AN AUDIOLOGICAL PROFILE OF SCHOOL AGED CHILDREN WITH HIV/AIDS AT AN ANTIRETROVIRAL CLINIC IN KWAZULU-NATAL

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DECLARATION

I, Vulyelwa Zandile Peter, hereby declare that this dissertation which is submitted to the University of KwaZulu-Natal for the degree of Master in Communication Pathology (Audiology), represents my own work in conception and execution and that all the sources and quotes that I have used, have been acknowledged.

Signed:  at Westville on 01 day of December 2014.

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Summary

There is limited research on hearing loss in the paediatric population infected with HIV/AIDS in South Africa. There is a need to establish an audiological profile in HIV infected children, as the prevalence of hearing loss is not known and there is limited published research available. This information will assist the audiologist to ascertain the extent of the disorder, establish a profile of hearing loss using hearing loss type, degree, configuration and symmetry, and dictate the necessary audiological and medical management strategies required. The aim of the study was to determine the audiological profile of school age children with HIV/AIDS at an antiretroviral clinic in KwaZulu-Natal. The study had the following objectives: To describe the prevalence and nature of hearing loss in terms of degree, type, configuration and symetry. To determine whether children with a hearing loss have received medical management and the type of treatment receive and to determine whether children with a hearing loss have received audiological management for their hearing loss and the nature of these interventions.

This was achieved through a non-experimental descriptive exploratory design. The research was carried out at the Philani Family Clinic which is an ARV clinic at King Edward VIII hospital in KwaZulu-Natal, South Africa. Convenience sampling was used to recruit 30 participants aged between 6-12 years. Seventeen (60%) participants were males and 13 (40%) were females. The participants underwent diagnostic audiological evaluation, which included a case history questionnaire, medical record review, otoscopic examination, immittance audiometry, pure tone audiometry, speech audiometry, Distortion Product Otoacoustic emissions (DPOAE) and a neurological Auditory Brainstem Response (ABR) test.

The results revealed, abnormal otoscopic findings in the right ear of 17 (57%) participants and the left ear of 19 (63%) participants. Tympanometry results revealed abnormal tympanograms in the right ear of 13 (43%) participants and the left ear of 12 (40%) participants. Ipsilateral acoustic reflex thresholds were abnormal in the right ear of 8 (27%) participants and in the left ear of 7 (24%) participants. Contra lateral acoustic reflex thresholds were abnormal in the right ear of 13 (44%) participants and in the left ear of 12 (40%) participants. Of the 28 participants assessed for pure tone audiometry, 15 (54%) presented with normal hearing in the right ear and 13 (46%) presented with normal hearing in the left ear. Conductive hearing loss was the most prevalent type of hearing loss, followed by sensorineural hearing loss and mixed hearing loss. Good SRT-PTA correlation was obtained in majority of the participants, indicating good test reliability. Only 18 participants underwent DPOAE testing and pass results were obtained in the right ear of 15 (50%) participants and the left ear of 12 (40%) participants. The ABR results revealed auditory dysfunction suggestive of neural dysnchrony.

Seventeen (43%) participants reported a history of ear infections with 15 (50%) participants reporting having receiving medical attention for ear infections. Three (10%) participants were fitted with hearing aids. Fourteen (46%) participants reported to have repeated a school grade. Fifteen (50%) participants reported not coping academically.

Study limitations included time constraints to conduct a more in depth protocol. A small sample size limited generalisation to the entire population under study. The study concluded that there was a prevalence of 53% hearing loss among children with HIV/AIDS. Therefore, the prevalence of hearing loss requires the expertise of the audiologist in the multi-disciplinary team, to both monitor and manage hearing loss and thereby improve quality of

life of children with compromised immune systems . "*It is always seems impossible until it is done*" Nelson Mandela

Key word: Audiological monitoring, audiological profile, HIV/AIDS, hearing loss, school children, communication, prevalence of hearing loss and intervention strategies.

Table of Contents

List of Tables **pg no.**

List of figures **pg no.:**

APPENDICES **pg no.:**

CHAPTER 1: INTRODUCTION

1.1. Introduction

This chapter introduces the rationale of the study, the research question, and key concepts used in the study. The chapter highlights the study aim and objectives. It also provides a short summary of forthcoming chapters.

1.2. Background

Acquired Immunodeficiency Syndrome (AIDS) develops as a result of the Human Immunodeficiency Virus (HIV) (Bankaitis & Schountz, 1998). It is a disorder characterised by the inability of the human body to defend itself against opportunistic infections. The disease is known to progress in stages, namely; the early, intermediate and final stages (Matas, Leite, Leite-Magliaro & Gonvcalves, 2006; Friedman & Noffsinger 1998). The disease progression has been linked to the maturity level of the immune system. Children are believed to be more susceptible to infection due to their immune functioning differing from adults and their immune systems being under developed (Bankaitis, Christensen, Murphy & Morehouse, 1998). It is estimated by Human Resource Council of South Africa (2014) that the number of children infected with HIV is approximately 360 000 or 2.4% in South Africa. Sub-Saharan Africa has highest number of children under the age of 13 years living with HIV/AIDS (Human research council, 2014). HIV/AIDS is known to result in sequale that affect the different organs of the body including the auditory system (Govender, Eley, Walker, Petersen & Wilmshurst, 2011).

One of the many sequale associated with HIV/AIDS is hearing impairment (Bankaitis & Schountz, 1998), with the predominant cause being strongly attributed to otologic infections (Gurney & Murr, 2003). Otologic conditions may give rise to a conductive, mixed, or sensorineural hearing loss, as well as central auditory deficits (Abrams, Moon, Robinson & van Dyke, 2006). Conductive hearing loss in the HIV/AIDS infected population may be as a result of otitis media, mastoiditis, tympanic membrane perforation, and recurrent otitis media with effusion (Abrams et al., 2006). Viral or bacterial infections, such as Cryptococcus meningitis, toxoplasmosis, viral meningitis, cytomegalovirus (CMV) and herpes can result in a sensorineural hearing loss. Neurological and central nervous system (CNS) abnormalities such as enchaphalopathy with associated language delays, and motor deficits have been reported in children with HIV/AIDS (Epstein, Sharer, Oleske, Connor, Goudsmith et al., 1986). One can therefore, conclude that a hearing loss which is conductive or sensorineural in nature could be as a result of otologic and/or central pathology, which may present in varying degrees of hearing loss.

Reports indicate varying types, degrees and configurations of hearing loss (Simdon, Watters, Bartlett & Connick, 2001), with the reported incidence of hearing impairment in children with HIV/AIDS varying from approximately 20% to 40% internationally (Matas, dos Santos Filho, de Juan, Pinto & Gonclaves, 2010). Two point four percent of the HIV/AIDS paediatric population in South Africa consist of primary school age children (6-12 years) and their hearing status is unknown as there is no data reporting on the number of children presenting with hearing loss (Smith, Adamns & Eley, 2008; South African Statistics, 2010 & National Department of Health, 2011). Olusanya, Okolo and Ijaduola (2000) estimated that 50% of school entrance grade children in Nigeria presented with a hearing loss that was not reported by the parents or detected through a universal hearing screening program, while

North-Matthiassen and Singh (2006) reported that 13,5% of children screened in the Western Cape required referrals for diagnostic audiological evaluation. North-Matthiassen and Singh (2006) reported that some of the contributing factors to the high prevalence of hearing loss in school children could be attributed to HIV positive children surviving longer due to antiretroviral treatment. Due to the life prolonging antiretroviral treatment, one can assume that hearing loss prevalence in school age children will be higher (North-Matthiassen & Singh, 2006). However, there is scarcity of data that directly links hearing loss to HIV/AIDS in adults, and one can conclude that the scarcity of data will be more so in the paediatric population (Khoza-Shangase, 2010).

Hearing loss, irrespective of the type, has adverse effects on linguistic development in children (Cook, Kirk, Bidwel, Hider & Tolan, 1998). There are adverse effects of hearing loss on speech perception, self-image and social skills (Niskar et al., 1998). Hearing loss can have a negative impact on early language development, affecting the different components of language such as syntax, semantics and other basic verbal skills (Feagans, Kipp & Blood, 1994). Zumach, Gerrits, Chenault, and Anteunis (2010) reported that language development is critical during the early childhood years, as it is essential for thinking and learning. Hence, hearing loss in the early years of life may result in gaps in the acquisition of language and learning affecting the school age population (Feagans et al., 1994; Niskar et al., 1998). It can also adversely impact the classroom and listening environments, as auditory dysfunction affects perception and understanding of speech sounds (Niskar et al., 1998). In addition, early onset of any hearing loss could result in reduced processing at the lower brainstem and cortical levels in subsequent years. This suggests that early onset of a hearing loss may lead to auditory processing difficulties (Maruthy & Mannarukrishnaiah, 2008), making it imperative that early identification of hearing loss be established.

To ensure that all children, including those with HIV related hearing loss, be given a fair and equal opportunity to achieve academically, hearing loss must be identified early and managed so that it does not negatively impede their ability to lead independent lives (Broste, Hansen, Strand & Steuland, 1989). Early diagnosis is crucial in school age children, and one can assume that those infected with HIV, as they are prone to hearing loss (Broste et al., 1989). The audiologist must, therefore, be involved in the early management of school-age children infected with HIV to minimise adverse effects of hearing loss on academic performance and their general quality of life.

1.3. Problem statement

There is limited research on the occurrence and nature of hearing loss in the paediatric population infected with HIV/AIDS in South Africa as majority of published research relating to HIV/AIDS and hearing research is focused on the adult population (Khoza-Shangase, 2010, North-Matthiasen & Singh, 2006). One can conclude that there is need to establish an audiological profile of HIV infected children, as the prevalence of hearing loss is not known. There is no published research available on the audiological profile of school age children infected with HIV/AIDS at antiretroviral clinics in KwaZulu-Natal, and the type of audiological and medical management they receive. This information will assist the audiologist to ascertain the extent of the disorder, establish a profile of hearing loss using hearing loss type, degree, configuration and symmetry, and influence the appropriate audiological and medical management strategies required. The role of the audiologist in the multidisciplinary management of HIV infected children is important and necessary (Matas et al., 2010). Services such as audiological screening, periodical monitoring and aural rehabilitation service which involve the audiologist in the management team for children

living with HIV is needed to minimise the impact on hearing, communication, academic performance and vocational opportunities (Copley & Frederichs, 2010).

1.4. Research Question

What is the audiological profile of school age children with HIV/AIDS at an antiretroviral clinic in KwaZulu-Natal, and what type of audiological and medical management do they receive, if any?

1.5. Significance of the study

The findings of the current study will add to the existing knowledge relating to HIV/AIDS and hearing in children. In addition it will be one of the few studies that is specifically focused on the paediatric school age population in the South African context, as majority of published research relating to HIV/AIDS and hearing research is focused on the adult population. Currently the South African government has invested millions of Rands into improving access to ARV and the public health system (National Department of Health, 2011). Children with HIV/AIDS have historically been referred for audiological assessment and intervention when otologic conditions have manifested not for preventative screening. This research will highlight the integral aspect of the audiological services as part of the ARV service package to improve service delivery.

1.6. Terminology and Abbreviations

The following section will provide definitions and brief descriptions of terms that will be used in the study:

- Acoustic Reflexes Thresholds (ARTs) test: This test is used to ascertain the minimal level of sound that triggers a reflex via the stapedius muscle of the middle ear (Hall & Swanepoel, 2011).
- Acquired Immunodeficiency Syndrome (AIDS): is a disorder characterised by the immune system's inability to defend the body against various infectious agents as a result of HIV (Gold & Tami, 1998).
- Antiretroviral drug: counters or acts against a retrovirus, understood to be HIV. The FDA-approved antiretroviral include reverse transcriptase inhibitors, nucleoside analogues and protease inhibitors (Hughes, 1995).
- Auditory Brainstem Response (ABR) test: is a neurological test of auditory brainstem function in response to auditory (click) stimuli (Janssen, 2008). Although the ABR provides information regarding auditory function and hearing sensitivity, it is not a substitute for a formal hearing evaluation and results should be used in conjunction with behavioural audiometry (American Academy of Audiology, 2002). ABR may be useful in monitoring subtle neurological changes (Norrix, Trempanier, Atlas, & Kim 2012).
- Cluster Difference Cell 4 (CD4): a major classification of T lymphocytes, referring to those that carry the CD4 antigen; most are helper cells. Also called CD4 T lymphocytes (Graber et al., 2008).
- Highly Active Antiretroviral Therapy (HAART): is the name given to aggressive treatment regimens used to suppress HIV viral replication and the progression of HIV disease (Hausler, Vibert, Koralnik, & Hirschel, 1991; Matkin, Diefendorf, & Erenberg, 1998).

- Human Immunodeficiency Virus (HIV): causes acquired immune deficiency syndrome (AIDS). It replicates in and kills the helper T cells (Gross, Wolff, Elidan & Elishar 2007).
- Opportunistic infections: are secondary infections that occur in patients whose immune systems are compromised, such as in AIDS (Gurney & Murr, 2003).
- Otoacoustic Emissions (OAE): The primary purpose of OAE testing is to determine cochlear status, specifically hair cell function with different type of stimuli such as transient evoked emissions (TEOAE), distortion product emissions (DPOAE) and spontaneous emissions (SOAE) (Delehaye et al., 2008).
- Otologic diseases: are pathologies related to the structure of the ear (Chandrasekhar, et al., 2000).
- Otoscopy: This test is done to identify pathological conditions of the pinna, ear canal, tympanic membrane (eardrums) and surrounding structures (Gelfand, 2001).
- Pure tones: The purpose of this test is to establish the client's hearing sensitivity across the range of audible frequencies that are vital for human communication. It is used to identify hearing threshold levels of an individual, enabling determination of the degree, type and configuration of a hearing loss, thus providing the basis for diagnosis and type of management strategy required (Arlinger, 2000).
- Retrovirus: is a group of viruses that contain two single-strand linear RNA molecules per virion and reverse transcriptase (RNA to DNA); the virus transcribes its RNA into a cDNA provirus that is then incorporated into the host cell (Meuller & Pizzo, 1997). There are two variants of the HIV virus, HIV-1 and HIV-2, both of which ultimately cause AIDS (Krogstad, 2006; Lindegren, Hammett, & Butleys, 2006).
- Speech Audiometry: Can be divided into Speech reception testing (SRT) and Speech Discrimination testing (SDT).

- Speech Discrimination testing (SDT) testing: determines the level of discrimination ability between sounds. The discrimination score is intended to be a measure of the clarity of which the person hears speech as well assisting in the detection of acoustic tumors and determining the individual's candidacy for hearing aids (Hall & Swanepoel, 2010).
- Speech Reception Thresholds (SRT): is defined as the level at which the listener can identify speech signal 50% of the time. It is a reliability test for pure tones and confirms the results of pure tone audiometry Gelfand, 2001).
- Tympanometry: Tympanometry is an objective test used to assess the condition of the middle ear and mobility of the eardrum (tympanic membrane) and the conduction bones by creating variations of air pressure in the ear canal (Beigh, Malik, Islam, Yousuf & Pampari, 2012).

1.7. Outline of the chapters

- Chapter 1. Introduction:

In this chapter the researcher will introduce the rationale of the study, highlights the research question, key concepts used in the study and significance of the study. Finally the study aims, and objectives will be introduced with a brief outline of the chapter provided.

- Chapter 2. Literature Review:

This chapter focuses on the epidemiology, classification system of HIV, the impact of the virus on the auditory and vestibular system. The impact of hearing loss on language

development, academic performance and the role of the audiologist in the management of paediatric population infected with HIV/AIDS are discussed.

- Chapter 3. Methodology**:**

This chapter outlines the methodological framework of the study, and includes the aims, objectives, study design, sample size, as well as the criteria used for the participant selection. In addition, there is a description of the investigative procedures used, data collection tools and data analysis.

- Chapter 4. Results:

This chapter presents the results of the study. The use of figures and tables serves to enhance the presentation and make clear the findings of the study.

- Chapter 5**.** Discussion:

This chapter focuses on the discussion of the findings of the study, while making reference to available literature. A discussion will be made regarding the current research findings and report on the similarities and differences to other related research in the context of paediatric HIV/AIDS.

- Chapter 6. Conclusion:

Chapter 6 is the conclusion of the dissertation. It includes a summary of the findings, the clinical and research implications of the study as well as the limitations.

1.8. Summary

The chapter presented an overview of the study. A review of the available literature revealed that there is a scarcity of information relating to the prevalence of hearing loss in school age children- infected with HIV/AIDS in South Africa. The researcher aims to investigate the audiological profile of HIV infected children to ascertain the prevalence of hearing loss and review medical management received by these children infected with HIV/AIDS attending an ARV clinic in KwaZulu-Natal.

CHAPTER 2: HIV/AIDS AND HEARING LOSS IN CHILDREN

2.1. Introduction

This chapter will focus on the HIV/AIDS mode of transmission, its classification system as well as the impact of the virus on the auditory system. The effect of hearing loss on language development, and academic performance will also be highlighted. In addition, the medical and audiological management strategies of hearing loss in children will be discussed, while, a brief description of audiological testing protocol for school age children will be presented.

2.2. HIV/AIDS mode of infection in children

AIDS is a disorder in which the immune system is unable to defend itself against various infectious agents, and develops as a result of the Human Immunodeficiency Virus [World Health Organisation (WHO, 2008)]. In a world that is dealing with the epidemic, children are not excluded from the challenges related to HIV. Children can be infected with HIV/AIDS as a result of sexual abuse, being care takers of infected parents, occult related sexual practices using children, nasocomial infection (hospital infection through the use of unsterilized infected equipment), and through vertical transmission i.e. mother to child transmission (MTCT) (Graber et al., 2008; Gross et al., 2007).

MTCT is the prevalent mode of infection in young children, and the virus can be transmitted during pregnancy, delivery or after birth during breast feeding (UNICEF, 2012). According to Trotta, Meli, Ginelli, Sbanagli and Leoncini (2000), 95% of paediatric HIV infections are a direct result of vertical transmission from mother to child due to maternal factors such as immune status (CD4 count), and vitamin A deficiency (Mueller & Pizzo, 1997). The

mother's high viral load levels can result in HIV infection, and this increases the chances of the infection being transmitted to the unborn child (Olusanya, Afe, & Onyia, 2009). In addition, behavioural factors such as smoking, drug consumption and unprotected sex during pregnancy have been reported to contribute towards MTCT (Trotta et al., 2000). Literature has also included obstetrical factors such as placenta infection, and prolonged rupture of membrane during labour resulting in the infection of the child (WHO, 2006). Infant factors such as foetal trauma, prematurity and breast feeding without the use of Ziddovudine (AZT) by an infected mother, may also contribute towards a high prevalence of MTCT (WHO, 2006). All these factors render the child's immunity compromised and the virus then destroys the immunity resulting in the disease progressing to the next stage (Mueller & Pizzo, 1997).

As the immunodeficiency progresses, HIV develop into AIDS through stages, namely the early, intermediate and final stages (Matas et al., 2006). The stage progression results in the inability of the human body to defend itself against opportunistic infections (Abrams et al., 2006). Extensive research has been conducted to better understanding of the virus workings in the human body, and its effect on the function of the immune system (Graber et al., 2008). This resulted in a profiling of the immunity degeneration and hence the need for HIV specific disease classification. Due to the disease profile, further investigations were required resulting in the Centre for Disease Control and Prevention (CDC) formulating a unique classification system (Bankaitis, 1998).

2.3. Disease classification

During the early 1980's, the CDC devised a definition for AIDS monitoring (Lindergren et al., 2006). This was accomplished by profiling a group of HIV infected adults according to their disease symptoms (Lindergren et al., 2006). Due to initial inadequacies, the system had to be revised in the adult population to accommodate the initial shortcomings. However, the adult classification system did not account for the complexities of the paediatric immune system. Therefore, further modification to the existing classification methods were required to suit their diverse needs (Bankaitis & Schountz, 1998). According to Bankaitis (1998) and CDC (1994), this classification system was inadequate due to the following reasons:

- Detecting the sensitivity of HIV positive or negative antibodies in an infant's blood was not possible as the antibodies could be passively transmitted to the infant from the HIV infected mother and persist for up to 15 months (Krogstad, 2006). This suggested that the infants of HIV positive mothers will test positive at birth, although only 15-20% will actually become infected. HIV positive or negative infants will serorevert more than a year later (CDC, 2009).

- Infants up to 15 months who were prenatally exposed to the virus through their infected mothers were considered HIV positive by meeting at least one of the following criteria: virus detection in the blood or tissue, presence of HIV antibodies with evidence of cellular and humoral immune deficiency and the development of symptoms meeting the CDC, 1993 definition of AIDS (CDC, 1994).

In the new classification, children are assigned to four mutually exclusive clearly categorized groups numbered 1 to 4 (Lindegren et al., 2006). This also includes the use of CD4+

lymphocytes count change and percentage of CD4+ lymphocytes (UNICEF, 2012). The additional parameters included:

(1) Infection status, where three levels appear ranging from 1 to 3 indicating the progression of the disease; where 1 indicates no infection, 2 indicates mild infection, and 3 indicates severe infection (Krogstad, 2006).

(2) Immunological status, which was further categorized into symptoms that were graded from N1 (which indicated no evidence of immunosuppression) to N3 (indicating severe immunosuppression status) (Krogstad, 2006).

(3) Clinical status, which ranged from mild-severe status, where A indicates mild, B indicates moderate, C indicates severe and N indicates no symptoms (Bankaitis et al., 1998).

This, therefore, suggests that children's immunity responds differently to the virus as compared to adults, making them more susceptible to infection, even if they present with high CD4+ T-cell counts (Bankaitis et al., 1998) . It is reported that the latency period is shorter in children, with disease progression being more aggressive with associated side effects in the different disease stages (Hugdson & Montgomery, 2008).. One therefore, needs to be cognisant of these differences when managing children with HIV as treatment that is offered to adults may not be suitable for children.

2.4. Medical management of children with HIV/AIDS

One of the recommended management strategies to fight HIV and to improve the immune system is through the administration of Antiretroviral (ARV) medication (Abrams et al., 2006). In 2004, the National Antiretroviral Treatment guidelines were released in South Africa. There are 3 main classes of antiretroviral agents which form part of the management strategy:

1. Nucleoside analogue reverse transcriptase inhibitors (NRTIs) are inclusive of drugs such as AZT (ziddovudine or ZDV), Didanosine (ddl), Lamivudine (3TC) and Stavudine (d4T) (Engud et al., 1997). These drugs are designed to block the action enzyme of the virus, reverse the transcriptase phase and, thereby, prevent the virus from using the host DNA to reproduce itself (WHO, 2006).
2. Non-nucleoside analogue reverse transcriptase inhibitors (NNRTI's) include drugs like Nevirapine and Efavirenz (Mofenson & Serchuck, 2006). The role of these drugs includes blocking the action of the enzyme Reverse Transcriptase, and thereby, preventing the virus from using the host DNA to reproduce itself (Farley, 2006).
3. Protease inhibitors (PIs) include Ritonavir, Nelfinavir, and Lopinavir/Ritinavir (Keletra) (Mofenson & Serchuck, 2006). The function of these drugs is to block the enzyme protease, preventing the virus from making new copies of itself.

Locally clinical practice of HIV Medicine KZN Step by Step Guide for Management of Children on ART (2010) which recommends the following indicators be used to determine when to commence ARV treatment:

- CD4 <350cell/mm^3 irrespective of the stage
- WHO stages 3 and 4 AIDS-defining illness, irrespective of CD4 count

- Patient expressing willingness and readiness to adhere to treatment (KZN Department of Health, 2010).

The prescribed drug regimen for children with HIV is intended to minimise the viral load in the blood stream, resulting in reduced disease burden and a stronger immune system. This is in keeping with international practices and the goal is to prolong life, improve quality of life and to save lives (WHO, 2006). The current prescribed drug regimen, as recommended by the KZN Department of Health (2010), is:

- Line 1 drugs i.e. Abacavir (ABC), Lamivudine (3TC), Efavirenz (EFV), and Stocrin.
- Line 2 drugs i.e. Zidovudine (AZT), Didanosine (ddI), and LPV/r (Kaletra).

  For children with TB the recommended regimen is Abacavir (ABC), Lamivudine (3TC), Efavirenz (EFV) and Stocrin.

Giaquinto et al. (2008) described uncertainties and challenges when prescribing antiretroviral drugs as part of the medical management of children with HIV. These included selecting the most appropriate regimen for an individual child which depends on a variety of factors. These factors include the age of the child, the availability of appropriate drug formulations, the potency, complexity and toxicity of the drug regimen, the home situation, the child and caregiver's ability to adhere to the regimen, and the child's antiretroviral treatment history (Giaquinto et al., 2008). As is evident ototoxicity is, unfortunately, not prioritised.

2.5 Ototoxicity as a result of life prolonging antiretroviral drugs

Since the introduction of Highly Active Antiretroviral Treatment (HAART) to manage the virus, other complications have been reported. These include peripheral and central auditory pathway abnormalities and hearing loss (Giaquinto et al., 2008). Bankaitis and Schountz (1998) reported that antiretroviral medication used in conjunction with other drugs, could

result in ototoxicity through drug interactions, and ultimately a permanent sensorineural hearing loss. Ototoxicity refers to the injury of the cochlea or vestibular system from frequent use of drugs resulting in an irreversible hearing loss (Schmelzele, Birthwhistle & Tan, 2008). Gurney and Murr (2003), reported that antiretroviral medication such as zidovudine (AZT), dideoxyctidine (ddC), Ritonavir(novir), Saquinavir (invarasse), and Epivir (3TC), are ototoxic and can result in permanent sensorineural hearing loss with associated vertigo, nausea, vomiting and ataxia. Most of these drugs are prescribed for HIV positive children, indicating the need for audiological monitoring for hearing loss due to ototoxicity (Gurney & Murr, 2003).

Antiretroviral drugs are used to manage the virus levels in the blood stream, in order to improve immunity, giving resistance against opportunistic infections like otitis media, TB, meningitis and syphilis. These infections will require additional drugs to combat the infections, which result in a higher number of drugs being taken by children infected with HIV/AIDS (Graber et al., 2008). This has a negative effect on the already compromised immune system (Post, Badri, Wood & Maartens, 2001; Harris et al. 2012) with the drug interaction resulting in adverse effects on the auditory system. According to Harrist et al., (2012), ototoxicity prevalence has increased, especially with HIV, tuberculosis and cancers; thus, highlighting the urgent need for audiological services for holistic patient management.

The audiologist should, therefore, not view auditory disorders associated with HIV in isolation, but rather consider holistic management by early identification to prevent the adverse effects of drug reactions and ototoxicity induced by drug overload (Harris at al., 2012). This impacts on the audiological services required, as the patient presentation becomes complex and requires holistic management (Mathew et al., 2012). One can therefore assume

that audiologists are essential in the management to minimise the negative effects of hearing loss on communication (Harris et al., 2012).

All children with HIV/AIDS should undergo audiological evaluation to assess if the auditory pathway has not been affected, even though they do not present with obvious signs of a hearing loss, as subtle audiological and neurological changes have been reported in children who are asymptomatic (Matas et al., 2010). Matas et al. (2010) reported that due to the growing incidence of hearing loss in HIV positive people, audiological as well as electrophysiological investigations of hearing should be conducted to detect the alterations of the peripheral and central auditory pathways as the HIV progresses to the AIDS stage.

Miziara, Weber, Cuhna, Filo, and Neto (2006), reported that hearing loss due to ototoxicity was high and ototoxicity required aggressive means of early audiological monitoring. The researchers recommend that audiological monitoring be achieved by conducting a hearing test battery, inclusive of pure tone frequencies ranging from 250Hz to 12000Hz, Otoacoustic emissions (OAE) and ABR, as this has been established to be best practice in audiology (Rapport, Fausti, Schechter, Frey, & Hartigan, 1985; Khoza-Shangase, 2011). The audiological test battery used to assess ototoxicity associated with HIV/AIDS needs to be sensitive enough to identify subtle changes in the auditory status.

2.6. HIV/AIDS and effects on the auditory system

The AIDS disease has been reported to progress from stage to stage, accompanied by pertinent symptoms or characteristics (UNAIDS, 1997), as indicated in Table 2.1.

Table 2.1

Stages of AIDS disease progression and symptoms

Stage	Laboratory evaluation	Clinical symptoms
Stage 1	CD4+ count of > 500cells/mm3	• Lymphadenopathy • Significant abdominal and mediastinal lymphadenopathy • Dermatological abnormalities • Oral lesions • Recurrent respiratory infections.
Stage 2	CD4+ count of 200-500cells/mm3	• TB • Bacterial pneumonia • Oral lesions • Chronic disease • Serous bacterial infections
Late stage	CD4+<200cell/mm3	• Disseminated TB • Opportunistic infections e.g. extra pulmonary TB • Fatigue, weight loss becomes worse • Severe neurological complications • Human papilloma virus • Haematological abnormalities

Adapted from: Moragan, Mahe, Manyanja, Okongo, Lubenga, & Whiteworth. (2002); Post, Badri, Wood, & Maartens, ((2001).

Due to the immune system being compromised, the individual is susceptible to various types of opportunistic infections, including otologic infections that could result in a hearing loss (Mueller & Pizzo, 1997). Paediatric patients are prone to opportunistic infections and neurological complications that can compromise the auditory and vestibular systems (Matthews et al., 2012), and which can negatively impact communication (Palacios et al., 2008). Due to the weaker immune system, the individual will become susceptible to various infections as the disease progresses (Graber et al., 2008). The critical factor to consider is the stage of the disease, the clinical symptoms and susceptibility to infections.

Opportunistic infections such as bacterial meningitis, tuberculoma meningitis, CMV, Epstein - Barr virus, and streptococcal meningitis are common in the HIV/AIDS infected population (Kutz, Simon, Chennupati, Giannoni & Manolidis, 2006). Other opportunistic and viral infections such as tuberculosis, *Pneumocystis carini*, cryptococcal meningitis and Herpes Zoster have been reported to affect the auditory and vestibular systems, resulting in hearing

loss that requires audiological intervention (Bankaitis & Schountz, 1998). Auditory and vestibular complications that arise as a consequence of HIV related opportunistic infections can be defined as otologic conditions associated with HIV/AIDS. Otologic conditions associated with HIV/AIDS may give rise to conductive, mixed or , sensorineural hearing loss or auditory deficits related to central pathology (Abrams et al., 2006). Otologic conditions together with site of lesion and management strategies are described in Table 2.2.

Table 2.2

Audiological and vestibular complications associated with HIV/AIDS

Component	**Disease**	**Manifestations**	**Proposed treatment**
Outer ear	Candida albicans Otitis externa Dermatological infections	Normally appearing in the oral cavity but can be found in the auditory canal. This can result in a conductive hearing loss.	Management includes removal of debris from the ear canal and administering of profloxin.
Middle ear	Otitis media and perforated tympanic membrane, Recurrent otitis media associated with chronic sinusitis, Serous otitis media associated with Eustachian tube dysfunction, Beginner nasopharyngeal lymphoid resulting in otitis media with effusion, Otomastoiditis	Can result in a mild to profound hearing loss that is unilateral or bilateral. This can result in a conductive hearing loss.	General treatment includes antimicrobial drugs and myringotomy.
Inner ear	Ototoxicity and opportunistic infections (like bacterial meningitis, tuberculoma meningitis, cytomegalovirus, and co-infection, Epstein - Barr)that can result in temporary or permanent hearing loss	Damage to hair cell function in the cochlea, resulting in an irreversible hearing loss that could be unilateral or bilateral. This can result in a sensorineural hearing loss.	Medical intervention is limited, but rather amplification and aural rehabilitation are recommended.
Vestibular and central system	Vertigo, ataxia, occulomotor changes, pathogens in the temporal bone resulting in cytological changes	Vestibular changes associated with equilibrium and balance disorders.	Medical intervention and vestibular rehabilitation are recommended.

Adapted from Gold & Tami (1998); Mattkin et al. (1998); Smith, Adamns & Eley (2008).

The most common pathologies resulting in conductive hearing loss are otitis media, mastoditis, tympanic membrane perforation, and recurrent otitis with effusion (Abrams et al., 2006). Sensorineural hearing loss could result from damage to the cochlea (sensory component) and/ or the auditory nerve (neural component) (Copley & Frederichs, 2010). Viral or bacterial infections such as Cryptococcus meningitis, toxoplasmosis, meningitis, cytomegalovirus, and herpes can result in a sensorineural hearing loss (Carney & Muller, 1998). Central nervous system neoplasm and ototoxicity have also been reported in children infected with HIV/AIDS. Furthermore, the pathologies causing conductive, sensorineural and central hearing loss will also result in varying degrees and symmetry of hearing loss (Abrams et al., 2006). Due to disease progression, audiological complications resulting from HIV/AIDS infection also manifest with undesirable effects on language development, scholastic performance and vocational opportunities (Hausler, Vibert, Koralnik, & Hischel, 1991). Therefore, to better understand the complexities of the auditory effect it is important to be aware of the prevalance, possible causes and impact of the virus as related to children.

2.7. Epidemiology of hearing loss

The reported prevalence of hearing loss associated with HIV/AIDS varies across the spectrum internationally and locally for adults and children (Khoza & Ross, 2002). Internationally, the reported prevalance of hearing impairment in children with HIV/AIDS varies from approximately 20% to 40%. In South Africa, while approximately 2.4 % of children under the age of 14 were reported to be living with HIV/AIDS, there is no data available of the percentage presenting with a diagnosed hearing loss (Matas et al., 2010; Prevalence, 2010). In the absence of accurate statistical data in South Africa, one can conclude there are varying prevalance rates relating to hearing loss associated with

HIV/AIDS. This indicates a need for a study that will focus on investigating the audiological profile and prevalence of hearing loss in the 4% of children living with HIV in South Africa (Khoza-Shangase, 2010). This will inform audiologists on the prevalence and the description of hearing loss in children relating to hearing loss type, degree, configuration and symmetry.

2.8. The prevalence of middle ear pathology in immunocompromised children

A study by Shapiro and Novelli (1998) indicated that 44.4% of the participants presented with one or more episodes of middle ear pathology, including otitis media. While the results of a pathogen type of immunocompetent children were similar to the general population of children not infected with HIV, the results suggested that severity of immunosuppression was associated with higher incidence of middle ear pathology. This is in keeping with Post et al. (2001) and Principi et al. (1991) who reported that children with low immunity and high viral load were prone to present with more episodes of middle ear pathology; making them prone to hearing loss. In addition, Principi et al. (1991, p. 560) reported that "HIV infection does not modify the occurrence of otitis media, but it was more common in HIV infected children".

A study by Miziara et al. (2006), assessed the changes in the prevalence of otitis media associated with the use of HAART in Brazil. Miziara et al. (2007) reported a prevalence of 10.5% for acute otitis media, 14.2% for chronic otitis media and 8.5% for serous otitis media; thus, suggesting a high prevalence of middle ear pathology in immunocompromised children. The study also highlighted that recurrent middle ear infections were more frequent in symptomatic children and possibly conductive hearing loss. Principi et al. (1991), and Shapiro and Novelli (1998), highlight that children who are immunocompromised tend reported to have a high prevalence of middle ear pathology. However, such findings have not

yet been published in South Africa and there is a need to report on this in HIV positive children, to better understand the role of the viral load on the auditory system and the medical management strategies required.

2.9. Medical management for middle ear related pathology in HIV infected children

Antibiotic (antimicrobial) treatment is the most common first line choice of management of middle ear pathology in children with HIV/AIDS. Antibiotics can cause ototoxicity as they can penetrate the middle ear through the ventilation tubes or perforated tympanic membranes since a recommended treatment method is with ear drops (Choung et al., 2008). Alternatives to antibiotics include topical aminoglycosides (such as selfrodex) as indicated earlier in Table 2.2. However, when administering such drugs, a limited duration is required as they are highly ototoxic (Gibney, Morris, Carapetis, & Skull, 2005).

In addition, literature has established that the combined use of aminoglycosides and antiretroviral medication will result in severe ototoxicity with an associated hearing loss, and must be avoided in the clinical management of children with HIV presenting with middle ear pathology (Gurney & Murr, 2003). Therefore, a conclusion can be reached that monitoring for ototoxicity and early identification of hearing loss by an audiologist should be mandatory to prevent permanent and irreversible ototoxic hearing loss (Jacob, Aguiar, Tomiasi, Tschoeke & Bitericourt, 2006). Beside the antibiotic treatment procedure, there are surgical procedures available for the management of children infected with HIV. Children with HIV/AIDS are reported to present with reduced rates of spontaneous recovery from middle ear pathology (Beigh et al., 2012). Though the recovery intervals are protracted in HIV positive children and medical and audiological intervention is necessitated, literature has suggested the use of virus levels in the body and immunity resistance measures can play a

positive role in the early identification of individuals who are susceptible to opportunistic infections that can cause in hearing loss (Srugo et al., 1991).

2.10. The use of CD4cell count and viral load count as indicators for audiological monitoring

Srugo et al. (1991) reported a positive correlation between disease burden and CD4 count and that symptomatic children carry a higher amount of virus in the plasma than asymptomatic children. It can, therefore, be concluded that viral load and CD4 count seem to have a direct correlation to susceptibility to infections, including otologic conditions that will affect hearing.

Palacios et al. (2008), reported that audiological abnormalities were more frequent in patients with more prolonged HIV-1 infections, higher viral loads, or lower absolute CD4+ cell counts. The authors correlated a lower CD4 cell count to auditory pathology and reached the conclusion that immunocompromised children are susceptible to otologic infections. It also suggested that CD4 cell count measurements can be linked to repeated rates of infections. Low CD4 count measures have been associated with compromised immunity and high disease burden as an indicator for susceptibility to conditions that affect the auditory system (Maziaria et al., 2007). This can be associated with a compromised immune system that can be identified through the CD4cell count and viral load blood measurements, which are carried out routinely for children with HIV/AIDS to monitor disease burden (Principi et al., 2001). CD4 cell count and viral load measures can be used as indicators for the need for audiological monitoring, as these measures indicate the disease burden and negative impact on the

immune system's ability to resist infections that can affect the auditory system (Bojrab, Bruderly & Abdulrazzak, 1996). One can, therefore, conclude that CD4 cell count and viral load measures can also be used to indicate susceptibility to auditory based pathology.

Principi et al. (1991), Shapiro and Novelli (1998), Srugo et al., (1991), and Palacios et al., (2008) conducted studies internationally, and indicate a scarcity of research in the paediatric population (Khoza- Shangase, 2011). There are limited published findings in South Africa that report on the auditory status of HIV infected children and there is a need for such research to be published (Morgan et al., 2002). Therefore, conducting an audiological profile study and reporting on the medical management will assist in adding to the literature available which is relevant to the South African context.

The consequence of limited availability of research that reports on the prevalence of otologic conditions in immunocompromised children highlights the need for urgent reporting on this population. There is a lack of data that directly links hearing status (in terms of hearing loss degree, type, and symmetry) with CD4 cell count levels and otologic conditions (Palacios et al., 2008). This will benefit the profession of audiology, as children with a low CD4 count or high viral load are monitored for middle ear pathology early and receive hearing evaluations timeously. Children with severe immunosuppression are likely to present with otologic conditions that will affect the hearing and subsequent language and scholastic development (Feagans et al., 1994). If the middle ear pathology is not managed, the infection can spread to the cochlea and the auditory nerve, resulting in damage to the middle and inner ear (Bankaitis, 1998).

2.11. The effects of the virus on the inner ear and cortical structures

Damage to the inner ear as a result of infections, trauma, exposure to excessive noise for long periods and ototoxicity will result in a sensorineural hearing loss (Gelfand, 2001). Matas et al. (2006) reported that sensorineural hearing loss (SNHL) can affect 21% - 49% of people living with HIV/AIDS, and sensorineural hearing loss is permanent and irreversible. HIV is reported to affect the inner ear, as the virus has been reported to be neurotropic and can present with neurological symptoms (Lasis, 2005). Viral agents have been reported to attack the spiral ganglion and acoustic section of the eighth cranial nerve resulting in sudden onset of a permanent hearing loss (Gross et al., 2007). The viral agents include cytomegalovirus (CMV), hepatitis B, herpes simplex, syphilis, herpes zoster and toxoplasmosis due to the compromised immunity (Sweeney & Harris, 1996). To effectively manage bacterial and viral infections as a result of the opportunistic infections in immunocompromised children, antibiotics and antiretroviral drugs have been reported to be ototoxic, compounding the severity of the SNHL (Khoza-Shangase, 2010).

In addition, it was initially believed that the virus affects only the immune cells of the body, and further research has indicated that the virus also attacks and destroys the central nervous system (CNS), with an estimated 10%-30% of people with HIV presenting with neurological abnormalities (Makar, Dhara, Sinha, Chatterjee, & Dutta, 2012; Khoza-Shangase, 2010; Matkin et al., 1998; Sweeney & Harris, 1996). Paken (2007) confirmed that there are neurological changes in normal hearing adults with HIV/AIDS. The neurological abnormalities can also be associated with the hearing related problems, with reports of auditory processing deficits, central hearing loss and auditory brainstem disorders which negatively affect language development and communication (Makar et al., 2012).

Neurological complications can manifest in young children through failure to attain developmental milestones with the most prominent milestone being language delay and cognitive impairment. These manifestations have been associated with cranial neuropathy, progressive encephalopathy, microcephaly, meningitis and neoplasm, and are reported to occur between the age of 6 months and 5 years, which is during the language acquisition phase (Hausler et al., 1991).

2.12. The effects of hearing loss on language development in children

Hearing loss, irrespective of cause, type, and degree has adverse effects on linguistic development in children (Cook et a1., 1998). Zumach et al. (2010) reported that language development is critical during the early childhood years and the American Speech and Hearing Association (ASHA) (1997) supported that hearing loss impacts on the development of speech, language, social, emotional, cognitive and academic progress. Hearing loss has a negative impact on the different components of language such as syntax, semantics and other basic verbal skills (Feagans et al., 1994). A reduction in auditory input causes challenges with the imprinting of speech language in the developing brain, as hearing loss alters the linguistic cues, the child misses out on spontaneous opportunities to hear language by means of adult demonstration during the early language acquisition phase (Carney & Muller, 1998). In addition, these children present with delayed receptive and expressive vocabulary, poor grammatical skills, and delayed grasping of concepts (Makar et al., 2012). They present with poor linguistic based pragmatic skills resulting in limited opportunities to use language appropriately in a social context (Olyer, Oyler, & Matkin, 1998). This results in generalised language development delays, including speech production (Bess, Dodd-Murphy, & Parker, 1998).

Speech production is considered to be affected, when articulation, vocal prosody, intonation patterns, and timing have been affected (Cole & Flexer, 2007). This can result in poor expression and understanding by the communication partner (Flexer, 1994). Consequences of global delay in receptive and expressive skills can result in challenges with social interaction, and reports of behaviour problems are significantly higher in children with a hearing loss (North-Matthiassen & Singh, 2006). In addition, behaviour problems can lead to isolation, depression and poor acceptance into the community (Hugdson & Montgomery, 2008; Smith et al., 2008). Language is essential for thinking, communication and learning. Hence, the presence of a hearing loss in the early years of life may result in gaps in the acquisition of learning, poor knowledge acquisition and cognitive impairment (Feagans et al., 1994). One can, therefore, conclude that if hearing loss affects speech-language development in children without HIV/AIDS, the same fate will be suffered by children with HIV/AIDS (Govender et al., 2011). However, hearing loss identified and managed early (within the first 6 months of life) can result in normal language acquisition (Swanepoel, 2007). One can conclude that by improving access to language by managing hearing loss, even children with HIV presenting with neurological impairment will be given a better chance to develop language normally as long as the auditory system is not compromised. Further early intervention can be provided to counter auditory deprivation from hearing loss, and thus minimise the negative impact on language development and on academic performance (Harris et al., 2012).

2.13. The negative impact of hearing loss on scholastic performance

Hearing loss in the school age population has an adverse effect in the classroom and other listening environments, as auditory dysfunction affects perception and understanding of speech sounds (Niskar, et al., 1998). Early onset of any hearing loss could result in reduced processing at the lower brainstem and cortical levels in subsequent years (Maruthy &

Mannarukrishniah, 2008). Auditory processing deficits may manifest as poor concentration, auditory recall, auditory analysis and synthesis. These aspects are, however, essential for reading and writing abilities (Feagans et al., 1994). Therefore, language and auditory processing deficits, resulting from a hearing loss, can interfere with the successful acquisition of literacy skills (Carney & Muller, 1998). Children with reading fluency problems associated with hearing loss also present with difficulties in reading comprehension (Chandrasekhar et al., 2000). It is, therefore, imperative that early identification of hearing loss be established to improve academic performance and vocational potential of each child (Paluski & Kaderavek, 2002).

One can deduced that to ensure that all children, including those with HIV related hearing loss, be given a fair and equal opportunity to achieve academically, hearing loss must be timeously managed so that it does not affect their autonomy and independence as adults (Broste et al., 1989). Early diagnostic certainty is crucial in school age children, especially those infected with HIV as they are prone to hearing loss (Broste et al., 1989). Therefore, the audiologist must be involved in the early management to minimise adverse effects of hearing loss on academic performance. Audiologists should therefore, intervene where auditory and vestibular impairments have been identified, to reduce the negative impact of hearing loss on language development, and scholastic development, and to improve the chance of vocational opportunities. In South Africa, there is limited research on the impact of hearing loss on the paediatric population infected with HIV/AIDS, highlighting the need to establish an audiological profile of the HIV infected children who are affected. In addition, this will advocate for a prominent role of the audiologist in the multidisciplinary management of HIV to minimise the negative effect on scholastic performance, which will have a bearing on vocational opportunities later in life (Khoza-Shangase, 2010; Matas et al., 2010).

2.14. Audiological management of children presenting with a hearing loss

Studies show that children with HIV presenting with otologic infections tend to present with a protracted course of infection, and the possibility of spontaneous recovery is limited due to the compromised immune system (Gold & Tami, 1998). Generally, audiologists tend to delay fitting of hearing aids, as they are waiting for the resolution of the middle ear pathology (Choung et al., 2008). It therefore appears that children infected with HIV/AIDS who have an associated hearing loss, require immediate amplification, and amplification should not wait until the middle ear pathology resolves (Diefendorf et al., 1990), as a hearing loss can lead to auditory deprivation which will result in the loss of linguistic input and subsequent delayed linguistic development (Cole & Flexer, 2007; Northern & Down, 2002). The recommended guidelines from literature relating to counselling, hearing aid selection, fitting, hearing aid verifications and validation should be implemented indiscriminately for all children including those who are immunocompromised (Dillon, 2001). However, special consideration for amplification should be made with immunocompromised children.

The goal of amplification is to enable audibility of speech and environmental noise which will allow for improved auditory input, including language (Evans, 2005). This can be achieved through the selection of the amplification characteristics that will include the style of hearing aid, as behind the ear (BTE) hearing aids are recommend for children. They are robust and allow for additional power in the device (Evans, 2005). While selecting the appropriate hearing aid style is crucial, the technology inside the device is more important. Evans (2005) advocates that children should receive the latest hearing aid technology available.

Hearing aids with advanced signal processors are available (Dillon, 2001). The technology should be carefully selected when considering hearing aids for children including those with

HIV, to provide maximal benefit (Evans, 2005). One can assume that immunocompromised children are prone to middle ear infections, alternatives to air conduction hearing aids are available in the form of bone conduction hearing aids (BCHA) and implantable bone conduction hearing aids (IBHA), but these are not cosmetically appealing, and require careful consideration (Hughes, 1995). BCHA are used with conductive hearing loss that otherwise cannot use the conventional air conduction hearing aids and moreover to minimise the development of opportunistic infections resulting from pressure sores. BCHA are widely available in South Africa, as they are affordable and easy to fit since they do not require custom ear moulds (Dillon, 2001). However, due to pressure sores associated with prolonged use, headaches and poor cosmetic appeal, compliance in terms of wearing the devices has been reported to be poor in the paediatric population without HIV (Dillon, 2001) and it is, therefore, likely that similar challenges could be reported in HIV infected population. Audiologists should be cognisant that in children infected with HIV pressure sores, associated with the use of BCHA could result in other opportunistic infections which could consequently result in the patient not using the device.

While, IBHA can be an alternative to BCHA, but there is a strict candidacy guideline for this type of device due to associated costs (Goebel et al., 2002). Unfortunately, these devices are costly and not widely used in the South African context; thereby, rendering them as a limited option to children infected with HIV who are poor candidates for surgery and prone to poor wound recovery (Principi et al., 1991). Audiologists, therefore, need to carefully consider the type of device selected to maximise benefit to the patient with a restricted budget. While these services are offered by audiologists in the South African public sector, the clinicians are required to use the most effective, accurate and cost effective tools (Matas et al., 2010) to identify and manage hearing loss amongst school age children who are receiving ARV treatment with budgetary constraints..

Emphasis has been on the medical model of service delivery and little attention has been given to quality of life factors (Friedman & Noffsinger, 199). This is evident when one reviews the current policy on HIV/AIDS, as stated by the National AIDS Foundation (2009) which identifies doctors, nurses, pharmacist, social workers, psychologists, counsellors and dieticians as crucial team members. The policy has identified these professionals and their roles and responsibilities in the management of people living with HIV. Regrettably, audiologists have been excluded from the team, even though they are the designated professionals responsible for the auditory and vestibular system. The audiologists' expertise has not been clearly understood and their significance in assessment, management and prevention of otologic conditions that impair communication including those that result from HIV/AIDS related conditions are underestimated requiring further research (Hall & Swanepoel, 2010); thus one can conclude that there is a need for a study to report on an audiological profile and audiological management of children with HIV/AIDS with associated hearing loss.

2.15. Audiological profiling in the context of hearing loss associated with HIV/AIDS

Internationally, research has focused trends on establishing hearing related profiles by describing prevalence of hearing loss in HIV/AIDS infected children. A study by Weber et al. (2006) in Brazil is an example of profiling. The study aimed to report on the prevalence of otitis media in children with HIV on HAART versus the children on ARV only. The results revealed that 65 of the participants (14.2%) aged between 0-5.11years on HAART had significantly lower prevalence of chronic otitis media than those children on ARVs. The Weber et al. (2006) study results highlighted that the use of HAART reduced the prevalence of otitis media which was similar to the findings by Miziara et al. (2007).

Miziara et al. (2007) conducted a study in Brazil where they assessed the prevalence of otitis media associated with the use of HAART in HIV positive children. This study utilised a cohort of 459 children below the age of 13 years. The results revealed that otitis media had a prevalence of 31 % and therefore, use of HAART resulted in a lower prevalence of otitis media. The age group studied in Miziara et al. (2007) study is similar to the current study. The current research will endeavour to provide a description of the prevalence of hearing loss in HIV positive children in the South African context to enable a comparison with international studies to establish if there are similarities or differences.

Various studies have been conducted internationally on the hearing profile of school children; a prominent African study that was conducted by Olusanya et al. (2000) in Nigeria, where children aged between 4.5-10.9 years had their hearing assessed. The study profiled Nigerian school age children with the aim to establish the incidence of hearing disabilities in school children. The results revealed that 10% presented with slight hearing loss, 64% were found to have a mild hearing loss, 20% had moderate hearing loss and finally 6% had severe hearing loss. Of the 50 children with hearing loss, 36% presented with a conductive hearing loss, while 24% presented with sensorineural hearing loss and 40% presented with mixed hearing loss. The alarming finding from the study was that hearing loss was not detected or reported by the teachers and parents. The researchers reported that the lack of understanding of the impact of hearing loss on academic potential was the contributing factor to such high incidence of unreported hearing loss (Olusanya et al., 2000). A similar age range has been used in the current study, as these children still acquire language and are in the primary phase or foundation phase of their academic program, which is a crucial phase for further education. However, Olusanya et al. (2000) focused on the general population, with no mention of the participants' HIV status, which may have an impacted on the results.

In the South African context, research has also been conducted on the school aged population without HIV i.e. North-Mathiassen and Singh (2006). The research focused on "The Hearing Profile among Learners in Schools in the Western Cape" with the findings indicating that 13.8% of the 1101 learners screened required referrals. The study highlighted that "establishing prevalence rates is important in determining whether a condition poses sufficient health risk to the population to warrant allocation of scarce resources to address it" (North-Matthiassen & Singh, 2006, p. 114). The conclusion stated that due to the high roll-out of ARV, children are surviving longer and entering school, with the prevalence of hearing loss in school children being expected to increase. This is the most recent study that is contextually relevant and targeting the same population (school age) despite its focus not being primarily on children living with HIV/AIDS.

In a study by de Lange (2007), on "A Hearing Profile of persons infected with HIV/AIDS" audiological assessments were conducted out on adults. de Lange's study used similar audiological measures to evaluate hearing as the current study i.e. otoscopy, immittance audiometry pure tone audiometry, OAE and ABR. However, the approach and population are different. The results for the first sub-aim related to a profile of persons diagnosed according to the different clinical stages revealed that 78% had normal hearing, 15% had mild hearing loss, 6% had moderate hearing loss and 1% had moderately severe hearing loss. From the study results, 60% had normal hearing in the low frequencies, while 18% had conductive hearing loss, 18 % had sensorineural hearing loss and 4% had mixed hearing loss for low frequencies due to sloping configuration. Pure tone audiometry results indicated hearing within normal limits but a decrease of hearing was noted with the progression of the disease for some of the participants. The concluding recommendations included hearing awareness

campaigns, improving audiologist's knowledge on the effects of HIV/AIDS on hearing and inclusion of the audiologist in the management of patients with HIV/AIDS (de Lange, 2007). While, there are no published studies on audiological profiling for children with HIV locally, these national studies have alluded to the need to conduct further research in the paediatric population.

In addition, another South African study conducted by Paken (2007) investigated the use of the ABR in detecting subtle and /or early neurological changes in HIV infected individuals in the three major groups of the 2003 CDC classification of CD4 cell count. The study concluded that ABR is able to detect subtle neurological changes in the HIV infected people and the study recommended that ABR should be used in the on-going monitoring for oto-neuro diagnosis.

Khoza-Shangase conducted numerous studies on HIV/AIDS and adults in South Africa. Khoza and Ross (2002), reported on "Audiological function in a group of adults infected with HIV/AIDS", where the prevalence of hearing loss was described in terms of type, degree, configuration and symmetry following an exploratory non-experimental observational study. The results indicated that 23% of the participants had a hearing loss. Of these, 17 % of the participants presented with a conductive hearing loss, while 29% presented with mixed hearing loss and 54% presented with sensorineural. The researcher reported that hearing loss was possibly resulting from opportunistic infections and associated treatment.

Another study by Khoza-Shangase (2010) on monitoring the hearing status of adults on HAART revealed significant changes in high frequency hearing. This leads to the conclusion that patients on HAART require audiological monitoring. The current study will be similar to

Khoza and Ross (2002) in terms of ascertaining the prevalence of hearing loss being described in terms of type, degree, configuration and symmetry, but the target population will be different due to the scarcity of data in the paediatric population.

2.16. Recommended diagnostic procedures for primary school age children

Extensive literature related to hearing screening for school age children is available from the American Academy of Audiology (AAA) (2011), and American Speech and Hearing Association (ASHA) (1997). There are no specific guidelines for the 6-12 year olds in terms of diagnostic testing but there exists broad audiological guidelines for testing infants and young children (which includes school age children). Locally, the South African Speech Language and Hearing Association (SASLHA), together with the South African Association of Audiology (SAAA) and the Health Professions Council of South Africa (HPCSA) have stipulated guidelines in terms of hearing screening in school children. Internationally and locally audiological guidelines recommend that practice for assessing auditory function in children include:

- The implementation of various techniques must be evidence based and meet the needs of the child (Sabo, 2013).
- The use of a test battery approach as a cross check principle to determine the audiological profile of children as recommended by Dworsack-Dodge et al. (2012). The final determination of hearing loss degree, type, configuration and symmetry should be based on the test battery approach and any discrepancies between the tests should be thoroughly investigated (Dillon, 2001).
- Both behavioural (i.e. audiometry, and speech audiometry) and physiological measures (i.e. acoustic immittance inclusive of tympanometry and acoustic reflexes),

as well as OAEs and in some cases electrophysiological measures (i.e. ABR and Auditory Steady State Response (ASSR) testing needed to be utilised. The clinician should ensure that accurate, and reliable results are obtained at all times (Gelfand, 2001).

- The gold standard of hearing measures is behavioural measures with pure tone audiometry as they establish hearing thresholds across the speech frequencies per ear. However, these are dependent on the child's cognitive abilities, developmental age, and linguistic level, as well as visual and motor development in order to respond appropriately (North & Downs, 2002).

General procedures should include case history and otoscopic examination, regardless of which tests are included in a specific test battery. In addition, immittance (tympanometry and acoustic reflexes both ipsilateral and contra lateral responses), conventional audiometry, speech audiometry, OAE, ABR and ASSR should be used. The current research has adhered to the recommended test battery with the exception of ASSR.

2.17 Summary

This chapter has highlighted the disease classification, mode of virus transmission in children, and reported on audiological profiling. Children who are immunocompromised are prone to otologic conditions that can result in a hearing loss (Krogstad, 2006). Emphasis was made on the need to consider CD4 cell or viral load as indicators of susceptibility to otologic infections and the necessity for early audiological management, due to the complex nature of the disease in the paediatric population (Lindegren et al., 2006). Due to the nature of the virus, ARVs are prescribed however, they suggest that ARV maybe ototoxic (Khoza &

Ross, 2002). Therefore, audiological monitoring is mandatory to ensure that hearing impairment is minimised.

Hearing loss, irrespective of the cause has negative effects on language development, scholastic success and finally vocational autonomy (ASHA, 1997). Therefore, it is clear that the audiologist must play an active role in the identification and management of hearing loss in immunocompromised children to ensure an improved quality of life. However, more investigations into the type of medical and audiological intervention strategies currently used for children who are immunocompromised are still required. This chapter has highlighted that medical management and audiological management is crucial, but due to the complexities of the disease, the audiologist should be cognisant of all the audiological strategies available to children with compromised immunity. This chapter has outlined the recommended audiological management guidelines used with children who are HIV negative and the challenges encountered when providing holistic management to children with HIV.

Unfortunately in the South African context, HIV/AIDS policies have not included the audiologist as part of the multidisciplinary team, which in the view of the researcher has resulted in audiological intervention not receiving the necessary attention. Studies have indicated that the expertise of an audiologist is beneficial when they are included in the management of children with HIV/AIDS.

In the next chapter, a description of the methodological aspects of the study will be focused on.

CHAPTER 3: METHODOLOGY

3.1. Introduction

This chapter describes the aim and objectives of the study, outlines the theory used to inform the research approach, as well as describes the study design and sampling technique used. The inclusion and exclusion criteria are provided, and the pilot study procedures highlighted. The data collection instruments, data collection process, data management, and data analysis are also elaborated on. The chapter also highlights reliability and validity issues and ethical and legal considerations of conducting a study of this nature.

3.2. Aims and objectives of the study

3.2.1. Aim of the study

The aim of the study was to determine the audiological profile of school age children with HIV/AIDS at an antiretroviral clinic in KwaZulu-Natal.

3.2.2. Study objectives

The study had the following objectives:

- To describe the prevalence and nature of hearing loss in terms of degree, type, configuration and symmetry.
- To determine whether children with a hearing loss have received auditory related medical management and the type of treatment received.
- To determine whether children with a hearing loss have received audiological management for their hearing loss and the nature of these interventions.

3.3. Study design

A non-experimental descriptive design which was exploratory in nature was used to achieve the objectives of the study to identify the occurrence of hearing loss, in school age children with HIV/AIDS (Greig Taylor & McKay, 2007; Shi, 2008; & Babbie, 2008). The research followed a quantitative approach to examine the relationships between variables, and provides a snap-shot of characteristics of a specific group (Gravett & Forozo, 2009; Simon & Burstein, 1985). The relationship between variables could be expressed using statistical procedures such as correlations, relative frequencies, or differences between means (Hopkin, 2008).

There are many types of methodologies that can be implemented to produce the best results and measure these variables effectively. Methodologies refer to "the structural framework within a study implemented" (Drummon, 1996, p. 30). Epidemiology is an umbrella term used to define a study of diseases, utilising experimental or non-experimental study design (Berg & Latin, 2004). Prevalence is a sub-type of epidemiological study used to assess a number of cases of a disease in a population at a specific time (Drummon, 1996). The number of cases of a disease in a population can be further described using a profile, which entails a description of variables of the disease in a specific population (Hulley, Cummings, Browner, Grady & Newman, 2007). In the field of audiology, profiling has been used to describe the prevalence of hearing loss in a specific population (North-Matthiassen & Singh, 2006; de Lange, 2007; Khoza & Ross, 2002; Zakzouk & Hajjaj, 2002). For the purpose of the current study, audiological profiling was used to ascertain the prevalence of hearing loss in school age children infected with HIV. The reasons for conducting a prevalence study were to assess the burden of disease in the population of children, report on the medical and audiological services offered, compare the prevalence of the condition in the local context

and internationally and to report prevalence trends or severity in a particular time frame (Drummon, 1996).).

3.4. Participants

3.4.1. Study site

Data collection was conducted at the Philani Family Clinic which is an ARV clinic at King Edward VIII hospital in KwaZulu-Natal, South Africa. This site was selected as it provides tertiary hospital services for children from the eThekwini District. As a result, the population being served is diverse in terms of ethnic groups, and residential areas. The Philani clinic attends to an average of 1750 children a month, majority of which are black African and operates daily during the week with a multidisciplinary approach to the management of children. The children attend the clinic on a monthly basis for medical intervention and to collect their medication (Dr. M. Achary, 2013).

3.4.2. Sampling technique

In quantitative non-experimental designs, non-probability sampling is recommended, as it does not include any random sampling (McMillan & Schumacher, 2001). Convenience sampling, which is a type of non-probability sampling, was used in the current study. The researcher used accessible participants with specific characteristics to meet the objectives of the study. In this study, the researcher aimed to understand the relationship between HIV/AIDS and hearing status (Maxwell & Satake, 1997).

3.4.3. Study sample size

Thirty participants were conveniently selected, as this is considered to be an adequate number of participants for an exploratory type of study using non-probability sampling technique (Hulley, Newman, & Cummings, 2007; Mrs. Fikile Nkwanyana, 2014). A small

sample size was feasible due to time constriants, lack of research assistants, length of testing per participant and late arrivals for the audiological testing. In addition, the participants were selected based on their availability, willingness to participate.

3.4.4. Inclusion and Exclusion criteria

The following inclusion criteria were adhered to:

- All out-patients attending the Philani ARV clinic at King Edward VIII Hospital in Durban.
- Aged between 6 - 12 years.
- HIV positive with a confirmed medical diagnosis.

Participant's caregivers were willing to participate voluntarily and provided signed consent, with the child participant providing signed assent.

The following exclusion criteria were applied to the study:

- In-patients were excluded due to ill health, as it may have affected result reliability,
- Adolesccents and adults were excluded as the focus of the study was on primary school going age.
- Infants, toddlers and pre-schoolers were excluded from the study for the following reasons (Gelfand, 2001):
  - A second audiologist is required to confirm responses in the subjective behavioural audiological assessment.
  - Sedation is required for the electrophysiological measures and there are ethical-legal considerations associated with sedation and time constraints involved.
  - Long periods of time are required to condition for testing.

3.4.5. Description of the participants

A description of the study participants is presented in Table 3.1. The study sample comprised of 30 participants, which 17 (60%) were males and 13 (40%) were females, aged between 6-12 years. All participants were Black African, according to the racial demographics and spoke isiZulu as a first language.

Table 3.1.

Demographic information of participants

Age			**Gender**		
Age in years	**Number**	**Percentage**	**Gender**	**Number**	**Percentage**
6	3	10.0%	**Male**	17	60%
7	5	16.7%	**Female**	13	40%
8	2	6.7%	**Race**		
9	9	30.0%	**Black African**	30	100%
10	4	13.3%			
11	4	13.3%			
12	3	10.0%			
Total	30	100.0%			

3.4.6. Pregnancy, birth and developmental milestone history

A detailed case history was obtained from the caregivers using a questionnaire developed for the purpose of this study. The information reflecting pregnancy, birth information, developmental history, medical history, hearing related problems, reported hearing difficulty; and medical intervention received is detailed in table 3.2.

Table 3.2.

Pregnancy, birth history and developmental milestones

Pregnancy and birth questions	Response				No responses	
	Yes	**%**	**No**	**%**	**Number**	**%**
Pregnancy and birth						
Full term pregnancy (n=30)	15	50%	7	23%	8	27%
Healthy mother during pregnancy (n=30)	12	40%	8	27%	10	33%
Types of deliveries						
Normal vaginal delivery (n=30)	14	46%	8	27%	8	27%
Caesarean section (n=30)	8	27%	14	47%	8	27%
Complications after delivery						
Reported complications after delivery (n=30)	6	20%	14	47%	10	33%
Developmental milestones						
Gross motor milestones within normal range (n=30)	22	73%	8	27%	-	-
Speech language development within normal range (n=30)	15	50%	15	50%	-	-

As indicated in table 3.2.

Eight (27%) caregivers could not report on the pregnancy and 10 (33%) could not report on the health of the pregnancy due to the following reasons:

- The mother of the child was deceased and the caregivers were not present in the early stages of development.
- The child was accompanied by another relative and the mother was not available during the case history interview. The relative did not have knowledge of the case history information.
- Due to family background, the mother did not reside with the caregiver during the pregnancy and hence the relatives do not have the information.

In addition the majority of 22 (73%) of the children were reported to present with normal gross motor development and 15 (50%) were reported to present with delays in speech-language developmental milestones.

3.4.7. Medical history

Table 3.3., describes the co-existing medical conditions.

Table 3.3.

Co-existing medical conditions

Medical condition (n=14)	**Number**	**Percentage**
TB	11	36%
Seizure	2	6%
Encephalopathy	1	3%
Total	14	46%

Fourteen (46%) participants had other co-existing medical conditions, i.e. 11 (36%) participants had TB, 1 (3%) had encephalopathy and 2 (6%) had seizures.

3.4.8.Scholastic history

Scholastic history was obtained from the participants in relation to grades as indicated in Table 3.4. The participant's grades ranged between grade R and grade 7.

Table 3.4.

Grades of the participants

Grade	**N=30**	
	Number	Percentage
R	2	6.7%
1	4	13%
2	7	23%
3	4	13%
4	6	20%
5	4	13%
6	2	6.7%
7	1	3.3%

The participants' academic performance is highlighted in Figure 3.1.

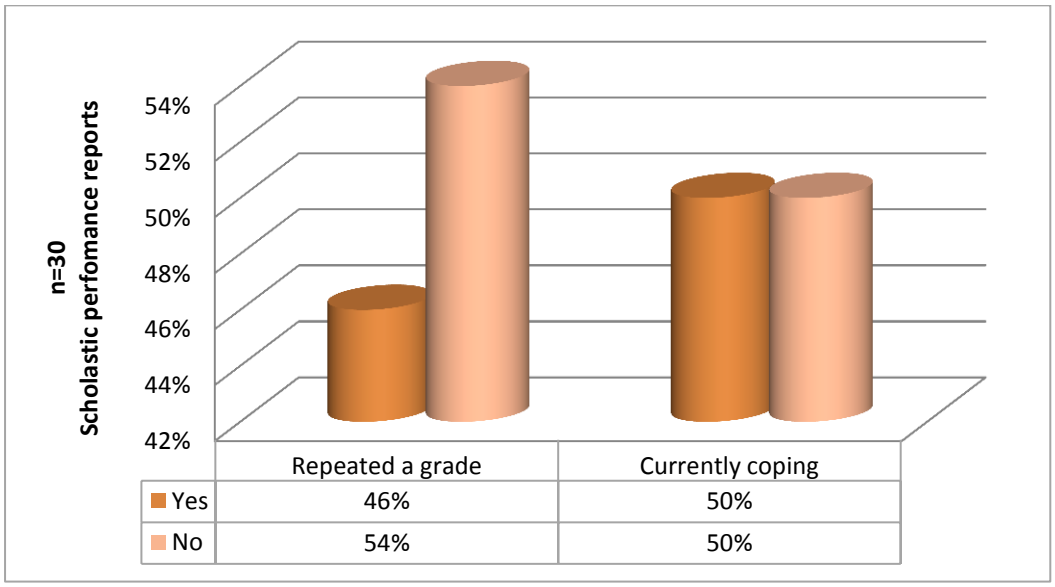

Figure 3.1: Reported academic performance of children

As described in figure 3.1., fourteen (47%) of the caregivers reported that the child has repeated a grade, while 16 (53%) had fifteen participants (50%) reported that the child was not coping currently academically while 15 (50%) reported that the child was coping academically as described in figure 3.1 above, which can be directly linked to hearing loss.

3.4.8. Antiretroviral treatment regimen

Figure 3.2, highlights the percentage of participants on each of the ARV regimens.

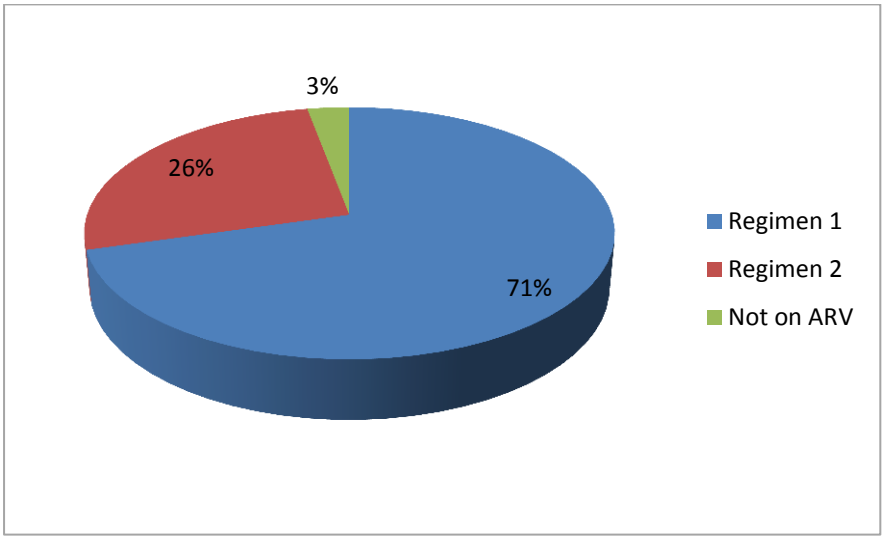

Figure 3.2: Antiretroviral regimen number

Twenty nine participants (97%) were on ARV and one participant (3%) was ARV naive at the time of testing as his viral load was below detectable levels most of the participants 21 (72%) were on regimen two while 8 participants (27%) were on regimen one, which are listed in chapter 2 section 2.5. Twenty four (82%) participants had been on ARV longer than five years and 6 (20%) participants have been on ARV less than five years, while one (3%) participant was ARV naive at the time of testing as his viral load was below detectable levels.

3.5. Data Collection Procedures

The following data collection process was followed:

- Ethical clearance to conduct the study was obtained from the University of KwaZulu-Natal Biomedical Research and Ethics Committee (See Appendix A).

- Authorisation to conduct the study at King Edward VIII hospital was obtained from the KwaZulu-Natal Department of Health (DOH) Research Ethics Committee (See Appendix B), and from the King Edward VIII Chief Executive Officer (CEO) (See Appendix C).
- The researcher liaised with health professionals (i.e. nurses and doctors) from the King Edward VIII Philani ARV clinic to make them aware of the study (See Appendix D) to facilitate recruitment of participants.
- The caregivers were given a letter that explained the study details in English (See Appendix E1) and isiZulu (See Appendix E2). Consent was obtained from the caregiver to participate in the study using a consent letter with a form for the care giver to sign in English (See Appendix F1) and isiZulu (See Appendix F2). The child had to provide assent and write their name on the form to indicate voluntary. participation. The form was available in the English (See Appendix F3) and in IsiZulu languages (See Appendix F4).
- A case history interview was conducted with the caregiver to obtain case history information in English (See Appendix G1) or IsiZulu (See Appendix G2).
- The researcher conducted a medical history review using a medical record form (See Appendix H).
- Audiological procedures followed the typical order of testing in a clinical setting:
    - Otoscopic examination.
    - Immittance audiometry.
    - Distortion product Otoacoustic emissions (OAE) testing.
    - Pure tone audiometry i.e. air and bone conduction.
    - Speech audiometry i.e. Speech Reception Thresholds (SRT) and Speech Discrimination (SD) testing.

- Auditory Brainstem Response testing.

- The caregiver and participant were given feedback of the audiological results. Participants were given the opportunity to ask questions related to the results.
- If abnormalities were observed during the assessment, referrals were made for the necessary follow up at the relevant departments.
- Information pamphlets regarding hearing loss in English (See Appendix I1) and IsiZulu (See Appendix I2) were given to patients after completing the audiological testing (See Appendix I).
- At the end of the session, the child and the caregiver were given light refreshments, and the caregiver was given R50 for travel as a token of appreciation.

3.6. Data collection method

A description of the data collection procedure, motivation for its inclusion, the data collection tool and the equipment is highlighted in Table 3.5.

Table 3.5.

Data collection procedure, motivation for procedure, and equipment used

Procedure	**Motivation for inclusion:**	**Tool & procedure:**	**Equipment**
1. Biographical information	Age, gender, and ethnic group was recorded for statistical purposes	Case history questionnaire (See Appendix G1 & G2).	N/A
2. Case History information	A case history questionnaire was developed for this study. The questionnaire had 26 questions, 10 closed ended and 16 open ended questions to provide elaborations on the response. The case history consisted of questions to obtain information relating to the following areas: • Pregnancy and birth information • Developmental history • Medical history	A case history questionnaire (See Appendix G1 in English and G2 in isiZulu). An interview was conducted with the caregiver.	N/A

	• Hearing related problems • Educational history such as scholastic performance • Reported hearing difficulty • Medical intervention received • Other pertinent information relating to hearing loss.		
3. A medical record form	A medical record form was developed for the purpose of this study. It consisted of 3 sections that used a checklist to capture the required information. Information on the following pertinent information was recorded: • CD4 cell measures within 6 month period • Viral load measures within 6 months • ARV regimen was recorded for those who had commenced ARV. • Other prescribed drugs for other medically related conditions • Audiological intervention which included audiological tests administered, results and management strategies employed to manage the presenting audiological condition. This provided information on medical factors that could have an impact on the results of the study and the researcher aimed to identify ARV drugs used to combat opportunistic infections affecting the auditory system.	Medical record review forms (See Appendix H), was developed by the researcher, and was administered prior to conducting audiological assessments.	N/A
4. Otoscopic examination	An otoscopic examination was conducted using a checklist. The otoscopic examination aimed to provide a detailed description of the external auditory canal to report any abnormalities and foreign bodies. In addition, the otoscopic examination allowed the researcher to report on the status of the external ear, to identify signs of outer and/or middle ear disease, and to ensure that no contraindications exist for performing tympanometry and Otoacoustic emissions (OAE) e.g. discharge, foreign bodies, and tympanostomy tubes as directed by ASHA (1997).	• An otoscopic examination checklist, developed for the purpose of the study was used to interpret the findings. • The results were recorded on the checklist (See Appendix J).	Wall mounted Welch Allyn diagnostic otoscope
5. Immittance	Tympanometry was used to assess middle ear	• Results from Immittance	Interacoustic AZ 26

audiometry	function (Nozza, Bluestone, Kardatzke & Bachman, 1994). Tympanometry is a standard method used to detect middle ear pathology, and is normally conducted using a 226 Hz probe and 85dBSPLs (Koivunen et al., 2000). The Jerger classification system was used Jerger, 1970 as cited in Gelfand (2001). Tympanograms were classified as Type A, Type As, Type Ad, Type C and Type B. Further the normative values specific to the GSI Tympstar and Interacoustic AZ 26 (diagnostic) middle ear analyzer were used. Ipsilateral acoustic reflex testing provided information related to the function of the conductive and the sensory pathway, and contra lateral reflex thresholds provide information regarding the neural and motor pathway associated with the "reflex arc" (Palmu, Puhakka, Rahko, Takala, & Kilpi, 2002). Acoustic reflex thresholds test is an acoustic test based on the direct recording of acoustic impendence of the middle ear (Weatherby & Barnet, 1980).	audiometry were recorded on the form designed by the researcher (See Appendix K1- Record form). • Immittance audiometry was conducted as per the procedure outlined in appendix K2. • The results were interpreted using normative data(See Appendix K3- Normative data).	middle ear analyzer GSI Tympstar middle ear analyzer
6. Distortion Product Otoacoustic Emissions (Diagnostic Protocol)	OAEs are predicted to be the by-product of the pre-neural mechanism of the cochlea amplifier and in particular they are linked to the normal functioning of the outer hair cells; thereby making them sensitive to hearing loss caused by outer hair cell damage (Koivunen et al., 2000). OAE can detect cochlea dysfunction before it is evident in pure tone audiometry, making these results crucial for detecting onset of cochlea dysfunction associated with ototoxicity. OAEs were used as an objective measure, as part of the audiological test battery for detecting outer hair cell damage as a possible indicator of ototoxicity (Marshall, Lynne, Heller, Laurie, & Westhusin, 1997). OAE may be absent if there is a middle ear pathology (Lehmann et al., 2008). According to Marshall et al., (1997), OAEs are very susceptible to middle ear variation, since the negative pressure affects the delivery of the stimulus through the, middle ear to the cochlea (Marshall et al., 1997).	• DPOAE were recorded on the form designed for the purpose of this study (See Appendix K1- Record form) and interpreted as outlined in appendix K4.	GSI Audera Distortion Product Otoacoustisc Emissions

	OAEs provide information about the integrity of the auditory system up to the cochlea (DeBonis & Donohue, 2008). OAEs are thought to be a more objective physiological measure. A diagnostic DPOAE protocol was used in the study.		
7. Pure tone Audiometry	Pure tone audiometry aimed to provide a distinction between normal hearing and abnormal hearing by describing the results in terms of degree, type, configuration and nature of hearing sensitivity (Gelfand, 2001). The frequency range was from 250Hz to 8000Hz via air conduction. Bone conduction testing was conducted from 250Hz to 4000Hz frequencies (Ahmad & Pahor, 2002). A pure tone signal was presented via TDH 49 headsets in a sound proof audiometric booth (Hall & Swanepoel 2010).	• Pure tone audiometry was conducted as per the procedure outlined in Appendix L1 • The Results were documented on an audiogram (See Appendix L- Audiogram) • Results were interpreted as per normative data presented in Appendix L1- Normative data)	Interacoustic AC 30 Or Madesen Otometrics Itera II
8. Speech Audiometry (Speech Reception Threshold Testing and Speech Discrimination Testing)	Speech audiometry was used to assess speech comprehension as part of communication, and was also used as a site of lesion test as an indicator of language comprehension development, making it essential that words used in the test be familiar and linguistically appropriate (Ramkisson, 2000). Speech audiometry is a crucial aspect to the diagnostic audiometry, as it provides information on linguistic abilities but can also be used for correlating immittance and pure tone findings (North & Downs 2002). Speech Reception Thresholds (SRT) was used to correlate and confirm reliability of the pure tone audiometry (Gelfand, 2001). Live speech testing was conducted using a microphone in a sound proof booth. Speech Discrimination Testing (SD) PI-PB Function was used to determine the lesion site. The isiZulu discrimination word list developed by Balkisoon,	• The results were documented on the audiogram (See Appendix L- Audiogram) • Speech audiometry was conducted as per the procedures outlined in Appendix M1 • The normative data for interpretation of the results is indicated in Appendix M2- Normative data). • The digit test, which has been proven to be reliable for non-native English speakers, was used (Ramkisson, 2000) for Speech Reception testing for the IsiZulu speakers (See Appendix M3) • IsiZulu speaking children were tested using the word list developed by Balkisoon,	Sound proof audiological testing booth (double suit). Interacoustic AC 30 Or Madesen Otometrics Itera II

	(2001) was used to establish the PI-PB function for isiZulu speaking children. While this has undergone formal development through research methods, its validation has not been formalised. Speech Discrimination was obtained using live speech testing. In this study, pure tones and speech audiometry was used to correlate immittance results using the cross check principle (Matas etal., 2010). Speech audiometry provided means for the researcher to understand the impact of hearing loss on communication (Hall & Swanepoel, 2010).	(2001) for establishing the SD PI-PB function (See Appendix M4)	
9. Auditory Brainstem Response (ABR) Test	ABR is not a hearing test but is a measure of synchronized nerve firing along the auditory brainstem pathways in response to auditory stimuli (Bachman & Hall, 1998). It can be used to assess peripheral auditory sensitivity. ABR is essentially unaffected by the state of consciousness and responses can be recorded at or near auditory threshold (Bachmann & Hall, 1998; Hurley, Hurley & Berlin, 2005). ABR was used as a site of lesion test to distinguish between cochlear and retrocochlear pathology (Niskar et al., 1998).	ABR was conducted as per procedure outlined in Appendix N. Data was analyzed using the normative data (See Appendix N2) for the procedure and normative data	GSI Audera Auditory Evoked Potentials (AEP)

All equipment had undergone the necessary calibration (See Appendix O, O2, and O3) and biologic calibration was carried out daily by the researcher to ensure the equipment was functioning.

3.7. Pilot study

A pilot study was conducted to establish whether the questions were clear and to identify ambiguity in the case history questionnaire. The pilot study aimed to assess the rate, ease of recruiting participants and the time to conduct a full audiological test on each participant (Babbie, 2008, Gravett & Foronzo, 2009). The recommendations from the participants of the

pilot study were used to guide the data collection process (Shi, 2008). The aims, outcomes and recommendations obtained from the pilot study are discussed in Table 3.5.

Table 3.6

Purpose, procedures, outcomes and recommendations from the pilot study

Purpose	**Procedures**	**Outcomes**	**Recommendations**
1. To determine the time taken to complete the case history interview	A case history interview was conducted and the time taken was noted.	The average time to conduct the case history was 5 minutes.	To retain the questionnaire and no amendments were required.
2. To determine the clarity of the questions asked during the case history interview	A case history interview was conducted using predetermined questions on five participants not included in the main study. This was done to determine if the questions were ambiguous or difficult for the participants to understand.	The questions were clear and easy to understand. The order of the questions was sequential and logical.	No amendments were required.
3. To determine the time taken to conduct a complete audiological assessment on one patient	A complete audiological assessment was conducted and the time taken was noted.	The average time to complete the audiological test battery was 1hour 45minutes.	The researcher to maintain the same time to speed up the data collection process to meet the target population. The order of testing had to be maintained.
4. To determine efficiency of the recruitment process from the ARV clinic to the Audiology department	A recruitment process was commenced with five participants. Time, efficiency and accessibility were noted.	The best way to recruit the participant was for the researcher to physically go to the clinic and address the participants in the waiting area and provide a brief explanation of the study. This made the participants willing to attend when referred by the medical staff as they were familiar with the study and the inclusion criteria. The best time was between 7.30-8.30 am.	No change.

3.8. Infection control

Infection control standards, as stipulated by Infection Control for Regulated Professionals (Browne, Gignac, Hamilton, Harrison, Hunter, James et al., 2007; Burco, 2007) were maintained (See Appendix P). Infection precautions included patient contact and environmental hygiene, which consisted of using latex gloves during handling the patient and instruments used for the patients. All specula, probe nubs and electrodes were disinfected after each patient to prevent infection transmission.

3.9. Ethical and legal considerations

The current study followed the guidline provided by the World Medical Association (2008) Helsinki Declaration.

The research protocol was submitted for guidance and comment to the University of KwaZulu-Natal Biomedical Ethics Committee prior to commencing the study (See Appendix A). Authorisation to conduct the study at King Edward VIII hospital was obtained from the KZN Department of Health Research Ethics Committee (See Appendix B), and from the King Edward VIII Chief Executive Officer (CEO) (See Appendix C). The researcher liaised with health professionals (i.e. nurses and doctors) from the King Edward VIII Philani ARV clinic (See Appendix D) to make them aware of the study to facilitate recruitment of participants.

The following ethical and legal issues and considerations were addressed:

- Permission from the gate keepers i.e. KwaZulu-Natal Biomedical Ethics Committee, King Edward VIII Hospital and KwaZulu-Natal Department of Health was obtained.
- The primary researcher was a qualified Speech Language Therapist and Audiologist with appropriate qualifications to conduct the audiological procedures.

- The researcher ensured that all participants understood the requirements of the study and voluntary participation was ensured through the signing of a consent form (Newman, Browner, Cummings & Hulley, 2007). The child's legal guardian had to provide consent. In the event of child headed households, the eldest child or relative who served as the guardian of the younger sibling had to provide consent. If the participants were English second language speakers, the researcher explained in isiZulu, as the researcher was fully competent in both languages. Informed assent was obtained from the child, as they are cognitively able to agree or disagree to participate. (Greig et al. (2007, p. 172) recommend that "informed consent from the child's legal guardian should be obtained and in addition the child's assent should also be sought. Even though a child may not be legally competent to give consent, researchers should gain informed *assent*"(Greig et al., 2007, p. 174). The child's caregiver was present with the child during testing. For illiterate caregivers, the consent was obtained verbally, and thumb prints were obtained to indicate voluntary consent to participate. Signed copies were kept with the audiological information in a folder, where the researcher is the only one who has access.
- The participants were informed that they can withdraw from the study without any negative penalties (Simon & Burstein, 1985). This explanation was in the information document to the caregivers in English or isiZulu and the information was also provided verbally before commencing with the case history and audiological testing.
- Confidentiality and anonymity was ensured by assigning numbers to participants instead of using names or hospital numbers which can reveal the identity of the participants. During the course of the study, the participants were identified by their numbers. The same numbers were used when the results were presented to research supervisors to maintain confidentiality of the participants. On completion of the

study, the documentation and data will be kept in a locked cupboard at University of KwaZulu-Natal Audiology Department for five years and thereafter shredding will be used to dispose of the information (Maxwell & Satake, 1997).

- All audiological results were explained to the participants in simple language that did not use jargon to make sure that they understood the implications of the audiological findings. Participants who required further audiological management or other medical intervention were referred to the relevant departments within the hospital.
- Participants were informed that the procedures were not invasive and no harm was to come to them. Adhering to test procedures and use of non-invasive tests was ensured. Calibrated equipment was used to ensure patient safety (See Appendix O). Appropriate sterilisation and cleaning of instruments during testing were carried out (McMillan & Schumacher, 2001).
- Information pamphlets relating to hearing loss and effects on language development were made available to all participants. The pamphlets are available in English (Appendix I1) and isiZulu (Appendix I2).
- The researcher has completed an accredited on line ethics course with the University of KwaZulu-Natal (See Appendix Q) to ensure that all research ethical principles were adhered to during the study.

3.10. Validity and reliability

Validity refers to the extent to which a test measures what it is supposed to measure (Berg & Latin, 2004). In the current study, measures used (i.e. audiological tests such as immittance audiometry, OAE, pure tone audiometry, speech audiometry and ABR) have been proven to be valid and are in keeping with best practice methods in audiology (Gelfand, 2001). Immittance audiometry measures the middle ear status, while OAE assesses the integritiy of

the outer haircells in the cochlea and ABR measures neural integrity (Kazunari, 2006). Therefore all the afore mentioned audiological assessment tools are considered to be objective tests, and have undergone rigorous construct validity assessments (Shi, 2008; Swanepoel, 2007).

A case history questionnaire and medical record form were developed for the purpose of the study to provide qualitative and quantitative audiological history. These forms were devised after consulatation with literature on case history form development. The medical record form was designed to capture the immunological status, medical and audiological history as well as drug regimen details. To ensure construct validity, a pilot study was conducted on five participants to ensure that the questions were relevant, appropriate and provided the required data (Babbie, 2008). In addition these measures were used to correlate the results, thus ensuring that the study tools have criterion validity (Leedy & Omrod, 2005).

These tests assisted the researcher to achieve criterion based validity, where the audiological results were obtained using the acceptable standard of audiological practice (Babbie, 2008). The researcher ensured that all equipment used was in good working order, met the clinical requirement standards and had been calibrated to ensure that results obtained are valid and to obtain face validity (Leedy & Omrod, 2005). This process aimed to counter against internal validity threats (Gravette & Forzano, 2009). A statistician was consulted to analyse and interpret the results. Berg and Latin (2004) indicated that statistical validity is considered to be the strongest form of validity.

Reliability measures the consistency of the test scores or data (Babbie, 2008). To ensure reliability, formal audiological tests were used. The selected test procedures, order of testing and interpretation of the results have been established to be reliable by literature. Short breaks between tests to enhance performance were included. While the audiologist calculated the

pure tone average, the participant was instructed to stand, stretch and to prepare for the next test. This provided a break and improved concentration to improve validity during testing (Gelfand 2001).

The case history questionnaire, information pamphlet, and consent document have been translated into isiZulu and the method of back translation has been used to ensure accuracy of translated materials. The researcher translated the documents, while a first language isiZulu person assessed correct dialect, grammar, and spelling. A bilingual clinician conducted back translations of the documents. This ensured that all materials translated captured the content, and the linguistic structures, and to validate the initial translation (Maxwell & Satake, 1997).

The ABR was used as an objective test to assess neural integrity and as a site of lesion test to differentiate between cochlea and retrocochlea pathology (Gelfand, 2001). The ABR was considered an objective test, as the response originates from neural generators and the participant does not provide any behavioural responses (Bachmannn & Hall, 1998). However, result interpretations are subjective, which could result in reliability challenges (Janssen, 2008). To ensure that ABR result interpretations were reliable, the researcher requested the assistance of an independent audiologist experienced in ABR testing to also interpret the result. This process was also known as interrater reliability (Berg & Latin, 2004, Leedy & Omrod, 2005). In addition the researcher attended training on ABR to improve skills in test protocols and interpretation. The researcher underwent training on the appropriate use of the equipment from HASS Medical and Interacoustics Equipment suppliers to ensure reliable and accurate results were obtained. The researcher followed standard clinical practice in audiology for administering the audiological tests i.e. case history, otoscopy, immittance, OAE, pure tones, speech audiometry and ABR. This ensured that standardization is achieved by administering the test in a consistent manner. All the above mentioned factors aimed to

counter bias, and to meet the criteria for admissible and reliable data (Leedy & Omrod, 2005).

3.11. Data Management

The researcher created a data base of all the participants, where detailed biographical information was recorded. Then each participant was allocated a number that was used for identification during the study. The hard copies of the data were stored in individual folders that were collated into one big folder that was stored at the Department of Audiology in UKZN in a locked cabinet for a period of 5 years, and then subsequently disposed of by shredding. The digital data was stored on a password protected computer, and the raw data was only made available to the researcher, supervisors and statistician. The files will be deleted with the supervisor's permission after five years.

SPSS version 22 software was downloaded from the University of KwaZulu-Natal (UKZN) website for data analysis. The researcher then consulted a statistician, Mrs. Fikile Nkwanyana from UKZN to advise with undertaking the analysis.

3.12. Data Analysis

Questionnaire

The biographical data, pregnancy and birth information, developmental history educational history inclusive of academic performance, hearing related problem, reported hearing difficulty and medical intervention were analysed using descriptive statistics (number and percentage), and were presented in tables. The researcher attempted to draw associations between reported hearing related problems and hearing status through cross tabulation of immune classification and hearing status. Cross tabulation is sub-type of

descriptive statistics that is used for determining association between nominal variables (Gradey & Heast, 2007). The level of significance was set at $p < 0.05$ for inferential statistics.

Medical history

The medical records were reviewed to gain information about the participant's HIV status and medication, the use of drugs for opportunistic infections, and any audiological diagnosis and interventions provided. The data was analysed using descriptive statistics such as proportions, and the results were presented in tables. The researcher attempted to determine if there is a relationship between hearing status and medical status in terms of CD4 count and viral load. This was achieved with the use of the Chi-square test for correlation (Gravett & Foronzo, 2009). Chi-square is a statistical test which, forms part of the non-parametric tests, used for establishing significant difference between the frequency of observed and expected observations or variables (Berg & Latin, 2004).

Audiological procedures

The data from the audiological tests were analysed to identify the occurrence of hearing loss type, degree, configuration and symmetry.

1) ***Otoscopic examination*** results were presented using descriptive statistics i.e. frequencies and percentages and were presented in tables.
2) ***Immittance audiometry*** results were classified as follows:
   a) Tympanometry results were first classified according to Jerger & Jerger's (1970) as cited in Gelfand (2001) classification, which indicated the four types (Appendix K3).

These were further analysed using descriptive statistics such as frequencies and percentages and were presented in tables. In addition the Chi-square test was used to compare tympanometry results and CD4+ T Lymphocyte categories.

b) Acoustic reflex thresholds were classified as absent, elevated or present (See Appendix K3). These were further analysed using descriptive statistics such as frequencies and percentages and presented in table form. The independent T test was used for correlation between immunological status and acoustic reflex results (Leedy & Omrod, 2005). The t- test is a correlation test used to compare means of two groups to establish significance and to assess if scores are related. In addition, this test can be used to compare two related groups (Berg & Latin, 2004).

3) ***Pure tone audiometry*** results were first classified according to hearing loss type as described in Table 3.6. Pure tone results were also used to classify hearing loss degree and configuration (Appendix K3). These were further analysed using descriptive statistics such frequencies and percentages and presented in bar graphs. Association between hearing status and immunological status was determined through cross tabulation where two variables were compared. The Pearson's correlation test and the Independent T- test were used to determine correlation between immunological status using CD4+T lymphocyte, hearing loss type and degree of hearing loss. Hearing loss symmetry and laterality was reported in frequencies and percentages. The Pearson's correlation test is a non-parametric statistical analysis for assessing a relationship between two variables (Berg & Latin, 2004).

4) ***Speech audiometry***:

a) Speech Reception Threshold was used to indicate reliability of the pure tone audiometry results, and was categorised as good, fair or poor based on the PTA/SRT correlation. The correlation was used to rate the audiograms reliability.

b) Speech Discrimination test results were classified (Appendix M) according to the normative data.

c) Descriptive statistics such as frequencies and percentages were used and the results presented in tables.

5) ***Otoacoustic Emissions (OAE):*** A response was considered present when the DP amplitude level was equal to or greater than 6dB above the noise floor. The DPOAE was expected to be present with pure tone thresholds better than 25dB HL and was absent for hearing losses greater than 40dB (Gelfand, 2001). Descriptive statistics such as frequencies and percentages was used and the results presented in tables. The Spearman's correlation test was used to determine if a significant correlation exists between immunological classification using CD4+T lymphocyte count, viral load and DPOAE results was carried out. The Spearman's test is similar to the Pearson's correlation test, which is classified as a non-parametric statistical analysis for assessing a relationship between two variables (Berg & Latin, 2004).

6) ***ABR***: A neurological ABR was used in this study to assess neural integrity. Matas et al., (2010) recommend that the results be classified as Lower brainstem (LB) and Higher brainstem (HB) to provide a site of lesion distinction along the auditory pathway based on absolute latancy results and interpeak results.These results were presented in a table and the Spearman's correlation test was carried out to determine the significance of the

correlation between immunological status and ABR results. The descriptive classification of hearing loss used in the study, is described in Table 3.7.

Table 3.7.

Classification of hearing loss

Type of hearing loss	**Immittance**	**Pure tones**	**Speech audiometry**	**OAE**	**ABR**
Conductive hearing loss	-Type As, Ad, C, and B tympanograms -Elevated or absent acoustic reflex thresholds	-Air Bone Gap (ABG) between Air conduction (AC) and Bone Conduction (BC) ≥10dB. -Depressed AC thresholds	PB Max of 100% achieved at higher intensity levels for PI-BP function	Absent emissions	Increase of electrophysiological thresholds; delay in absolute latencies of waves I, III and V; and normal interpeak I-III, III-V and I-V at high intensity
Sensorineural hearing loss	-Type A tympanograms -Present or absent acoustic reflex thresholds	-No ABG between AC and BC -Depressed AC and BC thresholds	**Cochlear** May reach PB Max of 100% or a dynamic range of <45dB suggest recruitment. Roll over ratio <0.45 **Retrocochlear** -Difficulty with attaining PB Max of 100% discrimination with roll over >20% and the -PI-BP function roll over ratio >0.45	**Cochlear** Emissions may not be present at affected frequency ranges or will be reduced **Retrocochlear** Clear emissions may be recorded and within normal range Note: Absent emission for hearing loss >50dB	Increase of electrophysiological threshold and absolute latencies of waves I, III and V; and normal interpeak I-III, IV and V at high intensity
Mixed hearing loss	-Type As, Ad, C, and B tympanograms -Elevated or absent acoustic reflex thresholds	Conductive and sensorineural component in the same ear	Conductive and sensorineural components	Absent emissions due to middle ear status	-Absolute latencies will be delayed. -Normal interpeak at elevated levels. -Wave V will be detected at high intensities

HIV status and hearing loss

The researcher attempted to draw inferences between case history findings and hearing status through correlation statistics such as Spearman's correlation test. Correlation was determined between hearing status and medical status, in terms of CD4 count and viral load, and treatment. This was done by using statistical tests such as Chi-squared test for correlation (Mrs. Fikile Nkwanyana, August 2011; Newman et al., 2007; Shi, 2008; Berg & Latin, 2004).

3.13. Summary

The current study utilised an exploratory non-experimental, non-probability convenient sampling technique to meet the objectives and aim of the study. Strict inclusion and exclusion criteria were stipulated and the data collection procedure was described in detail. The researcher established that case history, otoscopic examination, immittance audiometry, pure tone audiometry, speech audiometry, OAE and ABR test procedures constitute the best audiological practice to reach the aims and objectives of the study. Ethical and legal considerations were discussed in detail and the researcher highlighted reliability and validity issues associated with this study. Finally, the study described statistical measures used to analyse and present the results.

CHAPTER 4: RESULTS

4.1. Introduction

This chapter describes the results using descriptive statistics from SPPS version 22 statistical software package. The results are presented with reference to the objectives of the study. Audiological results will be described and inferential statistics will be used to find associations between hearing results and CD4 cell count. In addition, an overall audiological profile of hearing loss will be described using the audiological test results. A summary of relevant case history information focusing on reported hearing impairments and other co-existing medical conditions will be provided in this chapter in relation to the objectives of the chapter. Finally, a report will be given in relation to audiological and medical intervention received by the participants as indicated in the medical records.

4.2. Audiological profiling

The first objective of the study was to describe the prevalence and nature of hearing loss in terms of degree, type, configuration and symmetry of any hearing loss observed. Audiological profiling was achieved using the audiological test battery approach. A cross check principle was used to interpret the hearing test resultsA detailed spread sheet of the individual test result is presented in Appendix S.

4.2.1 Otoscopic examination

Table 4.1., highlights the salient findings of the otoscopic examination of both right and left ears.

Table 4.1.

Otoscopic examination results

Observation	**Right ear n=30**		**Left ear n=30**	
	Number	Percentage	Number	Percentage
Overall otoscopic results				
Normal results	13	43%	11	37%
Abnormal results	17	57%	19	63%
Total	**30**	**100%**	**30**	**100%**
Abnormal otoscopic results				
Stenosis of canal	1	6%	1	6%
Discharge	2	12%	2	12%
Wax	8	47%	6	35%
Perforated Tympanic membranes	4	24%	5	29%
Retracted tympanic membranes	6	35%	5	29%
Bulging tympanic membranes	2	12%	1	6%

Normal otoscopic findings were observed in the right ear of 13 (43%) participants, and the left ear of 11 (37%) participants. Abnormal otoscopic findings were observed in the right ear of 17 (57%) participants, which was more than half of the sample, and the left ear of 19 (63%) participants. The description for the presence of wax was inclusive of occlusive and impacted wax. Middle ear pathology was observed in 18 (60%) of the participants based on abnormal otoscopic findings indicative of middl ear pathology. In addition, middle ear dysfunction was confirmed by use of immittance audiometry results, which are described in detail in the next section.

4.2.2. Immittance results

4.2.2.1. Tympanometry

Table 4.2. represents the tympanometry results for both the right and the left ear.

Table 4.2

Tympanometry results

Immittance	**Right ear n=30**		**Left ear n=30**	
	Number	Percentage	Number	Percentage
Tympanometry				
Type A	17	57%	18	60%
Type B	2	6%	3	10%
Type C	5	17%	3	10%
Type As	-	-	-	-
Type Ad	1	3%	-	-
Could not test	5	17%	6	20%
TOTAL	**30**	**100%**	**30**	**100%**

It is evident from Table 4.2, that 17 (57%) of the right ear tympanograms were normal type A, while 8 (27%) were abnormal. Eighteen, (60%) of the left ear tympanograms were normal type A, while 6 (20%) were abnormal. The right ears of 5 (17%) participants and left ear of 6 (20%) participants could not be tested due to fluid in the ear canal and perforated tympanic membranes. A prevalence of 12 (40%) participant presented with middle ear pathology. Further analysis was carried out using the Chi-square test, a p value of 0.4 was obtained, indicating that there is no significant correlation ($p \leq 0.05$) between the CD4+T Lymphocyte measures and tympanometry.

4.2.2.2. Acoustic reflex threshold testing

Table 4.3.reflects the acoustic reflex threshold results.

Table 4.3.

Acoustic reflex testing results

Immittance	Right ear n=30		Left ear n=30	
	Number	**Percentage**	**Number**	**Percentage**
Ipsilateral				
Normal	17	57%	18	60%
Abnormal	8	27%	7	24%
Could not test	5	16%	5	16%
TOTAL	**30**	**100%**	**30**	**100%**
Contra lateral				
Normal	12	40%	13	44%
Abnormal	13	44%	12	40%
Could not test	5	16%	5	16%
TOTAL	**30**	**100%**	**30**	**100%**

Abnormal ipsilateral acoustic reflex thresholds were observed in the right ear of 8 (27%) participants and the left ear of 7 (24%) participants Abnormal contra lateral acoustic reflex results were obtained in the right ear of 13 (44%) participants and the left ear of 12 (40%) participants. The independent sample test revealed a p value of 0.48, indicating that there was no significant correlation ($p \leq 0.05$) between immunological status and acoustic reflex thresholds.

4.2.3. Pure tone audiometry

The following results will describe the prevalence and nature of hearing loss in terms of degree, type, configuration and symmetry. Twenty eight participants contributed data for the pure tone audiometry, as two participants could not be conditioned to perform the test.

4.2.3.1. Degree of hearing loss

Figure 4.1. describes hearing loss in terms of the occurrence and severity of loss.

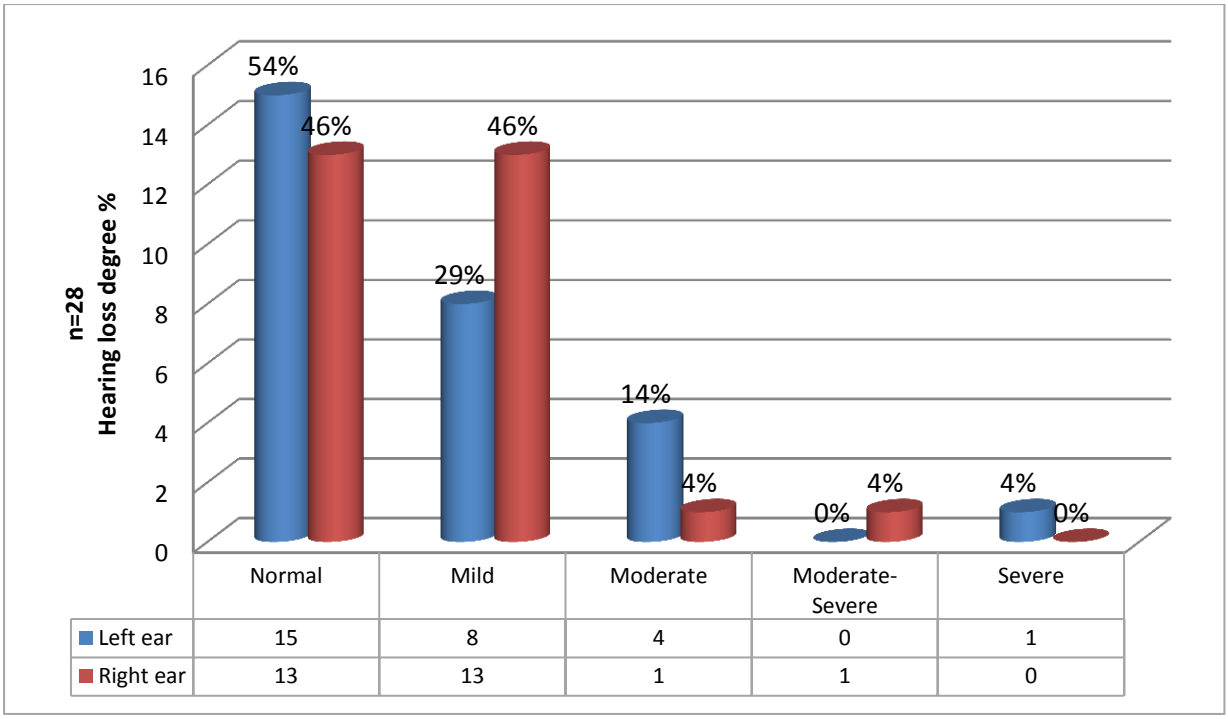

Figure 4.1: Degree of hearing loss

Of the 28 participants assessed, 13 (46 %) presented with normal hearing in the right ear and 15 (54 %) presented with normal hearing in the left ear. Thus hearing loss was observed in right ear of 15 (54%) participants and in the left ear of 13 (46%) participants. Mild hearing loss was the most common with a small percentage of moderate to severe hearing loss.

4.2.3.2. Type of Hearing loss

Figure 4.2., describes the pure tone results in terms of hearing loss type for both the ears.

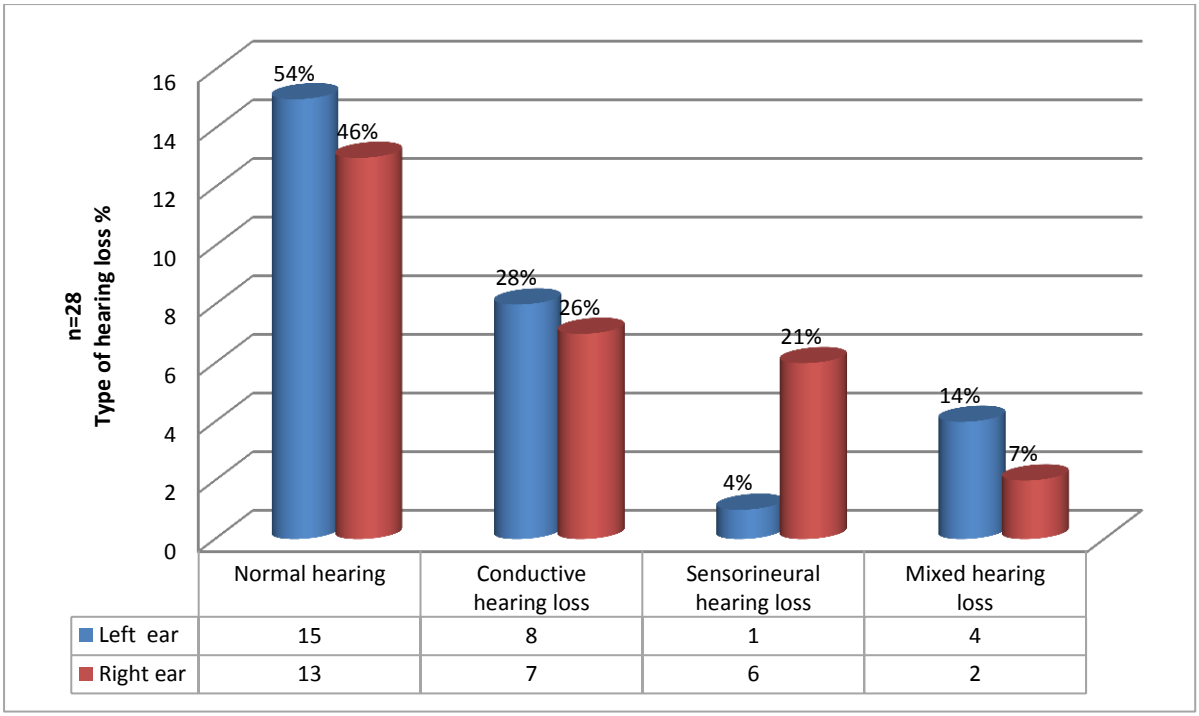

Figure 4.2: Type of hearing loss

Of the 28 participants assessed, conductive hearing loss was the most common, followed by sensorineural hearing loss and mixed hearing loss.

4.2.3.3. Configuration of hearing loss

It must be noted that the right ear had 15 (54%) hearing loss and the left ear presented with 13 (47%) hearing loss. Figure 4.3., describes hearing loss in terms of hearing loss configuration.

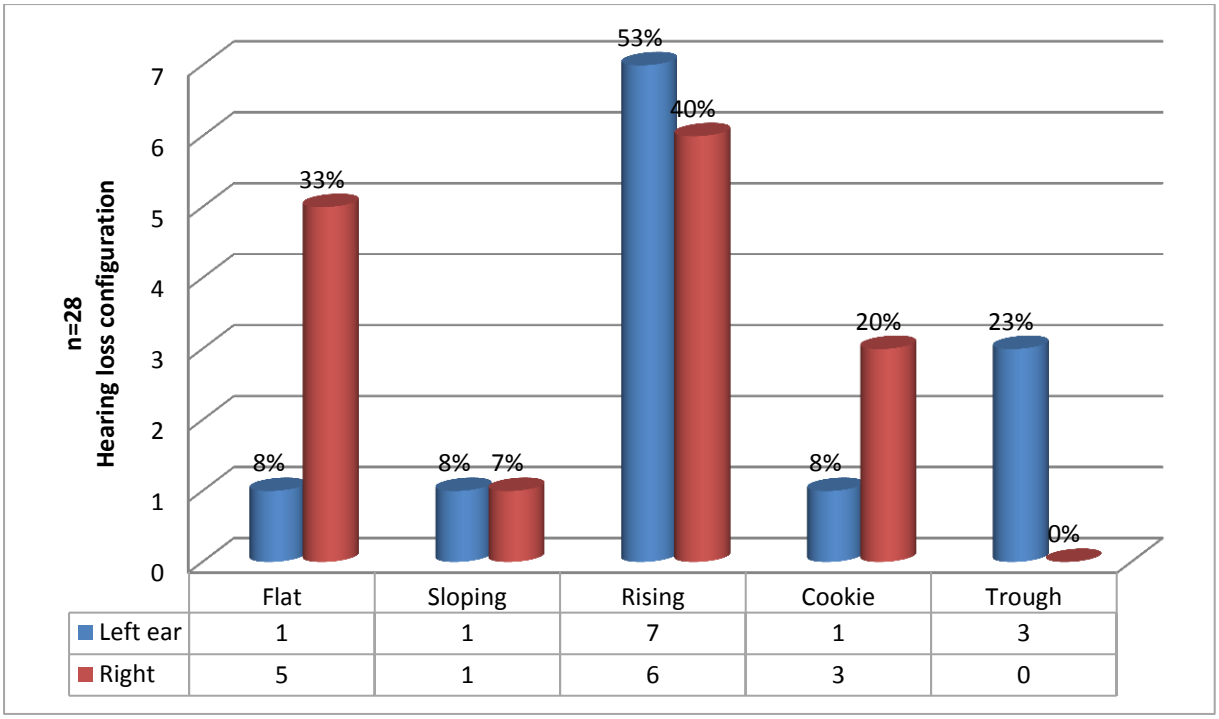

Figure 4.3: Configuration of hearing loss

Figure 4.3 above, illustrates that rising configuration was the most common configuration observed, seen in the right ear of 6 (40%) participants and the left ear of 7 participants (53%). A rising audiological pattern is reported to be common configuration associated with conductive hearing loss in this sample .

4.2.3.4..Hearing loss laterality

Of the 28 participants who underwent pure tone audiometry, 12 (43%) had normal hearing thresholds bilaterally. Sixteen (57%) presented with a hearing loss in either one or both of ears. Figure 4.4., illustrates hearing loss laterality in terms of unilateral versus bilateral hearing loss.

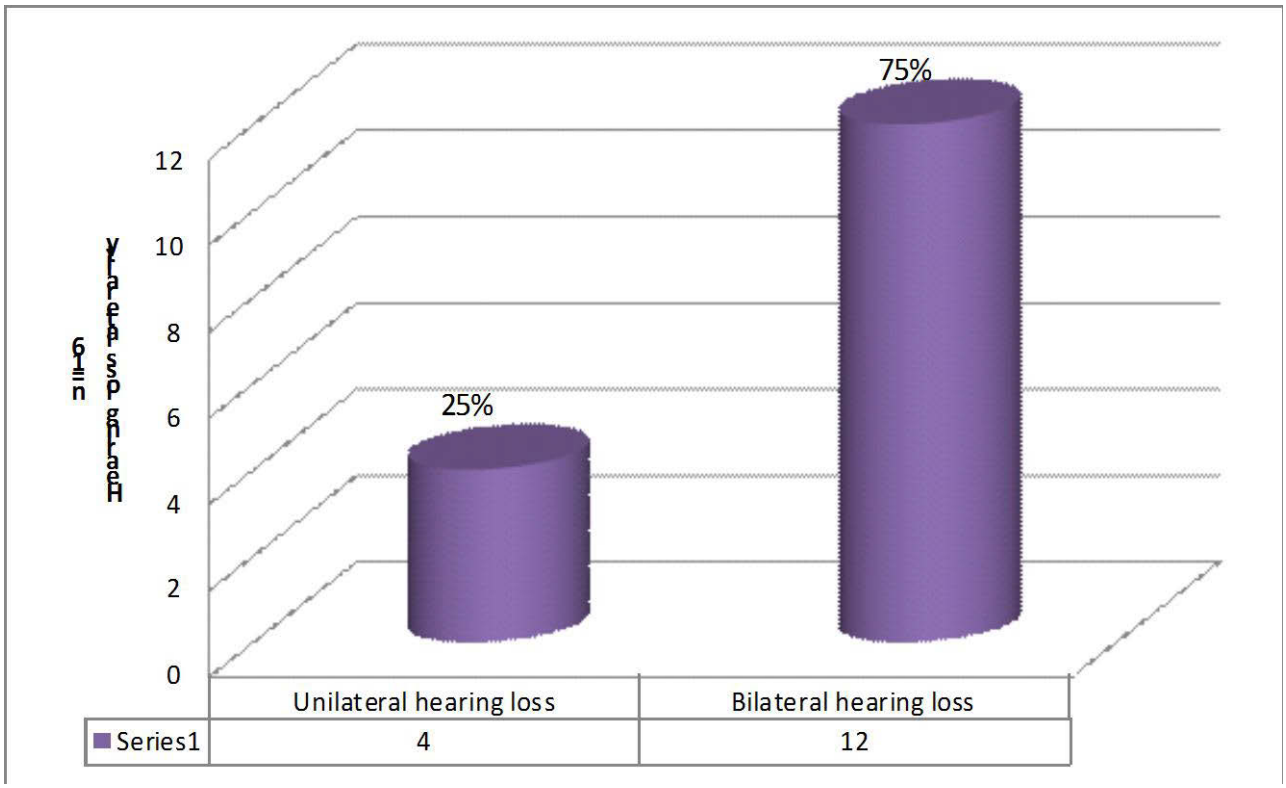

Figure 4.4. Hearing loss laterality

Of the 16 (57%) participants with a hearing loss four (25%) participants presented with unilateral hearing loss while the majority of 12 (75%) participants presented with bilateral hearing loss, as depicted by figure 4.4.

4.2.3.5. Hearing loss symmetry

Table 4.4. describes the hearing loss symmetry results.

Table 4.4.

Hearing loss symmetry

Hearing loss symmetry	**Number(n=12)**	**Percentage%**
Symmetrical	6	50%
Asymmetrical	6	50%
TOTAL	**12**	**100%**

Of the 12 participants with a bilateral hearing loss half of the participants 6 (50%) presented with symmetrical hearing loss while the remaining 6 (50%) participants presented with asymmetrical hearing.

The Independent T-test revealed a p value of 0.676 indicating that that there was no significant correlation between the CD4+ T-Lymphocyte classifications and degree of hearing loss. However, the Pearson's correlation coefficient value of 0.01 for the two tailed test was obtained indicating significant correlation between hearing loss type, hearing loss degree with viral load and CD4+ T-Lymphocyte classifications (See Appendix S Table 1-4). Therefore, one can conclude that there is a relationship between hearing loss degree and viral load levels.

4.2.4. Speech audiometry

4.2.4.1. Use of Speech reception threshold to determine pure tone reliability

Pure tone audiometry test reliability was established using the Pure Tone Average (PTA) and correlating it with Speech Reception Threshold (SRT) thresholds. Below in Table 4.5 is the detailed description of the pure tone audiometry test reliability results. Speech audiometry was conducted on 28 participants, as two participants could not be conditioned.

Table 4.5.

Pure Tone Average (PTA) Speech Reception Threshold (SRT) correlation

PTA/SRT Correlation	**Right ear N=28**		**Left ear N=28**	
	Number	**Percentage**	**Number**	**Percentage**
Good	23	82%	25	89%
Fair	2	7%	-	-
Poor	3	11%	3	11%
TOTAL	**28**	**100%**	**28**	**100%**

Good SRT-PTA correlation was obtained in the right ear of 23 (82%) participants, and in the left ear of 25 (89%) participants as indicated in Table 4.5, which is majority of the participants. Fair correlation was obtained in the right ear of 2 (7%) participants. Poor correlation was obtained 3 (11%) participants for both the ears. From the speech audiometry results it is evident that the majority of the participants obtained good SRT/PTA correlation

4.2.4. 2. Speech Discrimination testing

Speech discrimination testing was conducted in 28 participants as two participants could not be tested since they could not be conditioned. Speech discrimination results are presented in table 4.6.

Table 4.6.

Speech Discrimination Test (SDT) results

	Right ear N= 28		**Left ear N= 28**	
Speech discrimination scores %	**Number**	**Percentage**	**Number**	**Percentage**
90-100	27	96%	27	96%
89-75	-	-	-	-
74-60	-	-	-	-
60-50	-	-	-	-
<50	1	4%	1	4%
TOTAL	**28**	**100%**	**28**	**100%**

Speech Discrimination scores of 90 to 100% were obtained in the right ear of 27 (96%) participants bilaterally, while scores of less than 50% was obtained bilaterally for one (4%) participant. Roll over was not observed in any of the results. These results correlated with the pure tone audiometry, where good discrimination scores are anticipated with conductive pathology. Therefore, the majority of the participants presented with good speech discrimination results with only 1 (4%) participant presenting with poor speech discrimination results suggestive of cochlear or retrochochlear pathology.

4.2. 5. Otoacoustic Emissions

Distortion Product (DPOE) results are presented in table 4.7 below.

Table 4.7

DPOAE results

Otoacoustic Emission	Right ear n=30		Left ear n=30	
	Number	**Percentage**	**Number**	**Percentage**
Pass	15	50%	12	40%
Refer	3	10%	5	17%
Could not test	12	40%	13	43%
TOTAL	**30**	**100%**	**30**	**100%**

Distortion Product Otoacoustic Emissions (DPOAEs) were not conducted in right ear of 12 (40%) participants and the left ear of 13 (43%) participants due to the presences of outer and middle ear pathology. Only 18 (60%) participants underwent DPOAE testing in the right ear and 17(57%) in the left ear. Pass results were obtained in the right ear of 15 (50%) participants and the left ear of 12 (40%) participants, while refer results were obtained in the right ear of 3 (10%) participants and in the left ear of 5 (17%) participants. Refer DPOE result indicate cochlear pathology, was in the range from 3 (10%) and maximum of 5 (17%) participants, supporting pure tone findings that sensorineural hearing loss was the least.

Further analysis using the Spearman correlation coefficient revealed a p value of 0.037 for both ears, indicating a significant correlation between CD4+T-Lymphocyte classification, viral load and DPOAE results. Therefore, based on the results it appears that DPOAE has a relation with immunological status stage.

4.2. 6. Auditory Brainstem Response (ABR)Testing

Neurological ABR was conducted on 30 participants, resulting in 60 ears being tested.

4.2.6.1. Absolute latencies

Table 4.8. below reports on the ABR absolute latency results.

Table 4.8.

Absolute latency results

ABR Absolute latency	**Right ear N=30**		**Left ear N=30**	
Absolute latency I	**Number**	**Percentage**	**Number**	**Percentage**
Normal	20	67%	15	50%
Early	2	7%	3	10%
Delayed	4	13%	7	23%
Absent	4	13%	5	17%
TOTAL	**30**	**100%**	**30**	**100**
Absolute latency III				
Normal	20	67%	14	46%
Early	4	13%	2	7%
Delayed	2	7%	9	30%
Absent	4	13%	5	17%
TOTAL	**30**	**100%**	**30**	**100%**
Absolute latency V				
Normal	20	67%	16	53%
Early	5	17%	2	7%
Delayed	1	3%	7	23%
Absent	4	13%	5	17%
TOTAL	**30**	**100%**	**30**	**100%**

The overview of absolute latencies results revealed that at least half of the participants presented with normal absolute latencies. The absolute latency of wave I was normal in the

right ear of 20 (67%) participants and the left ear of 15 (50%) participants; however, it was early in the right ear of 2 (7%) participants and the left ear of 3 (10%) participants. The absolute latency of wave I was delayed in the right ear of 4 (13%) participants and the left ear of 7 (23%) participants; whilst it was absent in the right ear of 4 (13%) participants and the left ear of 5 (17%) participants.

The absolute latency of wave III was normal in the right ear of 20 (67%) participants and the left ear of 14 (46%) participants; however, it was early in the right ear of 4 (13%) participants and the left ear 2 (7%) participants. The absolute latency of wave III was delayed in the right ear of 2 (7%) participants and the left ear of 9 (30%) participants; whilst it was absent in the right ear of 4 (13%) participants and the left ear of 5 (17%) participants.

The absolute latency of wave V was normal in the right ear of 20 (67%) participants and the left ear of 16 (53%) participants; however, it was early in the right ear of 5 (17%) participants and the left ear of 2 (7%) participants. The absolute latency of wave V was delayed in the right ear of 1 (3%) participant and the left ear of 7 (23%) participants; whilst it was absent in the right ear of 4 (13%) participants and the left ear of 5(17%) participants. Thus most of the results, close to half of the study population reflected normal results.

4.2.6.2. Interpeak latencies of wave's I-III, I-V, and III-V

Table 4.9 represents the interpeak latencies of wave's I-III, III-V and I-V.

Table 4.9

Interpeak latencies of wave I-III, III-V and I-V

Inter-peak latency I-III	**Right ear n=30**		**Left ear n=30**	
Normal	19	64%	16	53%
Early	6	20%	6	20%
Delayed	1	3%	3	10%
Absent	4	13%	5	17%
TOTAL	**30**	**100%**	**30**	**100%**
Interpeak latency III-V				
Normal	18	61%	19	64%
Early	4	13%	4	13%
Delayed	4	13%	2	6%
Absent	4	13%	5	17%
TOTAL	**30**	**100%**	**30**	**100%**
Interpeak latency I-V				
Normal	17	57%	16	53%
Early	9	30%	6	20%
Delayed	-	-	3	10%
Absent	4	13%	5	17%
TOTAL	**30**	**100%**	**30**	**100%**

Once again, normal results were obtained for both the left and the right ear for more than 50% of the participants up to the range of 64% of the participants. The interpeak latency for waves I-III was normal in the right ear of 19 (64%) participants and the left ear of 16 (53%) participants; however, it was early in the right ear of 6 (20%) participants and the left ear 6 (20%) participants. The interpeak latency of waves I-III was delayed in the right ear of 1

(3%) participant and the left ear of 3 (10%) participants; whilst it was absent in the right ear of 4 (13%) participants and the left ear of 5 (17%) participants.

The interpeak latency for waves III-V was normal in the right ear of 18 (61%) participants and the left ear of 19 (64%) participants; however, it was early in the right ear of 4 (13%) participants and the left ear of 4 (13%) participants. The interpeak latency of waves III-V was delayed in the right ear of 4 (13%) participants and the left ear of 2 (6%) participants; whilst it was absent in the right ear of 4 (13%) participants and in the left ear of 5 (17%) participants.

The interpeak latency for wave's I-V was normal in the right ear of 17 (57%) participants and the left ear of 16 (53%) participants; however, it was early in the right ear of 9 (30%) participants and the left ear of 6 (20%) participants. The interpeak latency of wave's I-V was delayed in the left ear of 3 (10%) participants; whilst it was absent in the right ear of 4 (13%) participants and the left ear of 5 (17%) participants.

Possible auditory dysfunction associated with the lower brain stem was observed in the right ear of 3 (10%) participants and the left ear of 4 (13%) participants. In addition, possible higher brainstem auditory dysfunction was observed in the right ear of 3 (10%) participants and the left ear of 3 (10%) participants.

4.2.6.3. Inter-aural Latency differences

Twenty six participants (87%) presented with inter aural latency differences of greater than 0.5ms; while 4 participants (13%) presented with inter aural values of less than 0.5ms. Inter-aural latency differences revealed that the ears were not symmetrical. The Spearman's correlation p value of 0.20 was obtained indicating that there is no correlation exists between interpeak latencies and CD4+T-Lymphocyte classification.

4.3. Reported audiological and medical management received

This section will report on objective two which was to determine whether children with a hearing loss have received medical management for their hearing loss and the nature of these interventions thus was achieve through a detailed case history. Case history of information reflecting pregnancy, medical history, hearing related history and medical intervention received, was obtained during the case history interview with the participants' care givers.

4.3.2. Hearing related history

Figure 4.5., below describes the hearing related history.

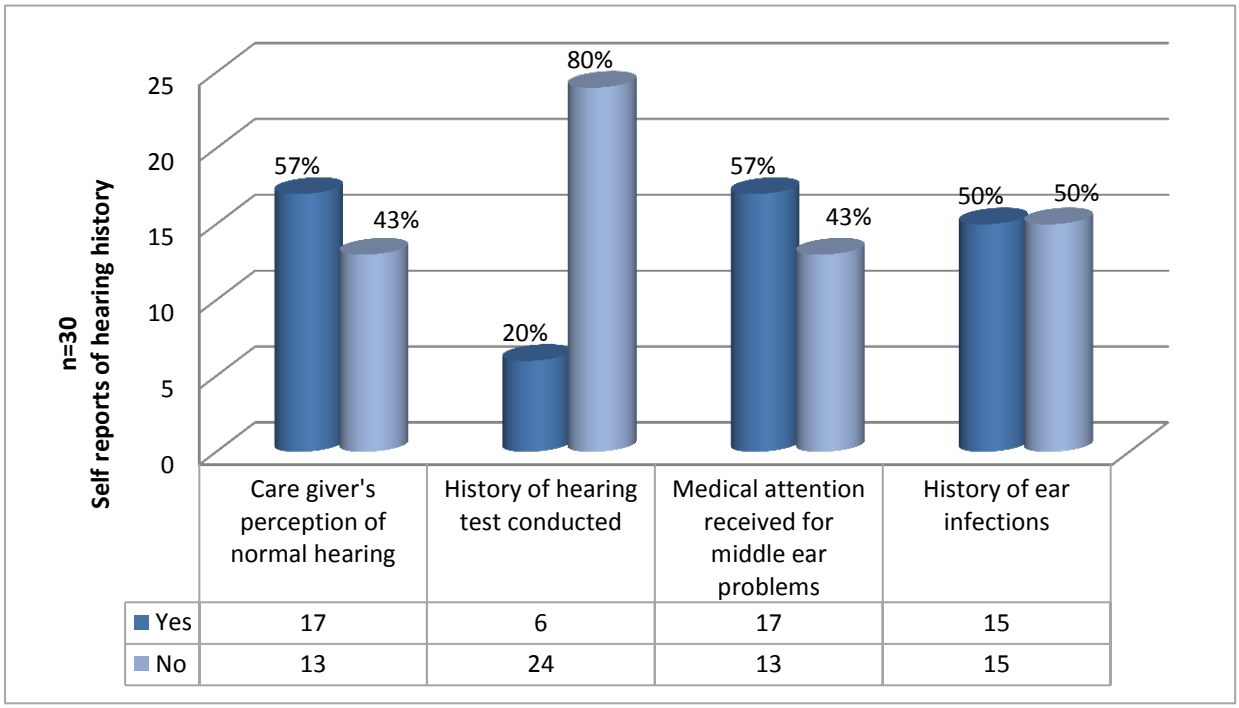

Figure 4.5: Self reports relating to hearing history

Thirteen (44%) participants caregivers reported hearing difficulties. Of those only 6 (26%) participants had a hearing test conducted prior to participating in the study. The majority of

the participants 24 (74%) did not have a hearing test prior the study even though hearing difficulty was reported. Seventeen (57%) participants had a history of ear infections. Of those, 15 (50%) participants reported that they had received medical attention for ear related problems. The caregivers of the participants reported that medical attention included antibiotics 5 (16%) ear drops from the clinics 1(3%), hospital medication 4 (13%), and 1 (3%) over the counter treatment, whilst no treatment was sought or received by 1 (3%) participant.

Figure 4.6. describes the otologic conditions reported.

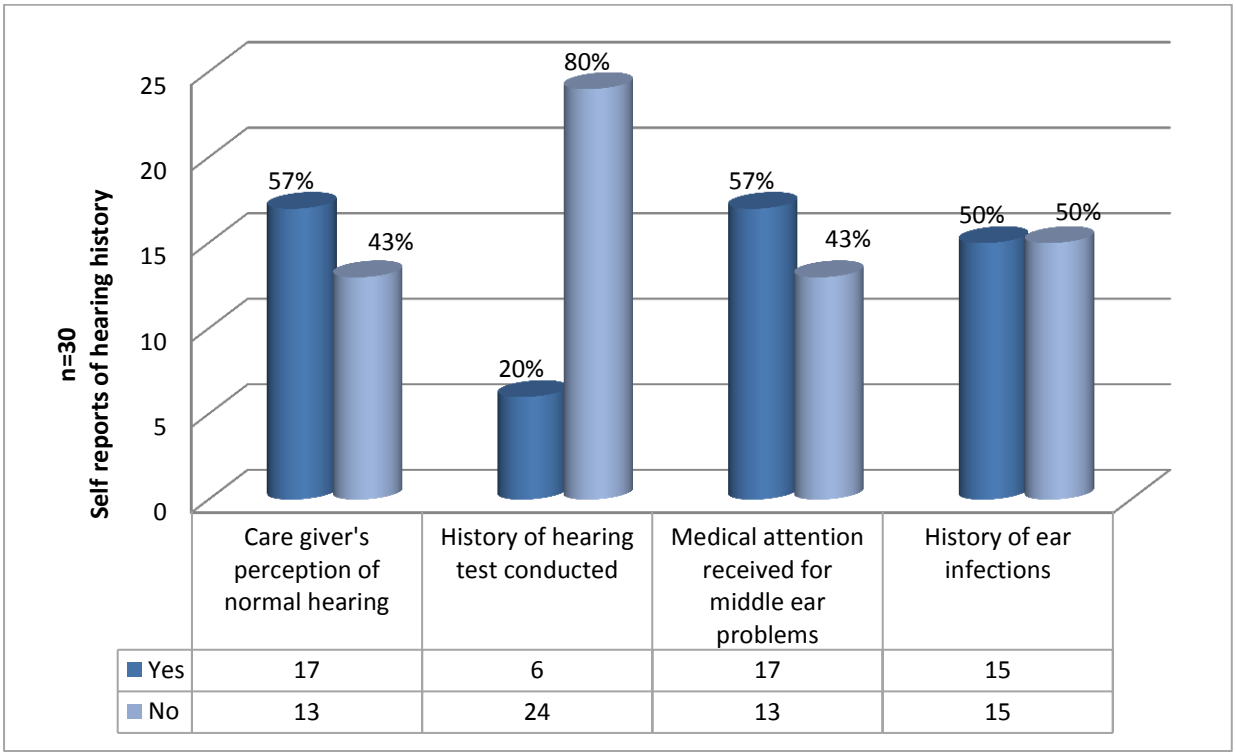

Figure 4.6: Otologic conditions reported by participants

Thirteen (43%) participants reported experiencing pain in the ears with ear infections and seven (23%) participants reported tinnitus. Two (7%) participants reported experiencing dizziness. Twenty five (83%) participants suffered from recurrent chest infections. A positive

correlation coefficient value of 0.01 was seen between recurrent chest infections and a predisposition to hearing loss due to middle ear pathology as observed in tympanometry results. A positive association was observed using cross tabulation, where participants that reported a positive history of middle ear infections had abnormal tympanometry results. This was observed, i.e. 1 participant presented with type B tympanograms and 3 participants presented with type C tympanograms and had affirmed history of middle ear pathology (See Appendix R Table 5-7).

4.4. Medical record

In terms of objective two, the medical records of the participants were reviewed to determine whether children with a hearing loss had received medical management and the type of management received. This was achieved through a review of the medical treatment that the children had received for HIV and was conducted using a form developed for the study.

Medical record reviews were compared to the case history and audiological findings. Table 4.10 reports on the medical record findings related to audiological and ear related management received by the participants.

Table 4.10.

Medical records indicating hearing related management received

Records	**Response**			
(N=30)	**Yes**	**%**	**No**	**%**
Audiological testing received	6	20	24	80%
Ear related management received	9	30	21	70%
Audiological intervention received	3	10	27	90%

Six (20%) participants had records of audiological assessments reflected in their ARV clinic file and/ or hospital file. Ten (33%) participants had to be referred for wax management which included syringing. One (3%) participant had an audiological screening conducted and the participant passed the screener as an infant.

In terms of objective three, reporting on the audiological intervention reported and documented, the results revieled that: Audiological intervention was received by 3 (10%) patients as described in Table 4.10 above. The Audiological intervention included:

- Diagnostic audiometry was conducted on 6 (20%) participants, where hearing loss was identified and patients referred to ENT for medical management.
- Three (10%) participants with hearing loss were fitted with hearing aids.

Nine (30%) participants received medical management that was ear related. The management included the following:

- Issuing of sofradex for ceruman management.
- Prescription of Augmentin for nasal congestion and otitis media.

4.5. Scholastic performance

Figure 4.7. describes reported scholastic performance.

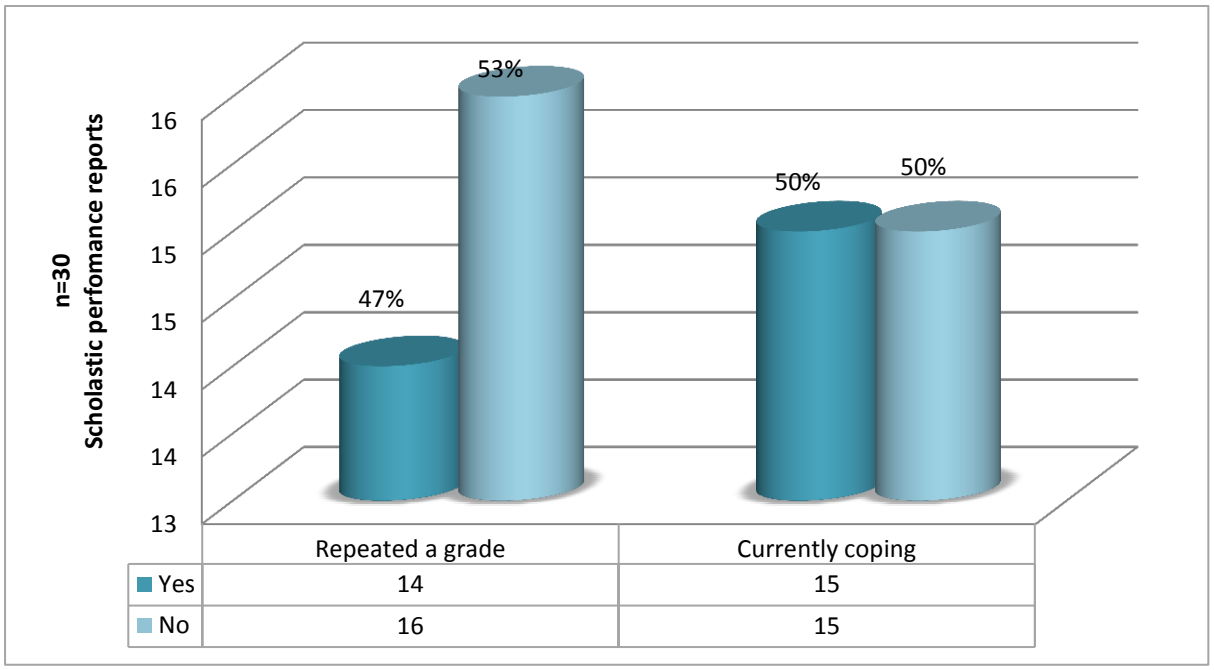

Figure 4.7: Scholastic performance

Scholastic history was obtained from the participants in relation to history of repeating grades. Fourteen (46%) participants were reported to have repeated a grade while 16 (54%) had not repeated a grade, which equates to half of the sample. Fifteen (50%) participants reported not coping academically while the remaining 15 (50%) participants reported to be coping academically. Cross tabulation was carried out between academic successes and hearing loss degree, coping academically and degree of hearing loss and repeating a grade and degree of hearing loss. Spearman's correlation between coping academically and degree of hearing loss resulted in a significant value of 0.044. Cross tabulation analysis was used to also find if a relationship existed between reported academic performance and hearing. A p-value of 0.220 was obtained with the Spearman's correlation co-efficient, indicating that

there is no correlation between repeating a grade and hearing status as described. The results suggested that the presence of a hearing loss does affect learning and academic progress

4.6. Recommendations based on audiological findings

Of the 30 participants that had undergone audiological evaluation 07 (23%) participants were referred for ceruman management, while 10 (33%) participants were referred to the ENT specialist for further management. Two (7%) participants were referred for hearing aid evaluation and fittings. Finally, 1 (3%) participant was referred for Speech Therapy, 1 (3%) was referred for Occupational therapy and 1 (3%) participant was referred for Educational psychology evaluation.

4.7. Summary

Objective one of the study was to profile hearing using different audiological procedures. Abnormal otoscopic findings were observed in 18 (60%) of the participants, which was the majority which included ear canal abnormalities such as stenosis, perforated tympanic membranes, discharge and wax, which had an impact on the immittance results.

Immittance results indicated the right ear of 13 (43%) and the left ear of 18 (60%) participants presented with abnormal tympanograms i.e. type B, C and Ad tympanograms. The right ear of five participants (17%) and left ear of 6 (20%) participants could not be tested due to outer and middle ear pathology. Ipsilateral acoustic reflex thresholds were normal in the right ear of 17 (57%) participants and the left ear of 18 (60%) participants. Contra lateral reflex thresholds were normal in the right ear of 12 (40%) participants and the left ear of 13 (43%) participants.

Of the 28 participants assessed, 16 (57%) participants presented with a hearing loss. Conductive hearing loss was the most prevalent type of hearing loss, followed by sensorineural hearing loss and mixed hearing loss. The Pearson's correlation coefficient value of 0.01 for the two tailed test was obtained indicating significant correlation between hearing loss type, hearing loss degree with viral load and CD4+ T-Lymphocyte classifications. Good SRT-PTA correlation was obtained for the majority of the participants, indicating good test reliability. Twenty seven (96%) participants presented with excellent speech discrimination ability i.e. scores of between 90-100%. Roll over was not evident in any of the participants.

Fifteen (50%) participants obtained pass DPOAE in the right ear, while 12 (40%) participants obtained pass DPOE in the left ear .The Spearman correlation coefficient revealed a significant correlation ($p= 0.037$) value indicating a correlation between CD4+T-Lymphocyte classification, viral load and DPOAE results bilaterally.

ABR results revealed hearing loss associated with the lower brain stem in the right ear of 3 (10%) participants and the left ear of 4 (13%) participants. Auditory deficits associated with the higher brain stem were evident in the right ear of 3 (10%) participants and the left ear of 3 (10%) participants.

Objectives two and three of the study was to report on the medical and audiological management received and the nature of management received by the participants for their hearing related impairments. Seventeen (43%) participants had a history of ear infections and 15 (50%) participants reported a receiving medical attention for ear infections which included a course of antibiotics, and ear drops. Audiological intervention was received by 3 (10%) participants, where intervention included diagnostic audiometry and referral to and ENT specialist for medical management. Three (10%) participants were fitted with hearing aids. Ten (34%) participants had to be referred for wax management. Finally participants were

referred to an ENT specialist, Speech Therapist, Educational psychologist and for ceruman management. A detailed discussion of the results will be conducted in next chapter.

CHAPTER 5: DISCUSSION

5.1. Introduction

The study aimed to describe the audiological profile of school-age children with HIV/AIDS at an antiretroviral clinic in KwaZulu-Natal. The results from the previous chapter will now be discussed in relation to the objectives of the study and explained with reference to the relevant literature.

5.2. Audiological profiling

Otoscopic examination, immittance audiometry, pure tone audiometry, OAE and neurological ABR tests were used to collect data i.e. to determine hearing status and the prevalence of hearing loss. A test battery approach was used as a cross check principle to determine test reliability, as recommended by Dworsack-Dodge et al. (2012).

5.2.1. Prevalence of hearing loss in children with HIV/AIDS

Results of the current study revealed that 15 (57%) participants presented with a hearing loss in the right ear and 13 (46%) participants presented with a hearing loss in the left ear as indicated by Figure 4.2. Seventeen of the participant's caregivers (56%) reported that the child could hear normally from the case history questionnaire. Therefore, it can be assumed that hearing loss in the four participants may have remained undiagnosed, had they not participated in the study or until the communication problem became evident. The current study finding are higher then the reported prevalance of 20% - 44% reported by Matas et al. (2010). Matas et al. (2006) findings reported that hearing loss prevalence in HIV positive children ranged between 32% - 42% for the age ranges 3-10 years. Matas et al. (2006) established that as a result of compromised immunity, children with HIV/AIDS are prone to

hearing loss. Matas et al. (2010)'s study was conducted in Brazil, a developing country with an economical status similar to that of South Africa (WHO, 2008). Therefore, it is evident that South Africa has a higher prevalence of hearing loss in HIV infected children than Brazil but it appears that audiological profile appears to be similar.

In the South African context, two studies focusing on audiological profiling were conducted i.e. Khoza and Ross (2002) and de Lange (2007); however, the target population were HIV positive adults. Khoza and Ross (2002) reported the prevalence of hearing loss was estimated at 23%, while de Lange's (2007) reported a hearing loss prevalence of 55% according to the 4 clinical stages of HIV/AIDS. In Khoza and Ross (2002) the prevalence of hearing loss appears to be lower than the current study but de Lange (2007) prevalence appears to be higher than the current study. This suggests that the prevalence of hearing loss has increased over the years possible due to an increased awareness of hearing impairment or early presentation of otologic symptoms.

Children are prone to hearing impairment due to high vulnerability to middle ear pathology as a direct result of the immature immune (Abrams et al., 2006) in addition, this compromised immunity has been directly linked to the increased susceptibility to infections and is related to the acute progression of the disease according to Hugdson and Montgomery (1994). One can conclude that the prevalence of hearing loss will therefore be higher in children than adults due to vulnerability of the immune system (Mueller & Pizzo, 1997) and that children are at a higher risk of susceptibility to middle ear infections that result in hearing loss.

5.2.2. Prevalence of hearing loss in terms of type, degree, configuration and symmetry of hearing loss

The current study used standard terms to describe the nature of the hearing loss (Gelfand, 2001) inclusive of terms like conductive, sensorineural and mixed hearing loss. The results of the current study, as indicated on figure 4.2., section 4.2.3.2 reveal that conductive hearing loss with 26% was the predominant cause of hearing loss in HIV infected school age children. Seventeen (57%) participants had a history of recurrent ear infections. The current study's high prevalence of conductive hearing loss echo similar sentiments as Shapiro and Noveli (1998) study, where 44% of participants presented with middle ear pathology. The current study findings are similar to Palacios et al. (2008) who reported that 33% of children who were immune compromised presented with a hearing loss as a result of middle ear pathology.

On the other hand, the results of the current study are contrary to Weber et al. (2006) and Principi (1991) with regards to immunological status and the prevalence of middle ear pathology. Weber, et al. (2006) reported a significantly lower prevalence of middle ear pathology i.e. 14.2%, associated with higher CD4+T-lymphocyte count (p= 0.02), while the current study found no significant association between CD4+T-lymphocyte count (p=0.48) and middle ear pathology. The Weber et al. (2006) study population age range was from zero to 12.11 years using retrospective medical charts review methodology. The difference in the sample size and age range can affect the prevalence, resulting in different outcomes. In addition, the sample consisted of 459 children, which is significantly larger as compared to the current study. This suggests that CD4+T-lymphocyte count alone cannot be used as a measure to indicate susceptibility to middle ear pathology and vulnerability to hearing loss in the South African context.

The researcher speculated that the high prevalence of conductive hearing loss could be related to the time of data collection. Data collection was conducted during the month of June, which in South Africa is winter, a season associated with a higher prevalence of upper respiratory tract infections (URTI). This correlated to the reported incidence of upper URTI (23%) in section 4.2.2.11. URTI are common risk factors associated with middle ear pathology (Cole & Flexer, 2007), and in this study 25 (83%) of the participants reported a history of recurrent URT infections increasing their predisposition to middle ear pathology. However, in the current study only eight (27%) presented with symptoms of URTI during the audiological testing and of the five (17%) presented with abnormal tympanograms supporting the presence of middle ear pathology. Principi et al. (1991) alluded that the pathogens responsible for middle ear pathology are the same in HIV positive children and negative children; however "HIV infection does not favour occurrence of AOM per se but predisposes to recurrence" (Principi et al., 1991 p.570). In addition, Lasis (2005) indicated that the cause of middle ear pathology in HIV positive children can be attributed to Eustachian tube dysfunction and reduced immunity function which increases the risk to middle ear infections (Lasis, 2005). Principi et al. (1991) and Miziara, et al. (2007), highlight that immunological status was linked to susceptibility to recurrent episodes of middle ear pathology. This current study finding as related to association between susceptibility to middle pathology and tympanometry supports Miziara et al. (2006), who reported that HIV positive children tend to suffer more frequent and severe episodes of otitis media as compared to immunocompetant counter parts (Miziara, 2007). In the current study, this was supported by caregiver reports, where 15 participants (50%) reported a history of ear infections that required and received medical management.

Further investigations are required to report on the type of middle ear pathology, protraction of the infection and pathogen type that are common to the South African context. Inevitably, conductive hearing loss can result from common pathologies such as otitis media, mastoditis, tympanic membrane perforation, and recurrent otitis with effusion which can be assessed using otoscopy and immittance audiometry (Abrams et al., 2006).

Otoscopic examination revealed abnormal results in 60% of the participants as reflected in Table 4.1., Section 4.2.1. The findings of the current study were also similar to the de Lange (2007) findings, where she reported dull tympanic membranes, retracted tympanic membranes and perforated tympanic membranes as well as in the Gold and Tami (1998) who reported that otologic conditions associated with HIV/AIDS include excessive wax, otitis media, otitis externa and perforated tympanic membranes. The abnormal ear canal and tympanic membrane abnormalities were indicative and suggestive of conductive hearing loss which was also confirmed by immittance audiometry. Firstly immittance audiometry could not be conducted in the right ear of 5 (17%) participants and the left ear of 6 (20%) participants as there was discharge or perforated tympanic membranes. Type B tympanograms and type C tympanograms were observed due to abnormalities of the outer ear and tympanic membrane.

These findings also correlate with the pure tone audiometry results where conductive hearing loss was seen in the right ear of 7 (26%) participants and the left ear of 8 (28%) participants as seen in Figure 4.1. in Section 4.2.1. The findings of the speech discrimination testing of the current study are consistent with majority of the participants presenting with conductive hearing loss as most participants, as indicated in Table 4.5 in Section 4.2.4.1. presented with excellent speech discrimination. Scores of 90 to 100% are usually seen in conductive hearing

loss as a patient with a conductive hearing loss does not experience distortion of speech sounds and mainly needs speech to be at a higher intensity to hear accurately (Bluestone, Stephenson & Martin, 1992).

OAE may be absent in fluid filled ears and is indicative of possible middle ear pathology, resulting in a fail result (Lehmann et al., 2008). In the current study, DPOAEs were conducted on the right ear of 18 (60%) participants and the left ear of 17 (56%) participants due to the presence of outer and middle ear pathology. In addition, 3 (10%) participants presented with a refer results for DPOAE on the right ear and 5 (17%) participants presented with a refer results for left ear. According to Marshall et al., (1997), OAEs are very susceptible to middle ear variation, since the negative pressure affects the delivery of the stimulus through the, middle ear to the cochlea. Great caution and vigilance is required when analysing the results to ensure that absent OAE are not mistaken for outer hair cell damage as opposed to the presence of middle ear pathology (Marshal et al.,1997).

In the current study, delays in the absolute latency of waves I, III and V and normal interpeak I-III, I-V and III-V were reported reported on in Table 4.8., on Section 4.2.6.1. Delayed absolute latencies of wave I, III, and V were reported these results suggest possible middle ear pathology, this could not be confirmed as audiological ABR was not conducted on the participants.

Khoza and Ross (2002) found that CHL was not the predominant cause of hearing loss in adults, but sensorineural hearing loss. Sensorial neural hearing loss could result from damage to the cochlea (sensory component) and/ or auditory nerve (neural component) (Copley & Frederichs, 2010). Viral or bacterial infections such as Cryptococcus meningitis,

toxoplasmosis, meningitis, cytomegalovirus, and herpes can result in a sensorineural hearing loss (Carney & Muller, 1998). Central nervous system neoplasm and ototoxicity have also been reported in children infected with HIV/AIDS. In the current study, only the right ear of 6 (21%) participants and the left of 1 (4%) participants presented with a SNHL, which was dominantly cochlea in origin. However, ototoxic medication results in SNHL (Matas et al., 2006). This requires further investigation as 21(70%) participants of the current study's participants were on ARV regimen two for a period greater than 2 years and ototoxicity has not been established. In addition Maziaria et al. (2006) reported that the prevalence of SNHL was as a result of ototoxicity associated with ARV use. Gurney and Murr (2003) highlighted that ARVs are ototoxic and result in an irreversible sensorineural hearing loss (Simdon et al., 2003). It is important to note that these are the same medication reportedly being used by the study participants.

To differentiate sensorineural hearing loss in terms of cochlea or neural loss, OAEs have been proven to be the most sensitive measure to detect early hearing loss as they measure the outer hair cell function of the cochlear (Kramer, 2008). OAEs are predicted to be the by-product of the neural mechanism of the cochlea amplifier and in particular can be linked to the normal functioning of the outer hair cells; thereby making them sensitive to hearing loss caused by outer hair cell damage (Koivunen et al., 2000). In the current study, the absent DPOAEs could also be attributed to damage to the OHC.

Literature suggests that the HIV virus does not only attack the immune system but there are reports of neurological changes which are subtle and can only be detected with the use of electrophysiological tests measures such as ABR (Matas et al., 2010). Neurological ABR was conducted in the current research to assess neural integrity using the Buchaman and Hall,

(1998) recommended parameter protocol. The ABR protocol used in the current study, where the stimulus rate and intensity, was similar to Paken (2007) study, reached similar findings, that ABR is a sensitive tool to identify subtle neurological changes in HIV infected population. In addition, faster stimulus rate of testing should be included in the diagnostic testing with ABR in HIV positive people (Paken, 2007). However, Paken (2007) cautioned that factors such as age, gender should be considered by the clinician conducting the testing as it will impact on the results obtained.

Therefore, the current study findings support the finding that ABR is sensitive to detect neurological subtleties in HIV positive children, which reinforces the importance of the test for neurological monitoring as a result of the virus affecting the neural pathway of hearing (Matas et al., 2010). In the current study, it was observed that 2 (6%) participants who presented with seizures and the 1 (3%) participants who presented with HIV enchaphalopathy presented with abnormal neurological ABR results. This seems to confirm the reporting by Matkin et al., (1998), Bankaitis (1998) and Govender et al., (2011) who indicated that HIV/AIDS also affects the neural and central pathways.

In addition, neurological abnormalities can also be associated with the hearing related problems, with reports of auditory processing deficits, central hearing loss and auditory brainstem disorders which can negatively affect language development and communication (Makar et al., 2012). Neurological complications can manifest in young children through failure to attain developmental milestones with the most prominent milestone being language delay and cognitive impairment. These manifestations have been associated with cranial neuropathy, progressive encephalopathy, microcephaly, meningitis and neoplasm, and are reported to occur between the age of 6 months and 5 years, which is during the language

acquisition phase (Matkin et al., 1998). Language acquisition, on the other hand, can be negatively affected by a hearing loss.

The degree of hearing loss was established through the use of the PTA average for 500Hz, 1000Hz and 2000Hz frequencies, as recommended by Hogdson (1980), as cited in Northern and Downs (2002). As indicated in Figure 4.1 in Section 4.2.3.1, the degree of hearing loss varied across the participants, with 8 (26%) participants presenting with mild hearing loss, while 5 (17%) participants presented with moderate hearing loss, 1(4%) participant presented with a moderately severe hearing and 1 (4%) participant presented with severe hearing loss. This highlights the increased need for audiological monitoring for immuno compromised children especially as immune suppression progresses along the HIV/AIDS stage classification by CD4 cell count.

The results of the current study are in keeping with that of Khoza and Ross (2002), where mild hearing loss was the predominant degree of hearing impairment in the adult population with HIV/AIDS. Similar findings were also reported by de Lange (2007), where 15% of the participants presented with a mild hearing loss. A mild hearing loss is usually not detected easily even though Speech Discrimination scores of 90 to 100% being obtained by 27 (96%) participants bilaterally evident in Table 4.6 on Section 4.2.4.2. These scores are a reflection of how well the participant understands speech at comfortable listening levels using the phonetically balanced (PB) words (Northern & Down, 2002) in an ideal listening environment i.e. with no competing sounds. However, school is not an ideal listening environment and therefore, Paluski and Kaderavek (2002) reported that children with mild hearing loss become easily fatigued in class due to needing extra effort to listen.

Difficulty with listening in the classroom can result in poor academic performance (Most & Tsach, 2010). The findings of the current study revealed similar findings with caregivers reporting the participants to present with scholastic difficulties, as indicated in Figure 4.7 in Section 4.5. The impact of hearing loss in the classroom situation includes difficulty hearing the teacher's speech due to background noise and the distance between the teacher and the student (Palulski & Kaderavek, 2002). These findings were reported in children without HIV; therefore the same will apply to children with HIV, which indicates that even children with a mild degree hearing loss require audiological intervention. Case history therefore, in audiology is an integral part of a complete test battery as it provides essential information related to hearing from the perspective of the family (Gelfand, 2001) as was in the case of the current study.

The right ear of twenty three (86%) participants and the left ear of 25 (89%) participants presented with good SRT/PTA correlation, while 2 (7%) participants presented with fair SRT/PTA correlation in the right ear and 3 (11%) participants presented with poor SRT/PTA correlation in both ears. SRT results are an indicator of speech perception at soft intensities indicative of communication difficulties in children with a hearing loss. In addition, children with hearing loss had poor early academic difficulties and higher rates of grade repetition due to language impairment (Wake & Poulakis, 2004), which this study's results allude to with possible learning difficulties associated with HIV/AIDS as a result of hearing loss. The fair and poor correlation could be attributed to poor listening skills and possible central auditory processing deficits (Ramkissoon, 2004).

Early onset of any hearing loss could result in reduced processing at the lower brainstem and cortical levels in subsequent years. This suggests that early onset of a hearing loss may lead

to auditory processing difficulties (Maruthy & Mannarukrishnaiah, 2008). Auditory processing deficits may manifest as poor concentration, poor auditory recall, poor auditory analysis and synthesis. The afore-mentioned aspects are essential in reading and writing abilities (Feagans et al., 1994). Hence, deficits in one or more of these aspects may adversely affect reading and writing (Most & Tsach, 2010).

A structured case history interview was carried out to obtain pertinent case history information. Six (20%) participants reported delayed gross motor development and 14 (46%) participants reported delayed speech language acquisition and development. Hearing loss can negatively impact on the different components of language such as syntax, semantics and other basic verbal skills (Feagans et al., 1994). From this study, one cannot draw the conclusion that the children with a hearing loss present with poor linguistic based pragmatic skills resulting in limited opportunities to use language appropriately in a social context (Olyer et al., 1998) as the case history questionnaire did not probe further. However, the results affirm the hypothesis that children with HIV/AIDS are prone to language delays that can make them susceptible to learning difficulties that can affect grade progression.

From the study, 14 (47%) participants reported that the child participant had repeated a grade indicating that possible hearing loss has not only affected language development but also scholastic performance. Cross tabulation results indicated those who repeated a grade presented with mild-severe hearing loss. The participants, who reported that they were not coping academically also presented with mild-severe hearing loss. This means children who are immunocompromised are also susceptible to learning difficulties associated with hearing loss as their HIV negative peers. Palulski and Kaderavek (2002) reported that children with a hearing loss will present with communication difficulties, resulting in poor scholastic

performance. Hence it is critical for audiologist to be proactive in the early identification of hearing hearing loss to minimise the negative impact on academic progress.

The difficulty with academic progress can be linked to delayed language acquisition, as Feagan et al. (1994) stated that language is critical for thinking and learning. The results of the current study suggest that early language development and scholastic performance are related and early intervention is crucial in early management of hearing loss and scholastic performance. Case history reporting is crucial as part of early hearing detection and management (Niskar et al., 1998).

Children with HIV are prone to illness due to their compromised immunity and high susceptibility to opportunistic infections resulting in a weaker immune system. In addition, ARVs are also reported to cause fatigue as side effects and drowsiness result in less than optimal concentration for learning (Giaquinto et al., 2008). Thus the degree of hearing loss coupled with weak immunity and vulnerability to illness will negatively affect scholastic performance resulting in decline in academic performance and progress. This was highlighted by the caregiver's reports on poor scholastic performance; thus making caregiver reports crucial in the holistic care and management of hearing in HIV positive children.

Similarly to the degree of hearing loss and speech discrimination scores impacting on academic performance, so too will the configuration of a hearing loss influence the child's performance. A child with a rising hearing loss will miss out low frequency sounds while a child with a sloping hearing loss will miss out on high frequency sounds in speech (Sabo, 2013). The findings of the current study, as indicated in Figure 4.3 in Section 4.2.3.3. revealed the majority of the participants presented with a hearing loss of a rising

configuration. Therefore, the finding of the current study were different to that of de Lange (2007) findings, who reported a flat configuration to be the most common followed by sloping, and then irregular configurations. These findings suggest that hearing loss configuration is dependent upon the aetiology of hearing loss (Paluski & Kaderavek, 2002) i.e. conductive and rising configuration, where low frequencies are affected and high frequencies are better. Hearing impairment, language impairment and scholastic performance in children has been directly correlated, and hearing loss symmetry is suggestive of the aetiology of hearing loss (Khoza & Ross, 2002).

The findings of the current study revealed that 6 (50%) participants presented with symmetrical hearing loss, as indicated in Table 4.4 in Section 4.2.3.4 and 12 (75%) participants with a bilateral hearing loss. The findings of the current study is, therefore, in keeping with that of Khoza and Ross (2002) where bilateral hearing loss was seen in majority of the participants i.e. 71% in Khoza and Ross (2002). Children with hearing loss, irrespective of it being unilateral or bilateral will have communication difficulties such auditory discrimination in the classroom (Palulski & Kaderavek, 2002); hence, the high prevalence of grade repetition due to difficulties in scholastic achievements, as indicated in figure 4.7 on section 4.5. Children with unilateral hearing loss were at a higher risk for repeating a grade as compared to the children who can hear normally (Most & Tasch, 2010). Therefore, unilateral or bilateral hearing loss in HIV positive children will require early identification and management. Early identification can be achieved through a test battery approach of hearing inclusive of otoscopic examination, immittance audiometry, pure tone audiometry, OAE and ABR (electrophysiological measures) which form part of a holistic test battery. Therefore, a complete test battery of both behavioural and electrophysiological tests

as well as a detailed case history is mandatory when dealing with HIV positive children (Beigh et al., 2012).

5.3 Medical record and audiological management received by children with HIV/AIDS on ARV

Retrospective medical record examinations were carried out by the researcher to ascertain medical and audiological intervention received by the participants related to hearing loss. Thirteen (43%) participant had other co-existing medical conditions i.e. 11 (36%) participants had TB, 1 (3%) participant encephalopathy and 2 (6%) participants had seizures. TB management requires the use of ototoxic drugs such as kanamycin, which is ototoxic. In addition, TB drugs are known to be ototoxic and yet no audiological monitoring was carried out for these participants. This is of great concern as it indicates the lack of ototoxicity monitoring, which is part of the scope of practice of an audiologist (ASHA, 2013).

The audiologists' expertise and their significance in assessment, management and prevention of otologic conditions that impair communication including those that result from HIV/AIDS have not been clearly understood. As from the case history reports, otologic symptoms included pain in the ears, tinnitus, and dizziness. Hearing related conditions are underestimated as only 6 (20%) participants were appropriately referred for audiological assessments and management. The remaining 24 participants (80%) reported otologic conditions but there were no referrals made to the audiologist, suggesting a limited understanding of the role and scope of the audiologist as part of the multidisciplinary team that manages children with HIV/AIDS as alluded to in Chapter 1 Section 1.2. Therefore, in the South African context, audiologist have not affirmed their role in the early identification

and management of children with compromised immunity. Secondly, though the caregiver may report otologic conditions to the medical professional, they may yet not be getting the necessary referrals for audiological evaluation. This suggests that the audiologist's role has not been considered and included in the team of people who manage children with HIV.

Only six (20%) participants received audiological management. This included amplification, as reported by three (10%) participants, which is in keeping literature trends mentioned in Chapter 2. Patients with a hearing loss are fitted with hearing aids, which include bone conduction hearing aids, due to recurrent middle ear infections that were not resolving (Diefendorf et al., 1990). This suggests that at the research site, audiological practices followed literature trends as indicated in Chapter 2 Section 2.10.

Therefore, the audiologist's role in the management of the peripheral and central pathology that affects communication needs to be included as part of the multi disciplinary team (MDT) team as the prevalence of hearing loss in children has indicated the need for early audiological intervention. In addition the results have highlighted the role of the audiologist in service delivery to the population with HIV, which is in line with "Improving the Quality of Health Service" as part of the Government's Medium Term Strategic Framework (MTSF) for 2009-2015.

5.4. Summary

A hearing loss prevalence based on the pure tone audiometry results revealed 15 (54%) on the right ear and the left of 13 (47%) presented with a hearing loss for a sample of 28 school age children with HIV/AIDS attending an ARV clinic in South Africa. These findings were

similar to Brazil, which is a developing country like South Africa, but South Africa has a higher prevalence of HIV/AIDS. In the paediatric population, conductive hearing loss was the most predominant type of hearing loss, where mild hearing loss was the most common degree of hearing loss and 12 (75%) participants with presented with bilateral hearing loss. The high prevalence of mild conductive hearing loss has been established to lead to auditory processing deficits that present as reading and writing difficulties, which result in poor scholastic performance and grade repetition.

Reported audiological and medical management included a standard hearing test battery to establish degree of hearing loss. Participants were fitted with hearing aids as standard practice of audiology. Medical management included prescription of medication. The alarming fact is that even with a reported history of hearing loss, 80% never had a hearing test conducted, indicating that audiological monitoring was not conducted. This implies that the audiologist needs to be more proactive in the screening of hearing loss, as this population (HIV positive) is prone to hearing loss. Finally audiologist, need to play a proactive role in the early identification and monitory of hearing loss with children diagnosed with HIV/AIDS as they are susceptible to otologic conditions that will result in hearing loss and this will, in turn, negatively affect academic progress.

CHAPTER 6: CONCLUSION

6.1. Introduction

This chapter provides a summary of the main findings, and highlights clinical and research implications of the study. In addition, limitations of the study and suggestions for future research are provided.

6.2. Summary of the main findings

Sub-Saharan Africa is the region with highest number of children under 13 years of age living with HIV/AIDS (UNICEF, 2012). It is estimated by UNICEF (2012) that the number of children infected with HIV is approximately 360 000 in South Africa. One of the side effects associated with HIV/AIDS are otologic conditions that can result in hearing loss (Graber et al., 2008) HIV/AIDS doe not only attack the immunity but also the peripheral and central auditory pathway (Lasis, 2005). Hence viral load, CD4 cell count and percentage measures can be used as indicators for vulnerability to otologic conditions that give rise to hearing loss (Bojrab, 1996). In addition, ARVs have been reported to be ototoxic; thus, resulting in a sensorineural hearing loss (Harris et al., 2012). There is literature that reports on audiological profile of adults living with but there is a scarcity of data that reports on the prevalence of hearing loss in the paediatric population in South Africa (Khoza-Shangase, 2010).

Otologic conditions can affect the outer ear, middle ear, inner ear and central nervous system as a result of opportunistic infections associated with compromised immunity (Smith et al., 2006). As a result hearing loss can range from mild to profound and could be conductive, mixed or sensorineural in nature and may require medical and audiological intervention (Friedman & Noffsinger 1998). Hearing loss can affect language development, which

negatively impacts on scholastic performance and progress (ASHA, 1997). Finally poor academic progresses will impact on the vocational opportunities available and financial independence (Carney & Muller, 1998). This, therefore, created an impetus to conduct a study on the hearing profile of school aged children on antiretroviral treatment.

The study was conducted at King Edward VIII Tertiary Hospital in KwaZulu-Natal. Thirty HIV positive participants aged between 6- 12 years were recruited, where a test battery of audiological assessments was carried out to create an audiological profile. A case history interview was carried to ascertain developmental history, hearing related history and scholastic history. A summary of the findings is highlighted below with hearing profiling as the first objective:

- Otoscopic findings revealed abnormal results in the right ear of 17 (57%) participants and the left ear of 19 (63%) participants indicative of conductive pathology.
- Abnormal tympanometry results were observed in the right ear, where 2 (6%) were type B tympanograms, 5 (17%) were type C tympanograms and 1 (5%) was a type Ad tympanogram. The left ear results revealed 3 (10%) type B tympanograms, and 3 (10%) type C tympanograms. Ipsilateral acoustic reflex thresholds were abnormal in the right ear of 8(27%) participants and the left ear of 7 (24%) participants. Contra lateral acoustic reflex thresholds were abnormal in the right ear of 13 (44%) participants and the left ear of 12 (40%) participants. There is no significant association between the CD4+T Lymphocyte measures and tympanometry using the Chi-square test.
- Of the 28 participants assessed, 16 (57%) presented with a hearing loss where the degree ranged from mild- severe to moderately severe on the right ear and mild to severe on the left ear. Conductive hearing loss was the predominant type of hearing

loss. The Independent T-test and the Pearson's correlation results were contradictory, where the Independent T-test indicated no significant association between the CD4+ T-Lymphocyte classifications and degree of hearing loss was observed. However, Pearson's correlation coefficient indicated a significant correlation between hearing loss type, hearing loss degree with viral load and CD4+ T-Lymphocyte classifications.

- Of the 16 participants with a hearing loss, four (25%) participants presented with a unilateral hearing loss, while the majority 12 (75%) presented with a bilateral hearing loss, of which six (50%) participants presented with a symmetrical hearing loss.
- Good SRT-PTA correlation was obtained in the right ear of 23 participants (82%), and in the left ear of 25 (89%) participants indicative of reliable audiological results.
- Speech Discrimination scores of 90 to 100% were obtained in both the ears of 27 (96%) of the participants, while scores of less than 50% were obtained bilaterally for 1 (4%) participant indicating that majority of the participants did not have difficulty with speech discrimination in quiet.
- The DPOAE testing was conducted in the right ear of 18 (60%) participants and the left ear of 17 (56%) participants. The remaining participants could not be tested due to the presence of outer and middle ear pathology. In addition, the right ear of 15 (50%) participants obtained a DPOAE pass and the left ear of 12 participants (40%) obtained a DPOAE pass. These findings confirmed that DPOAEs are susptible to middle ear status.
- While the ABR results indicated presence of neural dysfunction and there was no significant correlation between absolute latencies and CD4+T-Lymphocyte classification.

- Seventeen (56%) of the participant's caregivers reported that the child could hear normally. Six (26%) participants reported that they had a hearing test prior to participating in the study. Seventeen (57%) participants had a history of ear infections and 50% of participants received medical attention for ear infections. Of the 50% of participants with a history of ear infections, medical attention included antibiotics 5 (16%), ear drops from the clinics 1 (3%), hospital medication 4 (13%), and over the counter treatment 1(3%) whilst no treatment was sough or received by 1 (3%) participant. Thirteen (43%) participants reported pain in the ears with ear infections and seven (27%) participants reported tinnitus. Two (7%) participants reported dizziness. Twenty five (83%) participants suffered from recurrent chest infections. The recurrent chest infections was associated with predisposition to hearing loss due to middle ear pathology as there was a significant correlation between tympanometry and recurrent chest infections.
- In addition, 50% of caregivers reported that the child was not coping currently academically, while 14 (46%) reported that the participant had repeated a grade due to learning difficulties. Therefore, hearing loss has a direct link to academic progress.

6.3. Limitations of the study

The following limitations of the study have been identified:

- A small sample size of 30 participants could be recruited due to time constraints , limited, human resource to recruit and test. Thirty participants were recruited due to the following reasons:

- The primary researcher did not have research assistants to conduct data collection. Therefore, due to the the limited human resources only 30 participants could be recruited for the study.
- The primary researcher was employed full time by the Department of Health and had to comply with employment contract regulations, therefore there was not enough time to recruit and test the participants.
- The participants were recruited for the study, due to the long queues and procedures to be carried out, they arrived late for the testing.
- The number of audiological tests conducted were labour intensive and required time, hence a maximum of two patients could be assessed in a day.

- Furthermore, convenience sampling was used based on the available time for recruiting and the accessibility of the participants (McMillan & Schumacher, 2001). In addition, the clinic population could not be stratified to get a good representation of the general public and therefore, results of the study could not be generalised to the wider population (Leedy & Omrod, 2008). However, the participants were from various areas across Durban; thus providing a spectrum of participant, to counter the effects for bias (Maxwell & Satake, 1997).

- The research design: The current study was part of a short dissertation; as a result there was a limited time for data collection. In order to compile an audiological profile, longitudinal or cross sectional design has been recommended by literature (Hulley et al., 2007). This will allow adequate time to scrutinize variables and report accordingly. However, the current study was a descriptive non-experimental study, therefore the design allowed the research to meet the study objectives.

- Audiological assessment material limitations: Currently South Africa is a multilingual country with eleven official languages. The field of audiology is English proficient, therefore, vernacular assessment tools are lacking. Ramkisson, (2001) indicated the need to provide services that are culturally and linguistically relevant as linguistic diversity has an impact on audiology. This has posed a challenge with Speech audiometry testing for this study, as currently isiZulu SRT wordlists are available but have not been through the rigorous scientific validation process. The material was developed based on familiar words in the language. However, the isiZulu discrimination word list, by the virtue of the use at the site serves as a partial validation process as published validation of the word list is still lacking.
- ABR testing has only been limited to neurological ABR click high frequency. Low frequency tone burst and bone conduction ABR could not be done due to time constraints. Tone burst and bone conduction ABR are essential for distinguishing hearing loss types, and degree, as part of the cross check principle to validate pure tone audiometry results (Bachmann & Hall, 1998). In addition, the 11.1ms rate was used; however Matas et al. (2010) and Paken (2007) recommended a faster rate is more sensitive to detect the subtle neurological changes.

6.4. Significance of the study

The researcher highlighted the following:

- The research provided a description of the type, degree, configuration and symmetry of hearing loss for children with HIV/AIDS at an antiretroviral clinic in KwaZulu-Natal. This study reported on the medical and audiological management strategies

implemented to effectively minimise the negative impact of hearing loss on academic performance. The results may contribute to the national HIV/AIDS research body on the disease burden's impact on quality of life (National Department of Health, 2011).

- The findings of the current study can be aligned to the National Strategy Plan on HIV, STI, and TB 2012-2016 (National Department of Health, 2011), and proposes for audiologists to be included in the multidisciplinary HIV/AIDS management team. Through the incorporation of services offered by audiologists, there will be a positive impact on service delivery and the overall quality of life; thereby, increasing the chance of these children becoming financially independent adults.

6.5. Recommendations for future research

- Audiological profiling to be carried out on a larger sample size across various sites to improve generalization.
- A cross sectional study to profile HIV/AIDS disease stage with hearing status in children should be conducted in order to obtain data that will explore the relationship between disease stages and hearing further.
- A study examining the relationship between ARV regimens and ototoxicity should be conducted. This study will benchmark ototoxicity monitoring and testing intervals required in order to identify hearing loss due to ototoxicity early.
- A study focusing on the profile of vestibular pathology and impact on balance should be conducted since the HIV virus attacks the peripheral and vestibular system in the paediatric population.
- To further investigate the auditory processing abilities as part of the audiological assessment battery for children with HIV as they are prone to auditory processing deficits.

6.6. Clinical implications

- All children who are HIV positive should be part of an ototoxicity monitoring program, in order to identify a hearing loss early. A complete test battery inclusive of electrophysiological measures should be utilized.
- Audiological and medical intervention needs to work in a better collaboration to improve referral rates and promote early identification of hearing impairment as a result of hearing loss. In addition, early audiological intervention will assist with early language development and better scholastic out comes.
- Inclusion of audiologist in the multi-disciplinary team that manages HIV positive children for early identification and monitoring of hearing.

6.7 Summary

To improve quality of life, the right to communication is crucial and hence audiologists need to be proactive in the early screening, diagnosis and management of children with HIV. Through the incorporation of services offered by audiologists, this will impact positively on service delivery and the overall quality of life; thereby increasing the chance of these children becoming financially independent adults. *"It always seems impossible until it's done."- Nelson Mande*la"

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Appendix A

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

03 October 2013

Mrs. VZ Peter
Department of Audiology, Westville Campus
School of Health Sciences
University of KwaZulu-Natal

PROTOCOL: An audiological profile of school-age children with HIV/AIDS at an antiretroviral clinic in KwaZulu-Natal. REF: BE051/13.

EXPEDITED APPLICATION

A sub-committee of the Biomedical Research Ethics Committee has considered and noted your application received on 15 February 2013.

The study was provisionally approved pending appropriate responses to queries raised. Your responses dated 17 September 2013 to queries raised on 13 September 2013 have been noted by a sub-committee of the Biomedical Research Ethics Committee. The conditions have now been met and the study is given full ethics approval and may begin as from 03 October 2013.

This approval is valid for one year from **03 October 2013.** To ensure uninterrupted approval of this study beyond the approval expiry date, an application for recertification must be submitted to BREC on the appropriate BREC form 2-3 months before the expiry date.

Any amendments to this study, unless urgently required to ensure safety of participants, must be approved by BREC prior to implementation.

Your acceptance of this approval denotes your compliance with South African National Research Ethics Guidelines (2004), South African National Good Clinical Practice Guidelines (2006) (if applicable) and with UKZN BREC ethics requirements as contained in the UKZN BREC Terms of Reference and Standard Operating Procedures, all available at http://research.ukzn.ac.za/Research-Ethics/Biomedical-Research-Ethics.aspx.

BREC is registered with the South African National Health Research Ethics Council (REC-290408-009). BREC has US Office for Human Research Protections (OHRP) Federal-wide Assurance (FWA 678).

The sub-committee's decision will be **RATIFIED** by a full Committee at its next meeting taking place on **12 November 2013.**

We wish you well with this study. We would appreciate receiving copies of all publications arising out of this study.

Yours sincerely

Professor D.R Wassenaar
Chair: Biomedical Research Ethics Committee

Professor D Wassenaar (Chair)
Biomedical Research Ethics Committee
Westville Campus, Govan Mbeki Building
Postal Address: Private Bag X54001, Durban, 4000, South Africa
Telephone: +27 (0)31 260 2384 **Facsimile:** +27 (0)31 260 4609 **Email:** brec@ukzn.ac.za
Website: http://research.ukzn.ac.za/Research-Ethics/Biomedical-Research-Ethics.aspx
Founding Campuses: Edgewood Howard College Medical School Pietermaritzburg Westville

Appendix B

health
Department:
Health
PROVINCE OF KWAZULU-NATAL

Health Research & Knowledge Management sub-component
10 – 103 Natalia Building, 330 Langalibalele Street
Private Bag x9051
Pietermaritzburg
3200
Tel.: 033 – 3953189
Fax.: 033 – 394 3782
Email.: hrkm@kznhealth.gov.za
www.kznhealth.gov.za

Reference : HRKM 210/13
Enquiries: Mrs G Khumalo
Telephone: 033 – 395 3189

18 July 2013

Dear Mrs V Z Peter

Subject: Approval of a Research Proposal

1. The research proposal titled **'An audiological profile of school-age children with HIV/AIDS at an antiretroviral clinic in KwaZulu-Natal'** was reviewed by the KwaZulu-Natal Department of Health.

The proposal is hereby **approved** for research to be undertaken at King Edward VIII Hospital.

2. You are requested to take note of the following:
   a. Make the necessary arrangement with the identified facility before commencing with your research project.
   b. Provide an interim progress report and final report (electronic and hard copies) when your research is complete.

3. Your final report must be posted to **HEALTH RESEARCH AND KNOWLEDGE MANAGEMENT, 10-102, PRIVATE BAG X9051, PIETERMARITZBURG, 3200** and e-mail an electronic copy to hrkm@kznhealth.gov.za

For any additional information please contact Mrs G Khumalo on 033-395 3189.

Yours Sincerely

Clotilge

Dr. E Lutge
Chairperson, KwaZulu-Natal Health Research Committee
Date: 23/07/2013

Appendix C

health

Department:
Health
PROVINCE OF KWAZULU-NATAL

OFFICE OF THE HOSPITAL CEO

KING EDWARD VIII CENTRAL HOSPITAL
Private Bag X02, CONGELLA, 4013
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www.kznhealth.gov.za

Ref.: KE 2/7/1/ 22 /2013)
Enq.: Mrs. R. Sibiya
Research Programming

27 May 2013

Mrs. VZ Peter
Department of Audiology
Westville Campus
UNIVERSITY OF KWAZULU-NATAL

Dear Mrs. Peter

Protocol: "An Audiological profile of School –age children with HIV/AIDS at an Antiretroviral Clinic in KwaZulu-Natal" REF: BE051/13

Permission to conduct research at King Edward VIII Hospital is provisionally granted, pending approval by the Provincial Health Research Committee, KZN Department of Health.

Kindly note the following:-

- The research will only commence once confirmation from the Provincial Health Research Committee in the KZN Department of Health has been received.
- Signing of an indemnity form at Room 8, CEO Complex before commencement with your study.
- King Edward VIII Hospital received full acknowledgment in the study on all Publications and reports and also kindly present a copy of the publication or report on completion.

The Management of King Edward VIII Hospital reserves the right to terminate the permission for the study should circumstances so dictate.

Yours faithfully

SUPPORTED/~~NOT SUPPORTED~~

DR. H. GOSNELL
CHIEF EXECUTIVE OFFICER

18/6/2013
DATE

Appendix D

DISCIPLINE OF AUDIOLOGY

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

SCHOOL OF HEALTH SCIENCES
TEL: 031 260 7438/8986
FAX: 031 260 7622
Email: sitholep2@ukzn.ac.za
Email: naidoor1@ukzn.ac.za

INFORMATION DOCUMENT FOR MEDICAL PROFESSIONALS

My name is Zandile Peter. I am currently employed at King Edward VIII hospital as a Speech Therapist and Audiologist. I am pursuing my Masters degree in Communication Pathology (Audiology) degree at the University of KwaZulu-Natal. As part of the degree requirements, I am required to complete a research dissertation. My research topic is "An audiological profile of school-age children with HIV/AIDS at an antiretroviral clinic in KwaZulu-Natal"

I would appreciate your assistance with my study. Your role in the research is very crucial. You will be required to identify all children aged 6 – 12 years receiving ARV and refer them to myself.

Should you have any further queries please contact my supervisors Dr. L. Joseph Tel: 031 - 260 7625, email josphl@ukzn.ac.za or Ms. J Paken Tel: 031 - 260 7548, email pakenj@ukzn.ac.za. Or you can contact the Research Ethics office on the following details:

BIOMEDICAL RESEARCH ETHICS ADMINISTRATION
University of KwaZulu-Natal
Research Office, Westville Campus
Govan Mbeki Building
Private Bag X 54001, Durban, 4000
KwaZulu-Natal, SOUTH AFRICA
Tel: 27 31 2604769 - Fax: 27 31 2604609
Email: BREC@ukzn.ac.za

Yours sincerely

Zandile Peter

Audiology researcher

Cell: 0847794242

UZN Ethical Clearance Number: BE051/13

Appendix E1

DISCIPLINE OF AUDIOLOGY

SCHOOL OF HEALTH SCIENCES
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Email: naidoor1@ukzn.ac.za

INFORMATION DOCUMENT FOR CAREGIVERS

An audiological profile of school-age children with HIV/AIDS at an antiretroviral clinic in KwaZulu-Natal

Dear Parent/ Caregiver

I, Zandile Peter, under the supervision of Dr. L. Joseph and Ms. J. Paken, am doing research in HIV/AIDS and hearing. I intend to investigate the number of cases of children infected with HIV/AIDS that present with a hearing loss at this hospital.

The title of the my study is **"An audiological profile of school-age children with HIV/AIDS at an antiretroviral clinic in KwaZulu-Natal"**

There are many factors that could result in different types, and degrees of hearing loss in school age children. My study aims to report on the number of children who are receiving ARV treatment presenting with hearing difficulties.

Due to the fact that your child meets the requirements of the study (HIV positive), I would like to invite your child to participate in the study, if you agree.

If you agree for your child to participate in the study, you will be required to sign this document. The procedure I will follow includes:

1. Looking in the child's ear with an otoscope.
2. Placing a soft probe in the child's ear. It is not painful and the child will hear a series of beeps that they will listen to but do not need to respond.

3. Thereafter, headphones will be placed on the child's head and he/she will hear a series of beeping sounds. When they hear the sounds they will have to press a button. Thereafter, they will be expected to repeat words at different levels of loudness. This will give an indication about their speech perception and ability to tell the difference between words.
4. Auditory Brainstem Response (ABR) will be conducted while the child is asleep or sitting quietly. Special cables (electrodes) are placed on the child's head and these cables will not hurt the child. The computer presents sounds and measures if the sound was heard while the child is asleep or sitting quietly. This test will take approximately 20minutes to complete.

None of the above procedures will place your child at any risk of harm as they are commonly used procedures with children.

After all the tests have been completed, you will receive feedback on the results in simple language (not using technical terms). You are welcome to ask questions. If other difficulties or abnormalities are noted, your child will be referred to the appropriate health provider for further assessment and management in the hospital. An appointment will be made by the researcher prior your departure after the hearing test.

Your participation in the study, will make it possible for me to obtain further knowledge in this field and this will contribute towards improving audiological management of children who are HIV positive presenting with hearing difficulties.

The test is free, since it will be part of your visit to the ARV clinic. You can withdraw from the study at any time with no penalties or negative consequences to you or your child.

To maintain confidentiality and anonymity your personal details will not be used in the research but you will be allocated a number to identify your child. The results will be presented to my supervisors in the same manner.

At the end of the study, you are welcome to contact me to find out the results of the study.

BIOMEDICAL RESEARCH ETHICS ADMINISTRATION
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Tel: 27 31 2604769 - Fax: 27 31 2604609
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Yours sincerely

Vuyelwa Zandile Peter
Speech Therapist and Audiologist
BA(Speech & Hearing) Wits

Email: zandimnyoni@yahoo.com
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UKZN Ethics Clearance Number:
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Dr. L. Joseph
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Appendix E2

DISCIPLINE OF AUDIOLOGY

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

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INCWADI YOMININGWANO YOMZALI

An audiological profile of school-age children with HIV/AIDS at an antiretroviral clinic in KwaZulu-Natal

Mzali

Mina Zandile Peter, ngaphansi komphathi udikotela Dr. L. Joseph kanye nonkosazana Ms. J. Paken, ngenza ucwaningo kwi HIV/AIDS (ugawulana/inculazi) nokuzwa. Ngihlose ukwenza ukucwaningo ngesibalo samacala ezingane ezihanqwe isifo se-HIV/AIDS ezinokungezwa kulesisibhedlela.

Isihloko socwaningo sithi **"An audiological profile of school age children with HIV/AIDS at an antiretroviral clinic in KwaZulu-Natal**" noma "Inani elinika sithombe ngokuzwa kwabantwana besikole abanegciwane leHIV/AIDS abahamba eklinic yemishwanguzo ekwaZulu-Natali"

Ziningi izimbangela eziholela ezinhlobeni ezahlukene, emazingeni okungezwa ngokuhlukana kweminyaka yazo. Inhloso yocwaningo lwami ukuthi ngithole isibalo sezingane ezihamba ikliniki yemishanguzo (ARV's) zibe zibonakalisa ubunzima bokuzwa.

Uma kungukuthi umntwana wakho uyahlangabezana nokudingekayo kulolucwaningo labanegciwane. Ngingathanda ukumema umntwana wakho abambe iqhaza kulolucwaningo, uma uvuma.

Uma uvuma ukuba untwana wakho abambe iqhaza kulolucwaningo, kuzomele usayine lencwadi yemvume. Umntwana wakho uzohlolwa ukuzwa mahala. Inquba engezoyilandela ihlanganisa lokhu:

1. Ukubuka indlebe yengane nge lambu lokubuka indlebe noma i-otoscope.

2. Ukubeka i-probe thambile yerabha endlebeni yengane. Ayibuhlungu, ingane izozwa umsindo, kodwa asikho isidingo sokuphendula.

3. Emva kwalokho, ama-headphone azobekwa ekhanda lengane bese ezwa umsindo okhala uthi-beep. Uma ewuzwa umsindo kumele acindezele inkinombo. Ulindelekile ukuthi aphinde amagama kanye nezinombolo azizwile eshiwo emazingeni angafani okuzwa. Kuzosinika ukuqonda ukuthi uzwa inkulumo emazingeni angakanani, futhi kusitshele nokuthi ukwazi kanganani ukuhlukanisa magama.

4. Ukuhlolwa okusheshayo okubizwa nge Auditory Brainstem Response (ABR) kuzoqhutshwa. Ngizobeka izintambo (electrodes) ekhanda, ngalesikhathi ehleli noma elele. Angeke alimale umntwana. Icomputer izokhipha umsindo, okala izinga lokuzwa lomntwana. Lokhu kuhlolwa kuzothatha imizuzu engamashumi amabili(20minutes) kuphela.

Lokukuhlwolwa akubangi ngozi noma akuzumlimaza untwana wakho, ngoba kujwayelikile ukusentshenziswa ebantwaneni.

Emva kokuhlolwa sekuphelile uzothola imiphumela ngolimi oluzwakalayo. Wamkelekile ukubuza imibuzo. Uma kukhona okuxwayekile, uzothunyelwa noma adluliselwe kodokotela, athole ukuhlolwa nokunakekelwa okwanele esibhedlela. Usuku lokuphinda abonwe luzohlelwa ngaphambi kokuba uhambe, emva kokuhlolwa.

Ukubamba iqhaza kulolucwaningo, kuzosiza ekutholeni ulwazi, futhi kusize indlela usizo olungalethwa kubantwana abangezwa ezindlebeni ngenxa yeHIV/AIDS.

Ukuhlolwa kumahhala njengoba kuzobe kuyingxenye yoku vakashela kwakho emtholampilo wemishanguzo noma-ARV. Ungahoxa noma inini kulolocwaningo, awuzukuhlawula.

Ukuze kungcinakale kuyimfihlo ukuthatha iqhaza kulolucwaningo, uzonikwa inobholo. Igama lakho neminingwano yakho izokwaziwa umcwaningi kuphela. Othishela bomcwaningi bazokwazi ngenombolo. Imniningwano yakho ngeke yaziwe abanye abantu.

Uma ucwaningo seluphelile, uvumelekile ukungithinta ukwazi impulela yocwaningo.

Uma unemibuzo ungasabi ukubuza mina kanye nothishela bami. Ungasithola kulemininingwano Dr. L. Joseph Tel: 031 - 260 7625, email josephl@ukzn.ac.za or Ms. J. Paken Tel: 031 - 260 7548, email pakenj@ukzn.ac.za. Noma

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Ozithobayo

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Appendix F1

DISCIPLINE OF AUDIOLOGY

SCHOOL OF HEALTH SCIENCES
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Email: naidoor1@ukzn.ac.za

CONSENT DOCUMENT

Title: An audiological profile of school-age children with HIV/AIDS at an antiretroviral clinic in KwaZulu-Natal

You have been informed of the research study by the researcher at the clinic. Your participation in this research is voluntary and you will not be penalised if you decide to withdraw from the study at anytime.

Your personal information such as name and hospital numbers will be kept confidential by allocating you a number during the study. Your personal information will be seen by myself as the researcher. Once the research is completed, your records will be kept in a locked cupboard for 5 years thereafter it will be destroyed, giving you confidence that all information disclosed will be treated with the highest confidentiality and you will remain anonymous.

Your child will undergo a hearing test as part of the study. It is at no cost to you. The testing procedure will last approximately one hour to one and a half hour.

If you would like to participate in the study, please sign this document to indicate voluntary participation by signing below.

The research study intentions have been explained to me verbally. I understand that my participation in the study is voluntary.

You may contact the research office for any further queries on the following details:

BIOMEDICAL RESEARCH ETHICS ADMINISTRATION
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KwaZulu-Natal, SOUTH AFRICA
Tel: 27 31 2604769 - Fax: 27 31 2604609
Email: BREC@ukzn.ac.za

_____ _____

Signature of caregiver Date

Please tick √

Consent	**Yes**	**No**

Appendix F2

DISCIPLINE OF AUDIOLOGY

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

SCHOOL OF HEALTH SCIENCES
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Email: naidoor1@ukzn.ac.za

IMVUME YOKUHLANGANYELA UCWANIGO (CONSENT DOCUMENT)

Isihloko: An audiological profile of school-age children with HIV/AIDS at an antiretroviral clinic in KwaZulu-Natal

Usuchazeliwe ngocwaningo oluqhubekayo lapha esibhedlela, uchazelwa umcwaningi. Ukuvuma ukuthatha iqhaza kulocwaningo akuphoqiwe, uma usufisa ukuhoxa nomangasiphi isikhathi akunambandela noma isijezo. Uvumelekile ukuhoxa nomangasiphi isikhathi.

Imininingwano yakho efana negama, inombolo yesibhedlela kanye nenombolo yocingo, kuzogcinwa kuyimfihlo. Umncwaningi uzokunika inombolo ukuze imininingwane yakho ingaziwa. Uma uthatha iqhaza kulocwaningo kuzoba imfihlo. Uma ucwaningo seluphelile, imininigwano izogcinwa ekhabetheni elikhiywayo iminyaka emihlanu. Emva kwalesikhathi, imininigwano izobhujiswa ukukunika isiqiniseko sokuthi imininingwano yakho ihlala iyimfihlo.

Umntwana wakho uzopopolwa izindlebe mahhala njengengxenye yocwaningo. Akukhokhwa lutho. Uxilongo luzothatha isikhathi esingange hora kuya kuhora nengxenye.

Uma ufisa ukuthatha iqhaza ucwaningo, ngicela ugcwalise imininingwane elandelayo ukukhombisa ukuthi uzivumele awuphoqwa.

Umncwaningi usengichazele ngomlomo izinhloso zocwaningo. Ngiyaqonda ukuthi angiphoqiwe ukuzihlanganisa nocwaningo.
Ungaxhumano nehhovisi eliphethe ucwaningo kulemininingwano:

BIOMEDICAL RESEARCH ETHICS ADMINISTRATION
University of KwaZulu-Natal
Research Office, Westville Campus
Govan Mbeki Building
Private Bag X 54001, Durban, 4000
KwaZulu-Natal, SOUTH AFRICA
Tel: 27 31 2604769 - Fax: 27 31 2604609
Email: BREC@ukzn.ac.za

_____ _____

Sayina umzali Usuku

Ngicela uthikhe √

Ukuvuma	**Yebo**	**Cha**

Appendix F3

DISCIPLINE OF AUDIOLOGY

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

SCHOOL OF HEALTH SCIENCES
TEL: 031 260 7438/8986
FAX: 031 260 7622
Email: sitholep2@ukzn.ac.za
Email: naidoor1@ukzn.ac.za

ASSENT FORM FOR CHILDREN

Title: An audiological profile of school-age children with HIV/AIDS at an antiretroviral clinic in KwaZulu-Natal

My name is Zandile Peter. I am trying to learn about the number of children who have and hearing problems. Because you attended the Philani Family Clinic and you are aged between 6-12 years, if you would like, you can be in my study.

If you decide you want to be in my study, you will receive a hearing test. This includes:

1. Looking into your ears with a light.
2. I will put a rubber probe in your ear. You will hear a beeping sound, but you do not need to respond.
3. Headphones will be placed on your head and you will hear peep sounds and you will press a button to tell me you heard the sound.
4. While you are sitting quietly, special cables will be put on your head. The computer will present sounds, you do not have to answer, but sit quietly.

The hearing tests will not hurt you, as they are used on other children.

At the end of the test we will know if you can hear. If I find that there is problem, I will send you to a specialist that will help you. It is good to have your hearing tested to make sure you can hear the sounds around you and the people when they talk to you.

Other people will not know if you are in my study. I will put things I learn about you together with things I learn about other children, so no one can tell what things came from you. When I tell other people about my research, I will not use your name, so no one can tell who I am talking about.

Your parents or guardian have to say it's OK for you to be in the study. After they decide, you get to choose if you want to do it too. If you don't want to be in the study, no one will be upset with you. If you want to be in the study now and change your mind later, that is OK. You can stop at any time.

You can call me if you have questions about the study or if you decide you don't want to be in the study any more.

I will give you a copy of this form in case you want to ask questions later. At the end of the study, you are welcome to contact me to find out the results of the study.
Should you have any further questions please contact my supervisors Dr. L. Joseph Tel: 031 - 260 7625, email josphl@ukzn.ac.za or Ms. J. Paken Tel: 031 - 260 7548, email pakenj@ukzn.ac.za. Or

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Tel: 27 31 2604769 - Fax: 27 31 2604609
Email: BREC@ukzn.ac.za

Thank you very much

Vuyelwa Zandile Peter
Speech Therapist and Audiologist
BA(Speech & Hearing) Wits

Email: zandimnyoni@yahoo.com
Cell: 0847794242
UKZN Ethics Clearance Number:
BE051/13

Dr. L. Joseph
Research Supervisor
BSHT (UDW)
M (Com. Path)UP
(PhD) UP
josephl@ukzn.ac.za
Tel: 031 - 260 7625

Ms. J. Paken
Research Supervisor
B(Com.Path-Aud)UKZN
M(Com. Path-Aud)UKZN
pakenj@ukzn.ac.za
Tel: 031 - 260 7548

ASSESSNT FORM

I have decided to be in the study even though I know that I don't have to do it. Zandile Peter has answered all my questions.

Child's name/finger print _____ Date _____

Yes	No

Signature of Researcher _____ Date _____

Appendix F4

DISCIPLINE OF AUDIOLOGY

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

SCHOOL OF HEALTH SCIENCES
TEL: 031 260 7438/8986
FAX: 031 260 7622
Email: sitholep2@ukzn.ac.za
Email: naidoor1@ukzn.ac.za

IMMVUME YEZINGANE (CHILDREN'S ASSENT)

Title: An audiological profile of school-age children with HIV/AIDS at an antiretroviral clinic in KwaZulu-Natal

Igama lami nguZandile Peter. Ngifisa ukufunda kabanzi ngenamba yabantwana abenkinga nokuzwa. Ngoba uhamba ikliniki Philini Family, futhi uneminyaka engaphakathi kuka 6- 12 yeminyaka, bengifisa ungene ibe ingxenye yesifundo sami.

Uma ungathanda ukungena kulesisifundo, izohlolwa izindlebe. Kuzokwenzeka lokhu:

1. Ngizobuka indlebe yakho ngethoshi.
2. Ngizofaka i-probe ethambile endlebeni. Uzozwa umsindo othi peep. Awudingi ukuphendula.
3. Ngizobeka amheadphones ekhanda. Uzozwa umsindo okhala uthi peep. Uzocindezela ikinobho ukukhombisa ukuthi uzwile umsindo.
4. Ngizobeka intambo (cables) ekhanda. Umshini uzokhanda umsindo othi beep, awudingi ukuphendul, umshini uzobal ubone ukuthi uyezwa kangakanani.

Ukuhlola izindlebe akunabuhlungu, ngoba kwenziwa ezinganeni eziningi.
Nasesiqedile, ngizokwazi ukuthi uzwa kangakanani. Uma kunenkinga, ngizokuthumela kodokotela abozokusiza. Kuhle ukuhlolwa izindlebe, khona uzokuzwa imisindo okuyo kanye nabantu umabekhuluma.

Abanye abantu ngeke bazi ukuthi ungomunye abakulesifundo. Lonke ulwazi engilitholayo ngawe kanye nontanga angizukusebenzisa igama lakho, akekho ozokwazi ukuthi ubunengxenye. Uma ngixoxela abanye ngalisifundo, angizukusebenzisa igama ngebazi ukuthi ngikhuluma ngawe.

Umzali usevumile. Thatha isinqumo sokuthi uthanda ukwenzani. Uma ungathandi, ukungena, akekho ozojabha, noma ozothetha. Angizukuphatheka kabi. Futhi uvumelekile ukushintsha ingqondo noma kunini, akekho ozothetha noma akushaye. Ungayeka noma inini.

Usho uma unombuzo ngalesifundo noma ungasafuni ukuqhubeka.

Ngizokupha ikhopi yalencwadi. Nasengiqedile ngesifundo, wamukelekile ukuthola ukuthi ngitholeni kulesifundo.
Uma uneminye imubuzo ungathintana nothishela bami kulemininingwano Dr.L. Joseph Tel: 031 - 260 7625, email jospehl@ukzn.ac.za or Ms. J Paken Tel: 031 - 260 7548, email pakenj@ukzn.ac.za. Or

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Thank you very much

Vuyelwa Zandile Peter
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josephl@ukzn.ac.za
Tel: 031 - 260 7625

Ms. J. Paken
Research Supervisor
B(Com.Path-Aud)UKZN
M(Com. Path-Aud)UKZN
pakenj@ukzn.ac.za
Tel: 031 - 260 7548

Imvume(Assent)

Ngikhetha ukungena ukulesifundon, ngiyazi ukuthi angiphoqiwe. uZandile Peter useyiphendule yonke imibuzo yami.

Igama lengane/isithupha _____ Usuku _____

Yebo	Cha

Kusayina umncwanini _____ Usuku _____

Appendix G1

CASE HISTORY QUESTIONNAIRE

Patient no:

1Section 1. Biographical information

1. Age	
2. Gender	
3. Racial group	

Section 2: Hearing history (To be completed with the participant and caregiver)

Please tick in the correct column

Question	Yes	No
Pregnancy and birth 4. Was the mother healthy during pregnancy? 4.1. If no, please explain 5. Was the pregnancy full term? 5.1.If no, elaborate 6. How was the delivery? a. Normal b. Caesarean c. Assisted 7. Were there any complications during delivery? 7.1. If yes, please explain 8. Was the baby healthy after birth? 8.1. If no, explain (e.g. seizures, jaundice etc)		
Development 9. Was the child sitting, crawling, and walking within the normal age range? 9.1. If no, please explain 10. Are you concerned about your child's general development, speech-language development or hearing development? 10.1. If yes, elaborate		
Medical 11. Does the child have any co-existing medical conditions (e.g. TB, seizures)?		

11.1. If so please describe		
Hearing related problems 12. Do you think he/she can hear normally? 13. Did he/she have surgery conducted on the ears? a. If so, when b. What surgery? 14. Did he/she ever have a hearing test before? 14.1.If so specify 15. Has your child had ear infections? 15.1. If so, how many infections, when did they begin? 16. Did he/she receive treatment? 16.1.How were they treated? 17. Does he/she experience or complain of pain in the ears? 18. Does he/she complain of fullness of the ears? 19. Does he/she suffer from high temperature frequently? 20. Does he/she complain of ringing noise in the ear? 21. Does he/she complain that they cannot hear? 22. Does he/she complain of feeling dizzy? 23. Does he/she suffer from recurrent chest infections? 23.1. If yes, how often		
Educational history 24. What grade is he/she currently in? 25. Has he/she repeated a grade? 27.1.If so, why? 26. Is he/she currently coping with academic demands?		

Appendix G2

CASE HISTORY QUESTIONNAIRE (isiZulu)

Patient no:

Section1: Biographical information

1. Age (Iminyaka)	
2. Gender (Ubulili)	
3. Racial group (Uhlanga)	

Section 2: Hearing history (To be completed with the participant and caregiver)

Please tick in the correct column

Imibuzo	Yebo	Cha
Ukukhulelwa nokubeletha		
4. Umama ebenempilo enhle ngesikhathi ezithwele?		
4.1. Uma impendulo ingu cha, ngicela unabe/uchaze kabanzi		
5. Wayezithwele izinyanga ezingu 9?		
5.1. Uma impendulo ingu cha, ngicela unabe/uchaze kabanzi		
6. Wabeletha kanjani?		
6.1. Wazibelethela		
6.2. Wabeletha ngomthungo		
6.3. Wabelethwa ngokusizwa		
7. Zabakhona izinkinga ngesikhathi ubeletha?		
7.1. Uma impendulo ingu yebo, ngicela unabe/uchaze kabanzi		
8. Emva kokubelethwa, umntwana akazange abenezikinga?		
8.1. Uma impendulo ingu yebo, ngicela unabe/uchaze kabanzi (e.g. ukudlikiza, jaundice, ukuthamba komzimba etc)		
Izigaba zokukhula		
9. Umntwana wahlala, wakhasa, wahamba ngesikhathi esifanele?		
9.1. Uma impendulo ingu cha, ngicela unabe/uchaze kabanzi		

10. Ukhathazekile ngokuhluma kolimi lomntwana, nongendlela ezwangayo na? 10.1. Uma impendulo ingu yebo, ngicela unabe/uchaze kabanzi		
Isimo sempilo 11. Ingabe umtwana kukhona ezinye izifo anazo na (isibonenelo, TB, ukudlikiza)? 11.1.Uma impendulo ingu yebo, ngicela unabe/uchaze kabanzi?		
Izinkinga ezihambelana nokuzwa **12.** Ucabanga ukuthi umntwana wakho uzwa kahle? 13. Wake wahlinzwa izindlebe ngaphambili? a. Wahlinzwa nini? b. Wahlinzelwani? 14. Zake zahlolwa izindlebe zakhe ngambili? 14.1. Uma impendulo ingu yebo chaza kabanzi? 15. Wake waphathwa izindle umntwana bakho? 15.1. Uma impendulo ingu yebo, zaqala nini ukumhlupha futhi kangaki? 16. Walithola usizo? 16.1. Walithola kuphi, kanjani? 17. Ingabe wake wakhala ngezindle ezibuhlungu? 18. Wake wabika ukuthi kuzwakala ngathi zigcwele indlebe? 19. Uke uhlushwe ukushisa komzimba? 20. Wake wabika ukuthi kunomsindo okhalayo endlebeni? 21. Wake wabika ukuthi akezwa? 22. Wake wabika inzululwane/isiyezi?		

23. Simphatha njalo isifuba? 23.1. Uma impendulu kungu yebo nini?		
Imlando ngezemfundo 24. Ufunda liphi ibanga manje? 25. Wake waliphinda ikilasi ngaphambili/ wake wafeyila na? 25.1. Nini? 26. Njengamanje kuqhubeka kanjani esikoleni na?		

Appendix H

MEDICAL RECORD FORM

Patient no:

Test conducted (obtained from medical records)

Name of the test	Date of the results	Results
1. CD4 cell count		
2. VIRAL LOAD		
3. Other test(specify)		
4. Audiological assessments		
5. Ear related medical management		

5.1 ARV commenced on the_____

5.2 ARV program and dose

Medication	Dosage

FACTS ABOUT HEARING LOSS IN CHILDREN

There are three types of hearing loss:

Sensorineural hearing loss

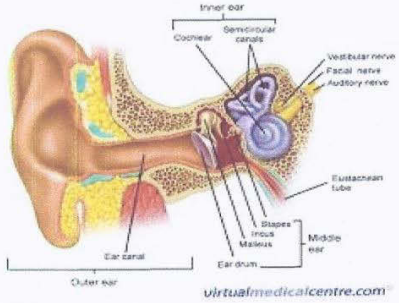
Is generally nerve-related deafness that involves damage to the inner ear caused by aging, pre-natal and birth -related problems, viral and bacterial infections, heredity, trauma, exposure to loud noise, fluid backup or a benign tumor in the inner ear. Almost all sensor neural hearing loss can be managed with hearing aids.

Conductive hearing loss I

Involves the outer and middle ear and may be caused by wax blockage, punctured eardrum, birth defects, ear infection, trauma or heredity. Often, conductive hearing loss can be treated medically or surgically.

Mixed hearing loss

Refers to a combination of conductive and sensorineural loss and means that a problem occurs in both the outer or middle and the inner ear.



The degree of hearing loss varies from person to person

There are many degrees between the two extremes of hearing well and not being able to hear at all. The terms used to describe degrees of hearing loss are mild, moderate, severe and profound hearing impairment. Most hearing loss is mild to moderate.

What does the degree of hearing loss mean?

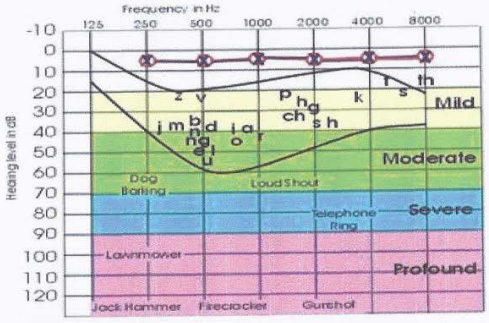
Mild hearing loss: unable to hear soft sounds, difficulty understanding speech clearly in noisy environments.

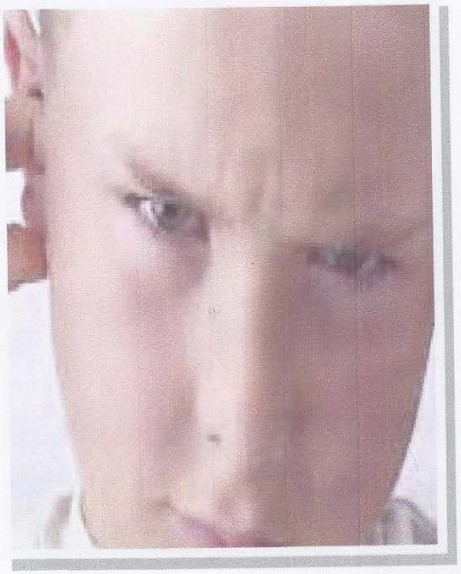
Moderate hearing loss: unable to hear soft and moderately loud sounds, considerable difficulty understanding speech in everyday situations, particularly with background noise, such as in a restaurant.

Severe hearing loss: some loud sounds are audible but communication without a hearing instrument is impossible.

Profound hearing loss: some extremely loud sounds are audible but communication without a hearing instrument is impossible.

AUDIOGRAM

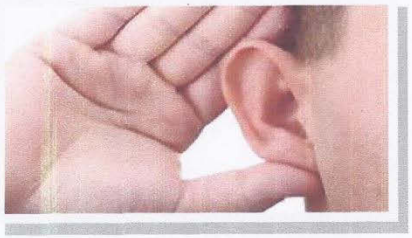




FACTS ABOUT HEARING LOSS IN CHILDREN

Did you know?

- Even mild hearing loss can significantly interfere with the reception of spoken language and education performance. (Bess et al. 1998)
- Children with mild hearing loss miss out 25–50% of speech in the classroom and may be inappropriately labelled as having a behavior problem. (Flexer 1994)
- Children with unilateral hearing loss (in one ear) are 10 times as likely to be held back at least one grade compared to children with normal hearing. (Oyler et al. 1998)
- The benefits of wearing two hearing aids are enhanced ability to hear better in the presence of background noise, determine where sound is coming from and hear soft sounds at lower levels. Speech intelligibility is also improved resulting in improved language acquisition (Hearing Loss Association of California Fact Sheet: www.hearinglossca.org/html/fact.htm)
- Approximately 1 in 1,000 newborns (or 33 babies every day) is born profoundly deaf (with significant permanent hearing loss). (www.cdc.gov/ncbddd/ehdi)
- Infants identified with hearing loss can be fit with amplification by as young as 4 weeks of age. With appropriate early intervention, many children who are deaf or hard of hearing can be successfully mainstreamed in regular elementary and secondary education classrooms. (Joint Committee on Infant Hearing Year 2000 Position Statement)
- Early identification and intervention combined with appropriate hearing technology – hearing aids and cochlear implants – enable many children who are deaf or hard of hearing to develop language skills comparable to their hearing peers. (Johnson et al. 1993)



Signs of hearing loss

- Does not startle or jump to loud sounds?
- Asks for things to be repeated?
- Seem to watch your face closely when you talk?
- Seem inattentive at home or school?
- Do not communicate as well as other children the same age?
- Often respond to a question with an unrelated answer?
- Prefer the TV or radio louder than others in the family?
- Have had many ear infections?
- Respond inconsistently to sound?

AMAQINISO NGOKUNGEZWA EZINGANENI

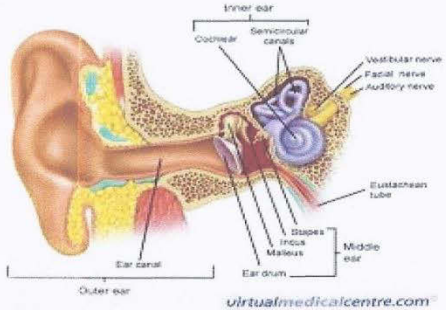
Zintathu izinhlobo zokungezwa:

Sensorineural hearing loss

Ukungezwa okubangelwa ukulimala komsipha wokuzwa kungabangelwa ukulimala kwendlebe ngaphakathi ngenxa yokuguga, izinkinga esiswini sikamama ngesikhathi ezithwele, izinkinga ngesikhathi umama ebeletha ingane, ukugula okubangwa amagciwane, (njenge menenjatisi) ufuzo, ukulimala kwendlebe okubangwa ingozi ekhanda, ukuba sendaweni enomsindo isikhathi eside njengemboni noma imayini, amanzi endlebeni kanye nomdlavuza wendlebe. Isikhathi esiningi lenhlobo yokungezwa isizakala ngokufaka insiza kuzwa (hearing aid).

Conductive hearing loss

Kungabangelwa isigonogono esiningi, imbombo ku ear drum, izitho ezingaphele ekuzwalweni, ukubhibha kwendlebe, ukulimala kwendlebe okubangwa ingozi kanye nofuzo. Isikhathi esiningi lokungezwa kuxazululwa ngemithi noma ukuhlinzwa kwendlebe.



Izinga lokungezwa ebantwini alifani

Maningi amazinga okungezwa. Amagama asetshenziswayo ukuchaza athi, ukungezwa okuncane, ukungezwa okuthe xaxa okukhulu nokungezwa nhlobo. Abantu abaningi bona abezwa kancane.

Amazinga okungezwa achaza ukuthini na?

Mild hearing loss

Ukungezwa kancane: ukuba nenkinga yokungezwa imisindo aphansi, inkinga yokuqonda inkulumo futhi nenkinga yokuzwa inkulumo endaweni enomsindo.

Moderate hearing loss

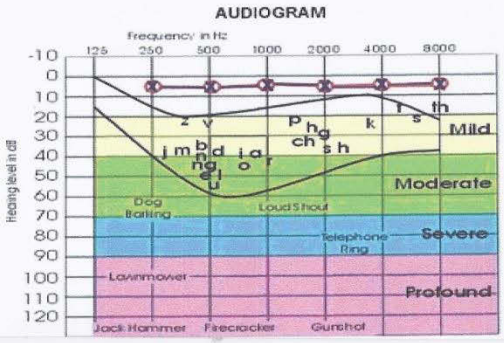
Ukungezwa okuthe xaxa: ukuba nenkinga yokungezwa imisindo futhi nokuqonda inkulumo nsukuzonke ikakhulu endaweni enomsindo njengekhefi.

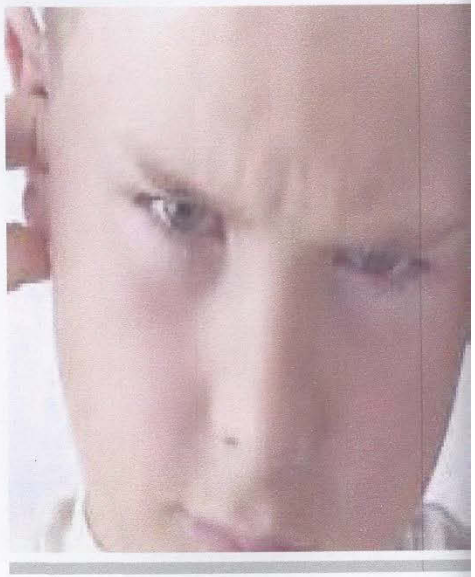
Sever hearing loss

Ukungezwa okukhulu : uzwa imisindo emikhulu kuphela, inkulumo ayizwakali.

Profound

Ukungezwa nhlobo: eminye imisindo iyazwakala kodwa awuzwa nhlobo ngaphandle kwensiza kuzwa.





AMAQINISO NGOKUNGEZWA EZINGANENI

Kuchaza ukuthini ukungezwa na?

◊ Ukungezwa okuncane kungathikameza ukuzwa inkulumo, ukuhluma kolimi futhi kuphazamise ukuphasa esikoleni? (Bess et al. 1998)

◊ Abantwana abangezwa kancane baphuthelwa ngu 25–50% wezinto ezifundwayo ekilasini, futhi babizwa ngokuthi izihluphi ngoba abezwa (Flexer 1994)

◊ Abantwana abezwa ngendlebe eyodwa bavame ukuphinda ikilasi uma beqhathaniswa nabezwayo. (Oyler et al. 1998)

◊ Kuyasiza ukufaka insizakuzwa (ihearing aid) ezindlebeni zombili, ikakhulukazi endaweni enomsindo ngoba kusisza ukuthola ukuthi uqhamuka kuphi umsindo. Inkulumo icaca kakhulu eholela ekuhlumeni okuhle kolimi (Hearing Loss Association of California Fact Sheet: www.hearinglossca.org/html/fact.htm)

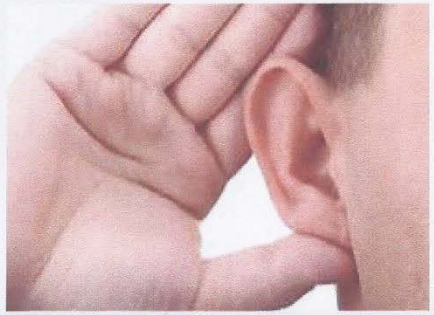
◊ Oyedwa phakathi kwabayi 1,000 uzalwa engezwa (noma ezinganeni ezingu 33ezizwalwa nsukuzonke) (www.cdc.gov/ncbddd/ehdi)

◊ Usana olutholakala masisha ukuthi aluzwa (enyangeni ezingu 4 lizelwe), beselufakwela insizakuzwa masisha, amathuba okukhula kahle nokufunda esikoleni esijwayelikile makhulu. Ngokusizwa okusheshayo nokubonakala masisha, ingane ezingezwa zingafunda esikoleni esijwayelekile (Joint Committee on Infant Hearing Year 2000 Position Statement)

◊ Ukuhlolwa izindlebe nokuthola usizo ebuntwaneni, kuhambelisana netechnology ephambili yensizwakuzwa, kuvumela abantwana abangezwa bathole amathuba okuhluma ulimi njengontanga abezwayo (Johnson et al. 1993)

◊ Usana olutholakala masisha ukuthi aluzwa (enyangeni ezingu 4 lizelwe), beselufakwela insizakuzwa masisha, amathuba okukhula kahle nokufunda esikoleni esijwayelikile makhulu. Ngokusizwa okusheshayo nokubonakala masisha, ingane ezingezwa zingafunda esikoleni esijwayelekile (Joint Committee on Infant Hearing Year 2000 Position Statement)

◊ Ukuhlolwa izindlebe nokuthola usizo ebuntwaneni, kuhambelisana netechnology ephambili yensizwakuzwa, kuvumela abantwana abangezwa bathole amathuba okuhluma ulimi njengontanga abezwayo (Johnson et al. 1993)



Impawu zokungezwa

◊ Iyathuka yini ingane uma kunomsindo omkhulu?

◊ Ucelwa ukuphindelwa okushiwo?

◊ Ubukeka sengathi, ubuka ubuso nondebe uma elalela

inkulumo?

◊ Ubukeka sengathi akalaleli ekhaya nasekiliasini?

◊ Akakhulumi njengontanga yakhe?

◊ Akaphenduli imibuzo ngempendulo efanele, uyabheda?

◊ Uma elalela iradio noma ebuka iTV ivoluyumi elalangayo

ibaphezulu kunabenye abantu?

◊ Uhlushwa indlebe njalo?

Appendix J

Patient no:

OTOSCOPIC EXAMINATION CHECK LIST

Inspection	**RE**	**LE**	**Comment**
External examination 1. Symmetry 2. Position in relation to the head 3. Atresia 4. Colesteotoma 5. Stenosis 6. Hematoma 7. Normal			
8. Skin condition 8.1.lumps, 8.2color, 8.3. lesions			
External auditory meatus 9. Swelling 10. Redness 11. Discharge 12. Cerumen, 12.1. soft 12.2. wet, 12.3. dry, 12.4 .blocking view of TM 13. Foreign body			
Tympanic membrane 14. Irritation 15. Scarring 16. Position a. retracted, b. bulging, c. normal 17. Perforation 18. Cone of light 19. Discharge 20. Fluid			

Adapted from: Gelfand, (2001)

Keys: √ yes- indicates normal

X no- indicates abnormalities observed

Appendix K1

IMMITANCE AND OAE RECORD FORM

Patient no:

Immitttance

Tympanometry				
Ear	Canal vol	Static compliance	Middle ear pressure	Type
Right				
Left				

ACOUSTIC REFLEX THRESHOLDS				
Right Stim	500Hz	1000Hz	2000Hz	4000Hz
Ipsi				
Contra				
Left stim				
Ipsi				
Contra				

Distortion Product Otoacoustic Emissions (DPOAE)

Frequencies	DP	Right ear	Left ear	Pass/Fail
8000Hz				
6000Hz				
4000Hz				
2000Hz				
100Hz				
500Hz				
250Hz				

Appendix K2

Immittance audiometry procedure:

Tympanometry:

Obtaining Tympanogram procedure:

- The tympnogram was obtained by inserting a colour coded probe into the ear canal and automatic function was used.
- Presentation of a pure tone sound (known as the probe tone) was carried out (Nozza, et al. 1994).

  Detection of the tone was via miniature microphone in the probe assembly of sound level meter within the ear canal (Koivunen et al., 2000).
- Air pressure changes in the ear canal resulted in the compliance of the tympanic membrane and the mobility measured by the probe (Lehmann et al., 2008).
- Tympanometry requires an airtight (hermetic) seal between the probe tip and the walls of the external ear canal. An airtight seal was confirmed when positive or negative pressure in the external ear canal is developed at +200 or – 300 mmH O (daPa) (Brouwer et al., 2007). If neither positive nor negative pressure could be created in the external ear canal, the probe tip should be replaced and reinserted in an attempt to adequately seal the external ear canal (Hall, Adlin, May & Bantwal, 2009).
- Tympanometry was very quick. The systematic change in external ear canal from +200 to -200 or -300 mmHO (daPa), and measurement of the resultant change in middle ear compliance, takes only 5 to 10 seconds (Hall et al., 2009).

Acoustic Reflexes

Procedure for obtaining acoustic reflexes:

- Ipsilateral acoustic reflexes were obtained by inserting a probe tip into the auditory canal and ensuring that a good seal had been obtained. Pressuring of middle ear cavity was initiated and the acoustic reflex was obtained across 500Hz, 1000Hz, 2000Hz, and 4000Hz.
- Contra lateral reflexes are obtained by placing a TDH 39 headphone/contra lateral phone was placed on the test ear and the ear probe was placed on the non-test ear to obtain contraleteral reflexes. Pressuring of middle ear cavity was initiated and the acoustic reflex was obtained across 500Hz, 1000Hz, 2000Hz, and 4000Hz (Kazunari, 2006).

Appendix K3

Immittance Result interpretation

Tympanometry

The Jerger classification system of tympanometry was used (Jerger, 1970 as cited in Gelfand 2001), with the Tympanograms being described as Type A, Type As, Type Ad, Type C and Type B. The normative values specific to the AZ 26 (diagnostic) were used.

Table 1

Normative values for specific AZ26 Middle ear analyzer

Measurement	**GSI Range of normal values**
Ear canal volume	0.2 – 1.00cm3
Compliance peak	0.2 – 1.8mmho
Peak pressure	+50daPa and -100daPa

Source: Gelfand, (2001).

Acoustic Reflexes

The range for normal acoustic reflex thresholds are between 70 to 100 dBHL for ipsilateral acoustic reflexes and contralateral acoustic reflex thresholds should range from 85 to 105dBHL, as suggested by Gelfand (2001).

Appendix K4

Distortion Product Otoacoustic Emissions (DPOAE) procedure and intepretation:

DPOAEs were ascertained by using the (f2/f1) paradigm. Two stimuli of different intensities (65/55dB SPL) with two frequency ratio of 1.2 were used. A response was considered present when the DP level was equal to or greater than 6dB (Gelfand, 2001).

Appendix L

KWAZULU-NATAL PROVINCIAL ADMINSTRATION

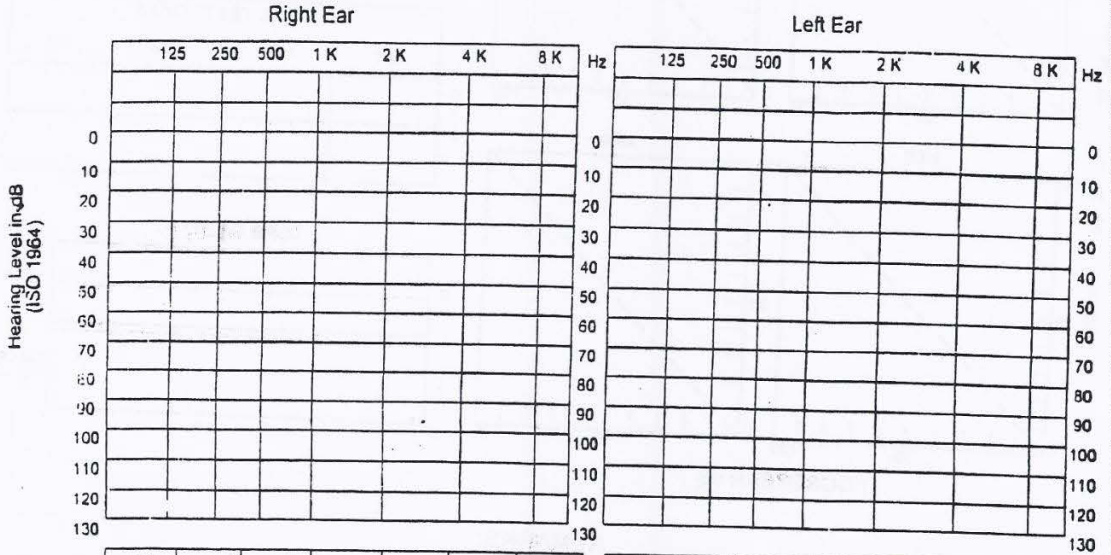
AUDIOMETRIC EXAMINATION

HOSPITAL .....

NAME ..... PATIENT NO. .....

AUDIOLOGIST ..... DATE .....

PURE TONE AUDIOGRAM



NBN dB Masking							
	AC						
	BC						

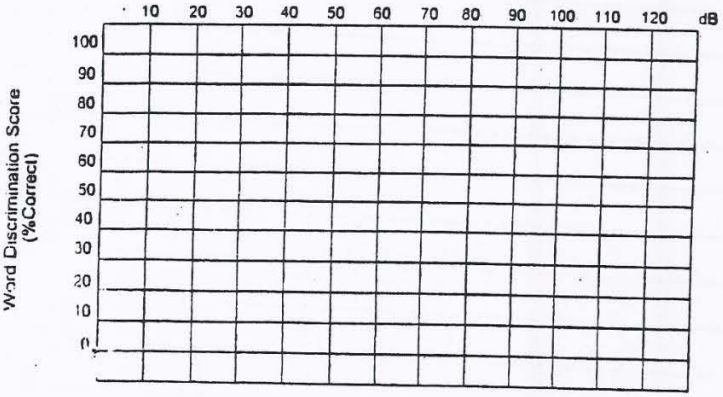
AC			
BC			

EAR	PTA	SRT	% max disc
Right			
Left			

TEST RELIABILITY

GOOD	FAIR	POOR

SPEECH AUDIOGRAM



WN Masking													dB

EAR	MCL	DL	Dynamic Range
Right			
Left			

AUDIOGRAM KEY

	Right	Left
AC unmasked	○	×
AC masked	△	□
BC unmasked	◁	▷
BC masticd masked	[	]
BC forehead masked	⊤	⊤
NO response	○	×

Appendix L1

Pure Tone Audiometry procedure

- **Air conduction procedure** (Kramer, 2008):
  - The patient was moved into the patient side of the audiometric booth and instructions were given.
  - The audiologist commenced with testing using a familiarization tone at 30-40dB above estimated thresholds. Once a response was obtained then threshold search began in the right ear at 1000Hz using the ascending bracketing method to thresholds.
  - High frequencies (2000Hz – 8000Hz) were assessed in the same manner.
  - Confirm the threshold of 1000Hz.
  - Low frequencies (250-500Hz) were tested in the same manner.
  - The results were recorded on the audiogram.
  - Masking was applied when there is a difference of >40dB between the test ear and non-test: AC_{non}-test ear +15.
- **Bone conduction procedure** (Kramer, 2008):
  - The participants were allowed a short break in the booth.
  - Bone conduction vibrator was then placed on the ear with poorer PTA results and testing commenced at 1000Hz using the descending by 10dB and ascending by 5dB method until threshold was obtained.
  - High frequencies (2000Hz-4000Hz) were assessed in the same manner
  - Low frequencies (250-500Hz) were assessed in the same manner.
  - The results were recorded on the audiogram.
  - In the cases where BC was 10 dB or better than air conduction, masking was introduced using headphones to raise the threshold in the non-test ear using air-conducted sound and effective masking formula, as recommend by Ahmad and Pahor (2002).

$$\mathbf{AC_{\text{of non test ear}} + 15 + \text{Occlusion effect}}$$

The following occlusion effect values are described:

Table 1

Occlusion Effect values

Frequency	Occlusion effect value
250Hz	15dB
500Hz	15dB
1000Hz	10dB
2000Hz	0dB
4000Hz	0dB

Source: Gelfand. (2001).

Appendix L3

Hearing loss classification

Table 1

Degree of hearing loss

Severity range(PTA)	**Decibels (dB)**
Normal	0 – 15 dB
Mild	16 – 40 dB
Moderate	41 – 55 dB
Moderately severe	56 – 70dB
Severe	71 – 90 dB
Profound	>90 dB

Source: Gelfand, (2001)

Table 2

Hearing loss type

Hearing loss type	**Description**
Conductive	The hearing loss is a result of the middle ear being affected. The audiogram results will indicate air bone gaps of >10dB across all frequencies. Bone conduction thresholds can be depressed not exceeding 25dB levels.
Sensorineural	This hearing loss results from cochlear impairment and the auditory nerve. The audiogram results will indicate depressed air conduction and bone conduction thresholds with no air bone gaps.
Mixed	This hearing loss indicates that there is a conductive and sensorineural component. Both air and bone conduction thresholds will be depressed with certain frequencies presenting with an air bone gap greater than 10dB.

Gelfand, (2001).

Table 3

Hearing loss configuration

Configuration	**Description**
Flat	No more than 5-10dB change per octave
Sloping	Greater hearing loss for high frequencies (15-20dB per octave)
Ski-slope	More than 20dB loss per octave
Rising	Worse in the low frequencies, improving by 10-20dB per octave
Cookie bite	Worse in the low and high frequencies
Trough	Worse in the mid frequencies
Irregular	Not in any of the above categories

Source: Hogdson, 1980 as cited in Northern, & Downs. (2002).

APPENDIX M1

SPEECH AUDIOMETRY PROCEDURE

- Speech Reception Thresholds (SRT): The participant was instructed to repeat words or numbers as they heard them. Then SRT was obtained in the right ear and then the left ear. The following procedure was used, as recommended in Kramer (2008).
    - The child was seated on a chair in a sound proof booth at 90 degree with headphones on their heads.
    - The audiologist commenced testing at PTA + 40dB L to familiarise the child to the word list.
    - The audiologist used the children's Spondee word list in English and the digit test for IsiZulu .
    - The child had to repeat the words as soon as they heard them, using the ASHA Method of obtaining SRT.

- Speech Discrimination Results (SD): SD was obtained in the same ear. Then SRT and SD were obtained in the left ear.
    - The researcher used 3 presentation levels where the following formulae were applied to establish the levels: Level 1-SRT+ 20dB, Level 2-SRT +30dB, and Level 3-SRT +40dB (North & Downs, 2002).
    - A list of 25 words was read and the percentage of words correctly identified was obtained through:

      $$SD\ Score = \frac{Number\ of\ correct\ words - Number\ of\ incorrect\ word}{25} \text{x}100$$

    - Once testing was completed the headphones were removed from the participant.

Appendix M2

Speech audiometry normative data

Speech Reception Thresholds (SRT)

Reliability rating

For each testing session the audiologist rated the reliability of results as "good," "fair," or "questionable." Reliability used Pure Tone Average (PTA) and Speech Reception Threshold (SRT) correlation. Good correlation will results from 0-5dB, fair correlation 6-10 and poor >10dB difference (Ahmad & Pahor, 2002; Northern & Downs, 2002).

Speech discrimination (SD)

Table 1

Word Recognition Scores and interpretation

Word Recognition Score Percent correct	**Degree of impairment**	**Word Recognition ability**
100-90	None	Excellent
89-75	Slight	Good
74-60	Moderate	Fair
59-50	Poor	Poor
<50	Very poor	Very poor

Source: Kramer, (2008).

Table 2

Interpretation of SDT data

Hearing loss type	**Speech results**
Normal hearing	PB Max of 100%
Conductive hearing loss	PB Max of 100% achieved at higher intensity levels for PI-BP function
Sensorineural (cochlear)	May reach PB Max of 100% or a dynamic range of <45dB suggest recruitment
Sensorineural (retrocochlear)	Difficulty with attaining PB Max of 100% discrimination with roll over >20% PI-BP function roll over ratio >0.45

Source: Kramer, (2008).

Appendix M3

DIGIT WORD LIST FOR NON-ENGLISH SPEAKERS (Ramkisson, 2000)

nine-four	eight-five	six-six
five-one	three-six	eight-ten
one-ten	four-six	one-four
six-ten	ten-nine	nine-nine
four-one	one-one	four-three
three-one	six-four	ten-ten
eigth-one	five-two	two-eight
six-one	two-one	six-five
one-three	nine-one	three-ten
eigth-nine	two-six	four-nine
nine-ten	nine-eight	one-two
two-four	five-ten	five-three
ten-four	four-four	three-five
four-two	three-four	six-three
one-eight	eigth-eight	two-two
six-nine	ten-one	five-nine
three-two	six-eight	nine-two
two-nine	eight-four	three-three
ten-five	one-five	nine-six
five-eight	five-four	two-five
nine-five	two-three	ten-six
ten-eight	ten-three	eight-three
ten-two	nine-three	one-six
one-nine	two-ten	three-eight
four-eight	six-two	four-ten
five-six	eight-two	five-five

Appendix M4

ISIZULU SPEECH DISCRIMINATION (Balkisson, 2001)

bheka	bonga
cela	cula
dlala	funa
faka	hlala
hamba	kama
luma	nika
ngena	phinda
phuza	phuma
pheka	qala
shaya	suka
susa	thinta
thatha	thula
vuka	vula
vala	washa
gcoba	geza
ndiza	thanda
buka	gqoka
gula	hleka
jika	khipha
khala	phatha
sula	shesha
fihla	nuka
gona	ganga
veza	yeka
gwinya	hlupha

Appendix N1

ABR Information

Skin preparation

The skin at the electrode sites were prepared to ensure that the impedance was low enough for a good recording. The skin was scrubbed with abrasive gel at the place of electrode placement (Jassen, 2008).

Electrode placement and impedance (Hall, 2007)

Placement:

1. Four electrodes were used (one on the high forehead (Fz) one on the forehead (Fpz) and two for the earlobes (A1 &A2).
2. The non-inverting electrode was placed on the high forehead as close as possible to the hairline, in the midline. The electrode lead was away from the face.
3. The inverting electrode was placed on each earlobe area.
4. The four electrodes were properly placed to provide two differential recording channels: forehead to left earlobe and forehead to right earlobe.
5. The common electrode was placed on the forehead, ≥ 3 cm over from the non-inverting electrode (centre to centre). The electrode lead was away from the face.
6. Electrode wires were kept close together and if possible braided to decrease 60-Hz artefact.

Impedence (Jassen, 2008):

1. Impedence should be less than 3Kohms
2. Low impedence values should be symmetrical

Table 1

Testing parameters

	Click ABR
Stimulus parameters **Transducers** **Duration**	 ER-inserts/TDH headphones 0.1ms(100μs) click
Ramping window	Transient
Intensity **Maximum** **Minimum**	 90dB Minimum response rate
Polarity	Rarefaction
Rate	11.1 seconds

Acquisition parameters	
Filters	100-3000Hz
Time window	15ms
Sweeps	1500-2000

Source: Bachmann, & Hall, (1998).

Testing protocol

The following test protocol, as recommend by Bachmann & Hall (1998), was adhered to:

1. To review the audiological function based on the behavioral audiogram.
2. Click ABR protocol
    - Start with a click ABR at 80dBnHL for and verify the presence of waves I, III, and V.
    - Repeat to verify the response.
    - Do the same in the opposite ear.

Appendix N2

ABR Result interpretation

Response present (Bachmann & Hall, 1998):

Visual criteria:

- The response amplitude is at least 3 times the amplitude of the average difference (noise) of the waveform within the SNR region

Statistical criteria:

- The signal to noise ratio (SNR) of the overall average of the waveforms is greater than 1.0
- The waveforms within the SNR region must be greater than or equal to 0.46

Response absent:

Visual criteria:

- Waveform should appear visually quiet, with no apparent replicable waveform

Statistical criteria:

- Waveform should be below: 0.11 μV for single waveform, and 0.08 μV for combined.

Auditory brainstem response latency values for click ABR.

Table 1

Anticipated absolute and interpeak latencies values for click ABR

Intensity levels	**Absolute Latencies**	**Anticipated values for click ABR**
80dBnHL	**Wave I** **Wave III** **Wave V**	1.64ms 3.92ms 5.78ms
80dBnHL	**Interwave latencies**	**Anticipated values**
	I-III	2.28ms
	III-IV	1.86ms
	I-IV	4.13ms

Source: Bachmann, & Hall, (1998).

Classification of click ABR results (Matas et al., 2010):

- Lower Brainstem (LB) will be identified as normal absolute latency of wave I and interpeak III-V latency and increased latencies of waves III and V and interpeak I-III and I-V.
- Higher Brainstem (HB) will be identified as normal absolute latencies of waves I and III and interpeak latency IIII and increased latency of wave V and interpeak III-V and I.

Stanyer ELECTROSERVE
SALES, SERVICE & REPAIRS OF AUDIOMETRICS & MEDICAL INSTRUMENTATION
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P. O. Box 273, Gillitts, 3603
No. 2 Gilro Park
34 Gillitts Road
Pinetown, 3610

Certification of Standard Calibration (RION)

Name of Company: KING EDWARD	Certificate Number: P13501201
Area: DURBAN, KZN	Model: ITERA II
Make: OTOMETRICS | MADSEN	Serial number: 455200

Left ear	Right ear	Pre. cal.	Post cal.
C610415	C617982	114,0	114,0

		Air/Pure tone			N.B. Noise			Bone con.		Free/Warble			Free/N/B		
Freq. Hz	Freq. Meas.	Left	SABS 70dB	Right	Left	SABS 70dB	Right	SABS 40dB	M.V	FF1	SABS 70dB	FF2	FF1	SABS 70dB	FF2
125	124,1	114,5	115	115,3	118,4	118	117,7			90,6	90	90,7	90,0	90	90,7
250	249,1	97,0	97	96,0	100,9	100	99,8	101.5	101,3	81,5	81	81,0	80,9	80.5	81,2
500	499,9	83,9	83.5	83,9	86,9	86.5	86,5	87.5	87,8	76,3	76	76,0	74,1	74.5	74,7
750	749,9	79,0	79	79,7	82,1	82	82,7	80.5	81,0	74,5	74.5	75,0	71,8	71.5	71,2
1 K	999,8	78,0	77.5	78,0	81,0	80.5	82,0	76.0	76,3	74,5	.74	74,0	72,0	71	70,9
1K5	1499	78,0	77.5	77,8	81,8	80.5	81,1	68.5	68,6	72,7	72.5	72,7	72,5	72.5	73,5
2 K	1998	74,0	79	89,5	82,9	82	82,8	58.5	58,8	71,5	71	70,6	72,5	72.5	72,2
3 K	2998	81,0	81.5	81,0	84,0	84.5	85,0	59.0	59,1	66,5	66.5	67,0	68,9	68	68,0
4 K	3998	83,0	82	82,6	84,9	85	85,0	59.5	59,3	66,3	66	66,1	67,1	67	67,9
6 K	5998	86,0	86	86,2	90,0	89.5	90,0	72.0	72,0	76,4	76.5	76,7	73,5	73.5	73,2
8 K	7998	85,3	85.5	85,3	89,7	89.5	89,4	73.0	73,5	85,3	85	84,9	81,5	81.5	81,8

LIN	95	90	85	80	75	70	65	60	55	50	45	40	35	30
4000H	107,5	102,5	97,6	92,6	87,6	82,6	77,6	72,6	67,6	62,6	57,6	52,6	47,5	42,5

Booth Levels

Frequency	8 K	4 K	2 K	1 K	500	250	125
Screen	35.5	37.0	31.0	24.0	22.0	38.5	52.0
Diagnostic	35.5	37.0	31.0	24.0	20.5	21.0	29.0
Levels	13,0	12,3	10,3	9,7	9,8	14,5	22,0

Booth Type: 1AC

Screening (N) (ATT+25Db		ATT LIN (1K TAPE+F	
Left	Right	Left	Right
95,3	96,0		

Date of Calibration 12/12/2013 (dd/mm/yyyy)

Due Date 11/12/2014 (dd/mm/yyyy)

Calibrated by: Mr. G.D. Stanyer / Mr. P.T. Stanyer

Signature: Stanyer

Member: Mr. G.D. Stanyer

Appendix O2

HASS GROUP

Ear Institute, 1240 Webb Str. Queenswood Pretoria. Tel: (012) 333-3131 Fax: (012) 333-2298

H.A.S.S. Industrial (Pty) Ltd

Certificate of Calibration
No. L GS0050513/13

Calibrated for:	**King Edward Hospital** Speech & Hearing Department, New Block C/o Francois & Umbilo Road Dalbridge Durban 4014
Calibration of:	**GSI Tympstar V2**
Manufacturer:	GSI
Serial Number:	GS0050513
Calibration procedure:	Complete probe, reflex and pressure calibration as described in the manufacturer's specification.
Traceability:	The calibration was performed using instruments traceable to national standards.
Date of Calibration:	**2013-12-10** **Cal. Due Date:** **2014-12-10**
Results:	The instrument complies with the requirements for use as specified by the manufacturer.
Remarks:	None.
Calibrated by:	Heinrich Kruse _____ Signature

NOTE: The values in this certificate are correct at the time of calibration. Subsequently the accuracy will depend on such factors as the care exercised in the handling and use of the instrument and the frequency of use. Re-calibration should be performed annually to ensure that the instrument's accuracy remains within the desired limits.

Appendix P

INFECTION CONTROL

- Patient contact:
    - Appropriately-fitting gloves, either latex or non-latex, were worn during all procedures. New gloves were used for each patient during otoscopic examination, immittance, and OAE probe insertion. The hospital was provided with gloves as part of the consumables for the department.
    - Protective apparel such as a white coat was worn at all times during audiological test procedures. Masks were used when the researcher was in contact with patients suspected of TB or any upper respiratory tract infection.
    - Hand hygiene strategies such as the use of medical grade liquid antibacterial soap was used after contact with each patient. Hand washing techniques was followed.

- Environmental hygiene
    - Contact surface cleaning. Touch surfaces could include tables, armrests of chairs, service areas, workbenches, or counter tops. Splash surfaces are areas that could be hit with blood, bodily fluids, or secretions from a patient. These were done using anti-micro bacterial alcohol based sanitizer such as habitane provided by the hospital.
    - Non-critical instruments are those instruments that either do not ordinarily touch the patient or touch on the externally intact skin. All instruments used with multiple patients was sterilized. Instruments such as head phones were sterilised using alcohol swabs to wipe them prior and after testing each patient. Otoscope specula, nubs for OAE probes and immittance probes were soaked in hebitane and antibacterial soap after use. Then the items were rinsed in water and dried with a disposable towel and stored in containers.

Appendix Q

University of KwaZulu-Natal

HPCSA CPD Accreditation No:
A003/005/10/2005
Category 4
No. of CPD Points = 10

HEREBY ACKNOWLEDGES THAT

Mrs Vuyelwa Peter

MPSTA0027197

HAS COMPLETED A COURSE IN

Human Subject Research Ethics

Completed On	Valid Until
18 - 5 - 2012	5 - 2015

THE FOLLOWING MODULES WERE COMPLETED IN THIS COURSE

Research Ethics in South Africa - An Overview
Guiding Principles of Ethical Research
Informed Consent
Research Vulnerabilities
Researcher Responsibilities

									Immittance audiometry								Pure tone		Speech		Electrophysiological			
	Biographical		Immunological status						otoscopic		Tymps		Ipsi		contra		pure tone		speech		OAE		ABR	
	AGE	Gender	CD4 cell absolute	CD4 Cat	CD4 cell %	Viral load	Viral load cat	ART Regimen	RE	LE	RE	LE	RE	LE	RE	LE	RE	LE	RE	LE	RE	LE	RE	LE
p1	7	m	943	1	43%	40	1	2	N	N	C	B	AB	NR	AB	NR	MILCHL	MILCHL	P	P	CNT	CNT	AB	AB (HB)
p2	9	m	982	1	19.7	39576	1	2	AB	N	C	C	NR	NR	NR	NR	MILCHL	MILCHL	G	G	CNT	CNT	AB(LB)	AB
p3	11	f	1577	1	38.5	LTD	3	1	N	N	C	A	AB	N	AB	AB	MILSNHL	MILMIXH	G	G	R	P	N	N
p4	6	m	19	3	0.66	151849	2	1	N	N	A	A	N	N	N	N	N	N	G	G	P	R	N	N
p5	6	m	2237	1	25.7	LTD	3	2	AB	AB	B	CNT	NR	CNT	CNT	CNT	MILCHL	MILCHL	G	G	CNT	CNT	AB(CHL)	AB
p6	8	f	1010	1	30.8	<40	3	2	AB	AB	B	B	AB	AB	AB	AB	MILSNHL	MILMIXH	F	G	CNT	CNT	AB	AB(LB)
p7	11	m	1125	1	35.2		3	1	N	N	A	A	N	N	N	N	N	N	G	G	P	P	N	N
p8	11	m	1129	1	30.7	250	2	2	AB	AB	CNT	CNT	CNT	CNT	CNT	CNT	MODCHL	MODCHL	F	G	CNT	CNT	AB(HB)	AB
p9	10	m	723	1	24.2	2392	2	2	AB	AB	CNT	CNT	CNT	CNT	CNT	CNT	MILCHL	MODCHL	G	G	CNT	CNT	AB	AB
P10	9	m	872	1	25.2	LTD	3	2	AB	AB	AD	CNT	N	AB	AB	AB	N	MILCHL	G	G	P	CNT	N	N
p11	7	f	1231	1	27.7	LTD	3	2	N	AB	A	A	N	N	N	N	N	N	G	G	P	P	AB(LB)	N
p12	11	m	1718	1	33.8	LTD	3	1	AB	AB	A	A	N	N	N	N	CNT	CNT	CNT	CNT	CNT	CNT	N	AB(LB)
p13	12	f	5312	1	29	LTD	3	2	AB	AB	A	A	N	N	N	N	N	N	G	G	P	P	N	AB(LB)
p14	8	m	382	2	8.7	22416	1	1	N	N	A	C	N	N	AB	AB	MILSNHL	N	G	G	P	CNT	AB(HB)	AB
p15	9	m	1432	1	31.7	LTD	3	2	N	N	A	A	N	N	N	N	N	N	G	G	P	P	AB	N
p16	8	f	1102	1	21.4		2	1	N	AB	C	B	NR	AB	AB	NR	CNT	CNT	CNT	CNT	CNT	CNT	AB(HB)	AB
p17	7	m	120	3	1	980	2	2	AB	AB	CNT	CNT	CNT	CNT	CNT	CNT	MILCHL	MILCHL	G	G	CNT	CNT	AB(LB)	AB
p18	10	m						2	AB	AB	CNT	CNT	CNT	CNT	CNT	CNT	DD-SEVC	EVMIXH	G	G	CNT	CNT	N	AB
p19	6	m	1010	1	29.9			1	AB	AB	C	C	AB	AB	AB	AB	MILCHL	MODCHL	G	G	CNT	CNT	N	AB(LB)
p20	9	m	595	1	32.6	LTD	3	1	AB	AB	A	A	N	N	N	N	MILSNHL	N	G	G	P	R	N	N
p21	7	f	702	1	26.6	LTD	3	2	N	N	A	A	N	N	N	N	N	N	G	G	P	P	N	N
p22	9	f	948	1	39.7			2	N	AB	A	A	N	N	N	N	N	N	G	G	P	P	N	AB(HB)
p23	7	m	2094	1	30.3	2494	1	2	AB	AB	A	A	N	N	N	N	N	N	G	G	P	P	N	N
p24	10	m	894	1	26.7	LTD	1	2	AB	AB	A	A	NR	N	NR	N	N	N	G	G	R	R	N	N
p25	12	m						2	N	N	A	A	N	N	NR	NR	N	N	G	G	R	R	N	N
p26	12	f	193	1	17	6882	1	2	AB	AB	A	A	N	N	NR	NR	MILSNHL	MILSNHL	P	P	P	P	N	N
p27	9	f	1046	1	40.5	LTD	3	2	N	N	A	A	N	N	N	N	MILSNHL	MILSNHL	P	P	P	P	N	N
p28	9	f	1699	1	31.5	LTD	3	2	AB	AB	CNT	A	CNT	NR	CNT	NR	MILMXHL	N	G	G	CNT	R	AB	N
p29	9	f	1766	1	46.1	LTD	3	2	AB	AB	A	A	N	N	N	N	N	N	G	G	P	P	AB	AB
p30	10	f	1577	1	44.8	LTD	3	1	n	N	A	A	N	N	NR	NR	N	N	G	G	P	P	N	AB(HB)

Note: N=Normal, AB=Abnormal, NR= No response, CNT= Could not test, G=Good, R= Refer, AB(HB)=Abnormal higher brainstem, AB(LB)=Abnormal lower brainstem
MOD=Moderate, SEV=Severe, CHL=Conductive hearing loss,MILD=Mild, Sensorineural hearing loss, MIXHL=Mixed hearing loss,

Appendix S

Table 1

Correlation between viral categories and hearing loss degree

		Viral categories	**right PTA degree of hearing**	**left PTA degree of hearing**
Viral load categories	Pearson's correlation	1	.079	-.127
	Sig. (2-tailed)		700	.536
	N	28	26	26
Right PTA degree of hearing	Pearson's correlation	.079	1	.827
	Sig. (2-tailed)		700	.536
	N	26	28	28
Left PTA degree of hearing	Pearson's correlation	-.127	.827	1
	Sig. (2-tailed)	.536	.000	
	N	26	28	28

Correlation is significant at the 0.01 level (2-tailed).

Table 2.

Correlation between CD4 cell categories and hearing loss degree

		Right PTA degree of hearing	**Left PTA degree of hearing**	**CD4 cell categories**
Right PTA degree of hearing loss	Pearson's correlation	1	.827	-.175
	Sig. (2-tailed)		.000	.392
	N	28	28	26
Left PTA degree of hearing loss	Pearson's correlation	.827	1	.100
	Sig. (2-tailed)	.000		.626
	N	28	28	26
CD4 cell categories	Pearson's correlation	-.175	.100	1
	Sig. (2-tailed)	.392	.626	
	N	26	26	28

Correlation is significant at the 0.01 level (2-tailed).

Table 3.

Correlation between viral load categories and hearing loss type

		Viral load categories	**Right hearing loss type**	**Left hearing loss type**
Viral load categories	Pearson's correlation	1	.044	-.212
	Sig. (2-tailed)		.831	.299
	N	28	26	26
Right hearing loss type	Pearson's correlation	.044	1	.706
	Sig. (2-tailed)	831		.000
	N	26	28	28
Left hearing loss type	Pearson's correlation	-.212	.706	1
	Sig. (2-tailed)	.299	.000	
	N	26	28	28

Table 4.

Correlation between CD4 cell categories and hearing loss degree

		Right PTA degree of hearing	**Left PTA degree of hearing**	**Viral load categories**
Right PTA degree of hearing loss	Pearson's correlation	1	.827	-.175
	Sig. (2-tailed)		.000	.392
	N	28	28	26
Left PTA degree of hearing loss	Pearson's correlation	.827	1	.100
	Sig. (2-tailed)	.000		.626
	N	28	28	26
Viral load categories	Pearson's correlation	-.175	.100	1
	Sig. (2-tailed)	.392	.626	
	N	26	26	28

Correlation is significant at the 0.01 level (2-tailed).

Table 5

Correlation between history of recurrent chest infections and middle ear pathology

		Recurrent chest infections	**Right tymp**	**Left tymp**
Recurrent chest infections	Pearson's correlation	1	-.144	-.157
	Sig. (2-tailed)		.550	.406
	N	30	30	30
Right tymp	Pearson's correlation	-.144	1	.748
	Sig. (2-tailed)	550		.000
	N	30	30	30
Left tymp	Pearson's correlation	-.157	.748	1
	Sig. (2-tailed)	.406	.000	
	N	30	30	30

Table 6

Cross tabulation between history of chest infections and right Tympanometric results

		Right Tympanometric type				
		Type A	**Type B**	**Type C**	**Could not test**	**Total**
History of chest infection	yes	2	1	3	1	7
	no	14	0	4	5	23
Total		**16**	**1**	**7**	**6**	**30**

Table 7.

Cross tabulation between history of chest infections and left Tympanometric results

		Left Tympanometric type				
		Type A	**Type B**	**Type C**	**Could not test**	**Total**
History of chest infection	yes	3	1	1	2	7
	no	15	4	0	4	23
Total		**18**	**5**	**7**	**6**	**30**