. There are advantages and disadvantages to both acoustic coupling options.

Earmolds come in a variety of styles and materials that allow them to be fit to various degrees of hearing loss. Compared to domes, earmolds provide a boost in hearing aid gain, especially in the low to mid frequencies (Taylor & Teter, 20009). The most frequently fit earmold styles were full shell, skeleton, and half shell. The most common materials used were silicone, acrylic, and vinyl, which is consistent with what is reported in the literature (Karl, 2003). There are pros and cons to each material and style.

Silicone was the most common material used. The soft material creates a good acoustic seal that reduces feedback, making it ideal for high gain hearing aids (Karl, 2003). The soft material provides good retention, but may cause issues with insertion for patients with loose skin (Karl, 2003; Pirzanski, 2003). Difficulty with earmold insertion was a common complaint noted by the patients in this study. The majority of the LASH patients were over 60 years old and it is likely that they had loose skin so acrylic earmolds would have been a more appropriate selection. Another con to silicone molds is that tubing can't be glued into the mold so it can easily become detached, which is not ideal for patients who remove the hearing aids by the tubing (Karl, 2003). The second material, acrylic, is hard and ridged allowing it to be used in several different styles; including the more open skeleton mold (Karl, 2003). The bodysoft canal option allows for more patient comfort. The third material, vinyl, is soft like silicone and is hypoallergenic. This makes it a good option for patients with extreme allergies. However, it is susceptible to deterioration from body chemicals (Karl, 2003).

A major disadvantage of earmolds is that they block off the ear canal that results in the "occlusion effect". The occlusion effect is the perception that one's own voice is loud or sounds hollow, which is due to the increase in dB SPL in the ear canal (Kuk, 2009; Taylor & Teter, 2009). A majority of the patients were fit with full shells increasing the likelihood that they would experience the occlusion effect. Smaller and more open style earmolds, such as skeletons and c-shells, can be used to help alleviate some of the occlusion (Kuk, 2009; Taylor & Teter, 2009). A study by Hodgson and Murdock (1970) found that patients with high-frequency hearing loss performed better on speech-in-noise tests when their hearing aid was coupled to an open earmold compared to a standard earmold. This would explain why skeleton earmolds were the second most commonly fit style in LASH patients. Vents can also be placed in the earmold to allow some of the low-frequency sound to escape (Kuk, 2009; Taylor & Teter, 2009). However, for patients with normal or slight low-frequency hearing loss, these modifications may not be enough and domes may be a more suitable option.

Coupling the hearing aid to a dome via a slim tube allows the ear canal to stay open, preventing occlusion. This is commonly referred to as "open-fit" since it is less occluding than an earmold (Hampson, 2012; Palmer, 2009). Some models of BTEs have the option of being paired to a slim tube instead of a tonehook. The slim tube is more discrete making it more cosmetically appealing than standard tubing. RITE devices are also typically coupled to domes. By placing the receiver in the canal, RITEs can have smaller casing while maintaining the same battery size (Palmer, 2009). However, by putting the receiver in the ear it is exposed to moisture, cerumen, and heat that can potentially cause damage to the hearing aid (Palmer, 2009). For patients with retention issues or more severe losses, custom earmolds can be made for RITEs and slim tubes to extend the fitting range (Palmer 2009; Taylor & Teter, 2009). Only one patient was fit with a slim tube BTE coupled to a micromold. As open-fit hearing aids become more popular, it is likely that the number of LASH patients fit with domes and micromolds will increase.

Appointments.

Hearing Aid Fitting. Patients were fit with hearing aids that were programmed using National Acoustics Laboratory (NAL) prescriptive fitting formulas (either NAL-1 or NAL-2). Real-ear measurements, which are standard practice for hearing aid fittings, were performed by the student clinician at 86% of the fitting appointments. REMs weren't performed at the fitting for the remaining 14% due to time constraints. For most of these patients, REMs were performed at the first follow-up visit.

According to the audiology best practice guidelines, real-ear measurements should be completed at the time of the hearing aid fitting to ensure that the devices are meeting prescriptive targets (Jorgensen, 2016). Real-ear measurements are obtained for soft, medium, and loud speech stimuli to verify that the hearing aid output is meeting prescriptive targets as best as possible. MPO testing ensures that the maximum output of the hearing aid will not exceed the patient's UCLs to avoid any discomfort. However, Jorgensen (2016) goes on to say that less than half of audiologists perform real-ear measurements at the time of the fitting. There is evidence that manufacturer's first fit can vary from prescriptive targets by as much as 20 dB SPL, especially in the high frequencies. This can be potentially detrimental to those with high frequency hearing losses (i.e., presbycusis) that require more gain in those areas. Use of real-ear measurements have been linked to decreased amounts of patient complaints, follow-up appointments, and returned hearing aids (Jorgensen, 2016). Jorgensen's 2016 paper, in addition to other research, supports the continued and regular use of real-ear measurements for hearing aid fittings (Kodera et al.,2016).

Patients were provided with informational counseling in 96% of the fittings. Informational counseling included: hearing aid orientation, maintenance and care, and battery use. Two patients didn't have formal fitting reports in their file so informational counseling was not documented. The other two patients that didn't have documented informational counseling were both experienced hearing aid users. For those two patients, it is likely that the clinician felt that they didn't require additional counseling. This follows the standard fitting procedure used by the EARS Inc. Project in the Dominican Republic (Carkeet, Pither, & Anderson, 2014). Participants in the EARS program were either fit by audiologists or audiology students. The hearing aids were programmed using NAL fitting formulas and real-ear measurements were obtained at the fitting (Carkeet, Pither, & Anderson, 2014).

Follow-ups. The range in days between the hearing aid fitting and first follow-up appointment ranged from 3 to 360 days. One possible reason for the wide range between the fitting and the first follow-up is that the TU-HBC's schedule follows the academic calendar and isn't open 52 weeks a year. Patients that were fit toward the end of an academic semester may have had to wait several weeks until school reconvened to schedule a follow-up. This was the case for several patients that were fit in the summer and were scheduled for a fall follow-up appointment which was typically several weeks after the fitting. Difficulty coordinating transportation could be another reason for the range in follow-up appointments since many of the patients relied on family members or public transportation to get to the clinic. Twenty-three participants were lost to follow-up, which is consistent with rates reported by similar programs (Iwahashi, Jardim, & Bento, 2013). The number of total follow-up appointments for each patient ranged from one to 14 with the average number of appointments being 3.04 during the 2-year period under review. Appointments are typically scheduled in 1.5-hour time slots.

Services Provided. Counseling was the most common service provided during the first two visits, followed closely by repairs and programming. Only a small fraction of patients had no complaints regarding the hearing aids. Iwahashi, Jardim, and Bento (2013) found similar results in their study of a publicly-funded hearing aid program in Brazil. The researchers reported that all but one participant required services, and the two most commonly performed services included counseling and program adjustments.

Repairs.

Forty-two of the participants, 6 with RITEs and 36 with BTEs, required at least one repair during the two-year period under review. There was a total of 83 repairs, 48 were completed in-house and 35 were returned to the manufacturer. The in-house repairs were split evenly between earmold issues (earmold modifications and tubing changes) and casing issues (tonehooks, microphone covers, and battery doors). A majority of the repairs were BTEs that were coupled to earmolds (n=30). Unlike RITE and slim tube devices, BTEs are susceptible to issues regarding the earmold, tubing, and tonehooks. The majority of the repairs sent out to the manufacturer were due the hearing aids being dead, followed by distortion and casing issues. One patient's hearing aids were lost and were replaced under warranty. This pair of hearing aids was donated to the participant by a family member and was still covered under the manufacturer 2-year loss and damage warranty. It is not surprising that more hearing aids were not replaced since LASH aids come with a 2-year repair warranty that doesn't include loss and damage coverage.

Billing.

Billable services were examined to determine the associated costs of the LASH program. The majority of the revenue generated was paid by LASH ($7820.00), followed by insurance ($3064.92), and self- pay ($1387.99). The total amount of revenue generated from participating in the program was less than half (32.18%) of the amount billed. This can be explained by the fact that 86 participants qualified for a reduced fee for services, which ranged from a flat fee of $2 up to 75% of the fees. Also, the TU-HBC didn't get reimbursed the full amount for audiologic evaluations by Medicare/Medicaid or BCBS. According to the Centers for Medicare and Medicaid Services (2017) website, the reimbursement rates by Medicare/Medicaid ranged from $21.98 in 2012 to $22.32 in 2014 for tympanometry and acoustic reflex testing, and $39.76 in 2012 to $37.92 in 2014 for comprehensive audiometry. The reimbursement rates by BCBS were obtained from the billing department and were similar to the reimbursement rates of Medicare/Medicaid. For tympanometry and acoustic reflex testing, BCBS reimbursed $23.52 (CareFirst, 2012). For comprehensive audiometry, BCBS reimbursed $36.29 (CareFirst, 2012). According to the 2016 Medicare Fee Schedule for Audiologist (2016), these rates are consistent with the national average. Additionally, it should be noted that one patient's insurance was not accepted and her account was put on hold since she refused to pay for the audiologic evaluation.

Limitations.

There were several limitations to this study. A major limitation was the inconsistencies between charts. Many of the patient's charts were missing and/or had incomplete reports and disposition notes. There were several instances where the reduced service fee form or insurance card was not filed in the patient's chart. In order to obtain this information, the head of the billing department had to go back through old records and pull up each individual patient.

Another limitation to this study was that information regarding patient's subjective report regarding their hearing aids could not be reliably obtained. One reason for this was that some of the patients were non-English speakers. Interpreters were provided in some instances, but in most cases the patient was accompanied to the appointment by a family member. This made it difficult to obtain accurate feedback regarding the hearing aids. Another reason that there was little utility for the data collected regarding patient report was that it was not consistently documented. Very few patient charts had completed COSI questionnaires, and majority of the reports and disposition notes did not include patient's subjective reports regarding their hearing aids.

Future Directions.

Future studies regarding the outcomes of the LASH program at the TU-HBC should include more information regarding patient demographics. There was limited information regarding the patient's SES in the clinic files and there was no documentation on the patient's race or ethnicity. Having this information will provide a better understanding of what population the LASH program is serving. To improve the future outcomes of the LASH program, interpreters should be required for all non-English patients to ensure that all important information is conveyed to and understood by the patient. A significant portion of patients didn't speak English and weren't always accompanied by an interpreter. In situation like this, the clinician can't be sure whether the patient understood all the information regarding test instructions, hearing aid recommendations, and hearing aid orientation that can greatly affect hearing aid outcomes. Four patient charts that were pulled for review were not included in the study because they were never fit with hearing aids. All four of these patients did not speak English and failed to obtain medical clearance. It is likely that the patients were unclear of what they were being instructed to do, which could have been avoided if an interpreter was present. In the future, clinicians should incorporate a QOL questionnaire to get a better understanding of how the patient is performing with the hearing aids. There was little utility to the subjective reports in the clinic files included in this study and few COSIs were completed. There was no way to measure how the participants were performing in their everyday life with the hearing aids. Future studies could also compare LASH patient outcomes to those with insurance or private pay. This would provide information on whether being financially responsible for the hearing aids has an impact on the patient's outcomes with the devices. Lastly, a better protocol for scheduling follow-ups should be implemented to avoid losing track of patients and to decrease the duration between the hearing aid fitting and the first follow-up visit. One way to do this would be to avoid fitting patients the two weeks prior to breaks in the academic calendar. Implementing these changes in the future would potentially provide a better understanding of the LASH patient population and improve the program outcomes.

Conclusion.

The LASH program is designed to help low-income individuals obtain access to hearing aids. This study found that the majority of patients that participated in the LASH program qualified for a reduced fee for services. To qualify for a reduced fee for services, patients must meet certain criteria based on their income, assets, and household size. Only 14 of the participants in the program didn't qualify for reduced fees, which indicates that the program was servicing the target population. To improve program outcomes, a better follow-up protocol needs to be implemented. A total of 23 patients were lost to follow-up, and there was a wide range in the duration between the hearing aid fitting and the first follow-up appointment. Implementing a stricter follow-up protocol would help decrease the number of participants lost to follow-up, as well as decrease the duration between follow-up appointments. Additionally, about half of the participants required at least one repair. If a stricter follow-up protocol was implemented, issues that led to repairs could be addressed earlier. Overall, the amount of revenue the TU-HBC generated from participating in the program was as expected. The amount of revenue generated from audiological evaluations was comparable to the average reimbursement rates by Medicare/Medicaid. The amount written-off for hearing aid evaluations and fitting fees was expected based on the number of participants that qualified for reduced fees. The average number of follow-up appointments over the two-year period was 3. Appointments are typically booked in 1.5-hour time increments making the average time spent with each LASH patient 4.5-hours every two years. The clinic doesn’t lose a lot of revenue by spending 4.5 hours per LASH patient every two years. Participating in the LASH program provides clinicians at the TU-HBC a unique opportunity to help those in need gain access to hearing aids. This study shows that the program is successful at dispensing hearing aids to the target population. However, there are many ways the program can be improved.

APPENDIX A

Outcome Variables

Name:
ID:

Part I. Demographic Characteristics

Age:___________

Sex: male female

Hearing Aid Experience: New Experienced

Medical Clearance: Yes No

IRC Referral: Yes No

Part II. Audiologic Assessment

Hearing Loss:

Type: Sensorineural Conductive Mixed

AC Thresholds	250 Hz	500	1000	2000	4000	8000
Right						
Left						

PTA: Right ____________ Left ____________

SRT: Right ____________ Left ____________

WRS: Right ___________ Left ____________ Binaural ______________

Part III. Hearing Aids

Fit: Monaural Binaural

Make: Rexton other ________________

Style: BTE RITE other________________

Acoustic Coupling:

Earmold: Material______________ Style________________

Dome: Open Closed

Part IV. Appointments

Hearing Aid Fitting:

Real-ear measurements obtained: Yes No

Counseling: informational documented? Yes No

Affective documented? Yes No

Duration (in days) between fitting and 1st follow-up: _____________________

How many additional appointments (in the first 2 years post-fitting; some appointments may fill more than one category):

Program adjustments: _______________

Counseling: _________________

Repairs: _________________

Conformity Check: ________________

Other: ____________________

Part V. Repairs

Number of total repairs in a 2 year period: ________________

In-house? _________________

Sent out?__________________

Part VI. Quality of Life

COSI: Administered? Yes No

Completed? Yes No

Patient Report:

Satisfactory:

Volume:_________________

Physical Comfort:________________

Sound Quality:__________________

Dissatisfactory:

Volume:_________________

Physical Comfort:________________

Sound Quality:__________________

APPENDIX B

Costs of Services

Name:
ID:

Audiometric assessment:

Amount billed: _______________

Amount reimbursed: ______________

Responsible Party: (select all that apply)

Patient/self-pay Insurance Third Party (i.e., Lions Club)

Hearing aids:

Amount billed: _______________

Amount reimbursed: ______________

Responsible Party: (select all that apply)

Patient/self-pay Insurance Third Party (i.e., Lions Club)

Earmolds:

Amount billed: _______________

Amount reimbursed: ______________

Responsible Party: (select all that apply)

Patient/self-pay Insurance Third Party (i.e., Lions Club)

Repairs:

Amount billed: _______________

Amount reimbursed: ______________

Responsible Party: (select all that apply)

Patient/self-pay   Insurance   Third Party (i.e., Lions Club)

Follow-up services:

Amount billed: _______________

Amount reimbursed: ______________

Responsible Party: (select all that apply)

Patient/self-pay   Insurance   Third Party (i.e., Lions Club)

TOWSON UNIVERSITY

Kaitlin Berry <kberry3@students.towson.edu>

IRB Approval # 1701013028
1 message

IRB <irb@towson.edu> Wed, Jan 18, 2017 at 8:49 AM
To: "Smart, Jennifer L." <JSmart@towson.edu>
Cc: IRB <irb@towson.edu>, "Smith, Elise D." <esmith@towson.edu>, "Berry, Kaitlin" <kberry3@students.towson.edu>, "Ashby, Tricia K." <TAshby@towson.edu>

The IRB has approved your protocol "**Evaluating LASH Patient Outcomes: A Retrospective Chart Review" effective 1/18/2017.**

Your IRB protocol can now be **viewed by your faculty advisor** in MyOSPR. For more information, please visit: http://www.towson.edu/academics/research/sponsored/myospr.html

If you should encounter any new risks, reactions, or injuries to subjects while conducting your research, please notify IRB@towson.edu. Should your research extend beyond one year in duration, or should there be substantive changes in your research protocol, you will need to submit another application.

We do offer training and orientation sessions for faculty/staff, please sign up for one of the sessions:

http://fusion.towson.edu/www/signupGeneric/index.cfm?type=OSPR

Check back to that registration site frequently – we'll post additional sessions for January and the spring semester soon.

Regards,

Towson IRB

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CURRICULUM VITA

Kaitlin E. Berry

[redacted]

EDUCATION

Towson University, Towson, MD September 2014- Present

Doctorate of Audiology (Au.D.)

GPA: 3.7

University of Maryland, College Park, MD May 2014

Bachelor of Art, Hearing and Speech Sciences

Minor in Human Development

GPA: 3.7, Major: 3.8

- Dean's List Fall 2011, Spring 2012, Fall 2012, Spring 2013

CLINICAL PRACTICA

Washington Hospital Center February 2017- May 2017

Washington, DC

- Standard audiological assessments with adults.
- Assist in vestibular evaluations including VNG assessments and treatment maneuvers.
- Electrophysiological evaluations including OAE, ABR, and ECochG evaluations.
- Hearing aid selection, issuance, and orientation with adults.

Baltimore County Public Schools August 2016- December 2016

Baltimore County, MD

- Audiological assessments of preschoolers and school-age children utilizing VRA, CPA, and conventional test methods.
- APD evaluations on school-age children.
- Perform listening checks and troubleshoots on hearing aids and FM equipment.

ENTAA Care February 2016-July 2016

Glen Burnie, MD

- Standard audiological assessments with adults and children
- Electrophysiological evaluations including OAE and ABR evaluations
- Hearing aid selection, issuance, and orientation with adults
- Assist in vestibular evaluations including ENG/VNG assessments and treatment maneuvers.
- Assist in mapping of cochlear implants.

Institute for Well-Being at Towson University September 2014- December 2015

Towson, MD

- Standard audiological assessments with adults and children
- Hearing aid selection, issuance, and orientation with adults
- Hearing aid trouble-shooting and in-house repairs
- Assist in vestibular evaluations including rotary chair and VNG assessments