INFANT HEARING SCREENING AT MATERNAL AND CHILD HEALTH CLINICS IN A DEVELOPING SOUTH AFRICAN COMMUNITY

BY

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'...so that God may be all in all'

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LIST OF ABBREVIATIONS

AABR	-	Automated Auditory Brainstem Response
AAP	-	American Academy of Pediatrics
ABR	-	Auditory Brainstem Response
AIDS	-	Auto-immune Deficiency Syndrome
AN	-	Auditory Neuropathy
ANHSC	-	Australian National Hearing Screening Committee
ASHA	-	American Speech-Language-Hearing Association
daPa	-	Deca Pascal
DPOAE	-	Distortion Product Oto-Acoustic Emissions
EHDI	-	Early Hearing Detection and Intervention
ENHR	-	Essential National Health Research
HIV	-	Human Immune Virus
HL	-	Hearing Level
HPCSA	-	Health Professions Council of South Africa
HRR	-	High-Risk Register (for Hearing Loss)
HSPS	-	Hearing Screening Position Statement
IHS	-	Infant Hearing Screening
JCIH	-	Joint Committee on Infant Hearing
MEE	-	Middle-Ear Effusion
MCH	-	Maternal and Child Health
NHS	-	Newborn Hearing Screening
NICU	-	Neonatal Intensive Care Unit
NIDCD	-	National Institute for Deafness and Other Communication Disorders
NIH	-	National Institute of Health
OAE	-	Oto-Acoustic Emissions
TEOAE	-	Transient-Evoked Oto-Acoustic Emissions
TNHS	-	Targeted Newborn Hearing Screening
TPP	-	Tympanic Peak Pressure
UNHS	-	Universal Newborn Hearing Screening
UNICEF		United Nations Children's Fund
USPSTF		US Preventative Services Task Force
WHO		World Health Organisation

ABSTRACT

TITLE: Infant hearing screening at maternal and child health clinics in a developing South African community
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Newborn hearing screening has become an increasingly important element of neonatal care in developed countries whilst only a few fragmented screening programmes are evident in developing countries. The numerous socio-economic, cultural and healthcare barriers in developing contexts do not, however, negate or diminish the need to ensure optimal outcomes for infants with hearing loss through early identification and intervention programmes. South Africa has taken a first step toward addressing this need by publishing a Year 2002 Hearing Screening Position Statement that was produced by the Professional Board for Speech, Language and Hearing Professions of the Health Professions Council of South Africa. Interim recommendations are made toward universal newborn hearing screening programmes in three contexts: well-baby nurseries,; neonatal intensive care units (NICU) and Maternal and Child Health (MCH) clinics through their 6-week immunisation programmes. Although these clinics constitute an unfamiliar hearing screening context, they are essential platforms toward widespread screening of the majority of infants in South Africa. An urgent need therefore exists to ascertain the feasibility of hearing screening programmes at MCH 6-week immunisation clinics in order to guide the future implementation of widespread hearing screening services in South Africa.

To attend to this need, an exploratory descriptive design that jointly implements quantitative and qualitative methods in a dominant-less-dominant model of triangulation was utilised to critically describe a screening programme conducted at two MCH clinics in Hammanskraal (a developing, peri-urban South African community). The quantitative methods included a structured interview to compile

biographical and risk information; high frequency immittance measurements; hearing screening with OAE and AABR according to specified protocols, and diagnostic assessment of referred infants. The qualitative methods included field notes and critical reflections describing clinics as screening contexts and elucidating interactional processes involved in sustaining programmes. A total number of 510 infant-caregiver pairs were enrolled as subjects during the five-month research period.

Results indicate that clinics not only provide a suitable context, but also the possibility of effective collaborations toward facilitating effective initial infant hearing screening programmes. The caregivers and infants who attended the clinics demonstrated significant degrees of socio-economic deprivation. They also reported an increased incidence of risk indicators exacerbating the population's risk for congenital hearing loss, poor participation in the hearing screening/follow-up process, and subsequent poor involvement in a family-centred early intervention process for infants identified with hearing loss. The screening protocol effectively classified infants into risk categories for hearing loss and established useful norms for high frequency immittance in infants. The efficiency of the programme was acceptable considering the short period of implementation, but inefficient coverage with the AABR and poor follow-up return rates were obtained at the clinics.

Despite prevailing barriers, the MCH 6-week immunisation clinics showed promise as platforms for widespread hearing screening programmes for infants in South Africa. The clinical implications and recommendations that emerged from the research conducted in this study were compiled and presented in the form of a preliminary service delivery model for infant hearing screening at MCH clinics.

***Key words**: audiological services, developing countries, early hearing detection and intervention programmes, high frequency immittance, high-risk register, immunisation programmes, infant hearing, maternal and child health, newborn hearing screening, services delivery model, South Africa.*

OPSOMMING

TITEL:	Gehoorsifting van babas by moeder-kind-gesondheidsorgklinieke in ‘n ontwikkelende Suid-Afrikaanse gemeenskap
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Neonatale gehoorsifting het ‘n toenemend belangrike element van neonatale sorg in ontwikkelde lande geword terwyl daar in ontwikkelende lande slegs enkele gefragmenteerde siftingsprogramme bestaan. Die uitdagings op sosio-ekonomiese, kulturele en gesondheidsorggebied in ontwikkelende kontekste verminder egter nie die behoefte aan optimale uitkomste vir kinders met gehoorverlies deur middel van vroeë identifikasie- en intervensieprogramme nie. Die Professionele Raad vir die Spraak-, Taal- en Gehoorprofessies van die Suid-Afrikaanse Raad vir die Gesondheidsprofessies het ‘n eerste tree geneem om hierdie behoefte aan te spreek met ‘n Jaar 2002 Gehoorsiftingsverklaring. Interim aanbevelings is gemaak met die oog op universele neonatale gehoorsiftingsprogramme in drie kontekste: gesondebaba-eenhede; by ontslag uit neonatale intensiewesorgeenhede en deur die 6-week immuniseringsprogramme van moeder-kind-gesondheidsorgklinieke. Hoewel hierdie klinieke ‘n ongewone gehoorsiftingskonteks is, bied dit ‘n essensiële platvorm vir uitgebreide sifting van die meerderheid babas in Suid-Afrika. Daar bestaan dus ‘n dringende behoefte aan die bepaling van die toepaslikheid van gehoorsiftingsprogramme by moeder-kind-gesondheids- en immuniseringsklinieke om leiding te gee ten opsigte van die implementering van toekomstige uitgebreide gehoorsiftingsdienste in Suid-Afrika .

Ten einde hierdie behoefte aan te spreek, is ‘n eksploratiewe beskrywende ontwerp, wat beide kwantitatiewe en kwalitatiewe metodes in ‘n model van triangulasie implementeer, aangewend om ‘n kritiese beskouing van ‘n gehoorsiftingsprogram by twee moeder-kind-gesondheidsklinieke in Hammanskraal (‘n ontwikkelende,

buitestedelike Suid-Afrikaanse gemeenskap) te verskaf. Die volgende kwantitatiewe metodes is gebruik: ‘n gestruktureerde onderhoud om biografiese en risiko-inligting te versamel, hoë-frekwensie immittansiemetings, gehoorsifting met OAE en OBR volgens gespesifiseerde protokolle, en diagnostiese assessering van babas wat verwys is. Die kwalitatiewe metodes het veldnotas en kritiese refleksie aangaande die klinieke as siftingskonteks ingesluit, en ook lig gewerp op die interaktiewe prosesse vir die volhoubaarheid van programme. Altesaam 510 babaversorger-pare is tydens die vyf-maandelange navorsingsperiode as proefpersone ingeskryf.

Resultate dui daarop dat die klinieke nie slegs ‘n gepaste konteks daarstel nie, maar ook die moontlikheid bied van doeltreffende samewerking met die oog op die fasilitering van suksesvolle gehoorsiftingsprogramme. Die versorgers en babas wat die klinieke besoek het, het beduidende grade van sosio-ekonomiese agterstand vertoon. Daar was ook by hulle ‘n verhoogde voorkoms van risikofaktore wat die bevolking se kanse vergroot om aan kongenitale gehoorverlies te ly en om onvoldoende in te skakel by die gehoorsiftings- en opvolgproses, asook by ‘n gesinsgesentreerde vroeë-intervensieproses vir babas met gehoorverlies. Die siftingsprotokol was effektief om babas in risikokategorieë vir gehoorverlies te verdeel en het bruikbare norme vir hoë-frekwensie immittansiemetings in babas verskaf. Die doeltreffendheid van die program was aanvaarbaar, gesien dat dit nog maar vir ‘n baie kort tydperk geïmplementeer is. Die OBR se bruikbaarheid en die swak terugkeersyfer vir opvolgevaluasies was egter oneffektief.

Ten spyte van voortdurende uitdagings hou die moeder-kind gesondheidsorg- en immuniseringsklinieke heelwat belofte in as platvorms vir uitgebreide gehoorsfitingsprogramme van babas in Suid-Afrika. Die kliniese implikasies en aanbevelings wat uit die navorsing in die huidige studie voortspruit, is saamgestel en aangebied in die formaat van ‘n voorlopige diensleweringsmodel vir gehoorsifting van babas by moeder-kind gesondheidsorgklinieke.

***Sleutelwoorde**: oudiologiese dienste, ontwikkelende lande, vroeë gehooridentifiserings- en intervensieprogramme, hoë-frekwensie immittansie, hoë-risiko register, immuniseringsprogramme, gehoor by babas, moeder-kind gesondheid, neonatale gehoorsifting, diensleweringsmodel, Suid-Afrika.*

CHAPTER 1

INTRODUCTION AND ORIENTATION

Aim: To introduce the problem addressed by this study, to provide the rationale thereof, to describe the terminology used, and to present an overview of the content and organisation of the study

"Blindness separates people from things, deafness separates people from people"

Immanuel Kant (German philosopher)
Translated by Helen Keller (Keller, 1910)

1.1. INTRODUCTION

Audiology is a dynamic profession, characterised by continued and rapid growth, in which traditional practices are constantly reviewed in a quest to improve efficacy and accountability. Screening for hearing loss, however, is not a new development in the field of audiology; in fact, it is as old as the profession itself (Northern & Downs, 2002:259). The relatively invisible nature of hearing loss and an innate desire among audiologists to intervene as early as possible has provided the impetus for implementing hearing screening programmes to identify children for further testing for at least the past 60 years (Northern & Downs, 2002:259). Mass hearing screening of school children in the United States of America was already implemented on a large scale in 1927 (Downs, 2000:286). This process of identifying the section of the population at highest risk for hearing loss is an inherent component of audiological practice and serves as the first step toward providing effective audiological services to the paediatric population.

The screening of children and infants for hearing loss is a steadily evolving process that has accelerated exponentially over the last 10 years (Gravel et al., 2000:131). Until recently the average age at which a child with a moderate to profound sensori-neural hearing loss was identified in the United States has remained at 30 months (Harrison & Roush, 1996:60; JCIH, 2000:10). This seems to be also true of other countries. For example, Bamford and Davis (1998:1) report that 24% of children with congenital permanent hearing loss in the UK are not identified before they have turned 3½ years old. Even though a number of different methods of detecting hearing loss were tried out earlier, it was only during the early 1990s that significant progress was made in reducing the average age at which significant hearing loss is identified (Mauk & White, 1995:6). Children with milder hearing loss were frequently identified only at 3 to 4 years of age, whilst those with a unilateral or high frequency hearing loss were identified even later, by age 5 to 6 (Elssmann, Matkin & Sabo, 1987:15). This was primarily due to a lack of systematic screening programmes and the limitations of subjective behavioural screening methods. Fortunately the emergence of more accurate and rapid means of screening for hearing loss has resulted in a new population with very unique needs that have to be met by the audiologist: – the neonate and the infant with a hearing loss (Parving, 2003:154).

The quiet birth of paediatric audiology in the 1940s and its slow but steady growth over the last five decades has therefore culminated in the reality of delivering services to the youngest and most vulnerable population, making preventative audiology a viable endeavour in current times (Northern & Downs, 2002:v). Early detection and intervention for hearing-impaired infants has become an increasingly important aspect of neonatal care and has expanded the audiological scope of practice significantly as a form of secondary prevention (Diefendorf, 1999:43; Parving, 2003:154). This change has produced a multitude of new challenges in the delivery of effective and accountable services to newborns and young infants. It has also resulted in large-scale research initiatives to address the rising tide of questions regarding the improvement of methodologies for identification of and intervention for hearing loss (Mason et al.,

1997:91-102; Lutman et al., 1997:265-276; Davis et al., 1997:1-177; Vohr et al., 1998:353-357; Arehart et al., 1998:101-114; Prieve & Stevens, 2000:85-91; Spivak et al., 2000:92-103; Prieve et al., 2000:104-117; Dalzell et al., 2000:118-130; Gravel et al., 2000:131-140; Finitzo et al., 1998:1452-1460; Folsom et al., 2000:462-470; and Martineau et al., 2001:276).

Most of this research was conducted in developed countries such as the USA and the UK (Mencher & DeVoe, 2001:19). In the developing countries of the world throughout Asia, South America and Africa, where an estimated two-thirds of the world's population with hearing loss reside (WHO, 2001a:1), the problems of hearing loss are often even more pronounced because of additional barriers such as low socio-economic levels, paucity of accessible healthcare, inadequate resources, ignorance and the absence of regular screening programmes for ear disease (McPherson & Swart, 1997:2; Jacob et al., 1997:134; Olusanya, 2000:167; Gell et al., 1992:646). In addressing the obstacles posed to audiological service delivery for newborns and young infants in developing countries, use must be made of the large knowledge base of international research efforts to initiate and guide context-specific, locally relevant, innovative research endeavours.

The global challenge to improve the health status of *all* people must reach those communities in developing contexts that most often experience the direst need for services (Kritzinger, 2000:6; WHO, 1981). In contrast, the Western world will soon see most newborns enrolled in hearing screening programmes. According to Downs (2000:293), developed countries should now extend their expertise to developing countries so that – to paraphrase the declaration by the Milan Newborn Hearing Systems Conference of 2000 – *all new citizens of the world will have a greater opportunity and better quality of life into the next millennium.* It was this visionary goal to provide a better future for children with hearing loss that led to the development and implementation of universal newborn hearing screening (UNHS) programmes in the developed countries. It is this same purpose and vision that must now spill over into the developing world, driven and

guided by the wealth of knowledge from existing early hearing detection and intervention (EHDI) programmes.

1.2. DEVELOPMENT OF INFANT HEARING SCREENING

UNHS programmes are now mandated in 39 of the 50 states of the USA and other states have legislation pending (Rabbitt-Park, 2003:1). Europe produced a consensus statement on neonatal hearing screening in 1999, listing ten consensus points (Lutman & Grandori, 1999:95-96). This statement proposed UNHS as the least expensive and most efficient programme when used in parallel with 7 to 9 month behavioural testing. More recently, in 2000, Britain's Minister of Health announced the introduction of UNHS in 20 initial pilot programme sites throughout the United Kingdom (Russ, 2001:525). The implementation of these programmes has only become possible during the last decade due to the considerable progress with and development of screening methods for the detection of hearing loss during infancy (Mauk & White, 1995:11; Lutman, 2000:371-373).

Recommended screening protocols reveal the growth in new technologies that are applied in an effort to improve the practicality, validity and cost efficiency of early identification programmes for infants with hearing loss (White et al., 1995:10-11). Behavioural observation hearing screening tests were conducted initially for babies at risk for hearing loss as specified by a High-Risk Register (HRR) developed and compiled by Downs and Sterrit (1964:69) and Downs and Hemenway (1969:72). The HRR approach was an attempt to focus attention on those infants most likely to have significant hearing loss, rather than to screen every baby. The at-risk infants were thus screened by means of behavioural observation procedures. This type of observation audiometry for the high-risk population did not prove reliable in detecting hearing loss in infants, primarily due to inattention or erratic responses to sound being characteristic of newborns and young infants (Arehart et al., 1998:102; Kile, 1993:156). All behavioural observation screening tests were characterised by the same limitations, namely

that only severe-to-profound losses were identified (Downs, 2000:289). Although the Joint Committee on Infant Hearing (JCIH) in 1982 stated that neonates could be screened by observing a behavioural *or* electrophysiological response to sound (JCIH, 1982:1018), electrophysiological techniques such as oto-acoustic emissions (OAE) and automated auditory brainstem response (AABR) only began replacing behavioural techniques in the early 1990s when these technologies became more readily available (Downs, 2000:202).

The development and implementation of electrophysiological screening techniques resulted in UNHS becoming a feasible reality and the JCIH released a new position statement in 1994. This statement endorsed the universal detection of infants with hearing loss as early as possible, with identification not later than 3 months, and intervention not later than 6 months of age (JCIH, 1994:6). Based on the findings from working groups that recommend acceptable protocols for use in state-wide UNHS programmes, the characterisation of auditory performance and intervention strategies following neonatal screening, and the empirical evidence to date, the JCIH considers that accepted public health criteria have been met to justify the implementation of UNHS (JCIH, 2000:10).

The implementation of these screening programmes, however, encompasses a much more comprehensive approach than the hearing screening itself. It must be an integrated system (White, Behrens & Strickland, 1995:12), referred to as EHDI programmes (JCIH, 2000:10), that provides a seamless transition for infants and their families through the process of screening, diagnosis of hearing loss, medical diagnosis of hearing loss and related disorders, and intervention (JCIH, 2000:10). Screening constitutes only a single, though very important, component of an EHDI programme. The basic model of service delivery in early intervention comprises four basic components (Fair & Louw, 1999:15), which include an early identification and screening programme; an in-depth assessment and evaluation strategy; the design, planning, direct delivery and monitoring of treatment programmes; and case management and administration.

Figure 1.1 illustrates these components as a series of phases according to the population size that accompanies each phase.

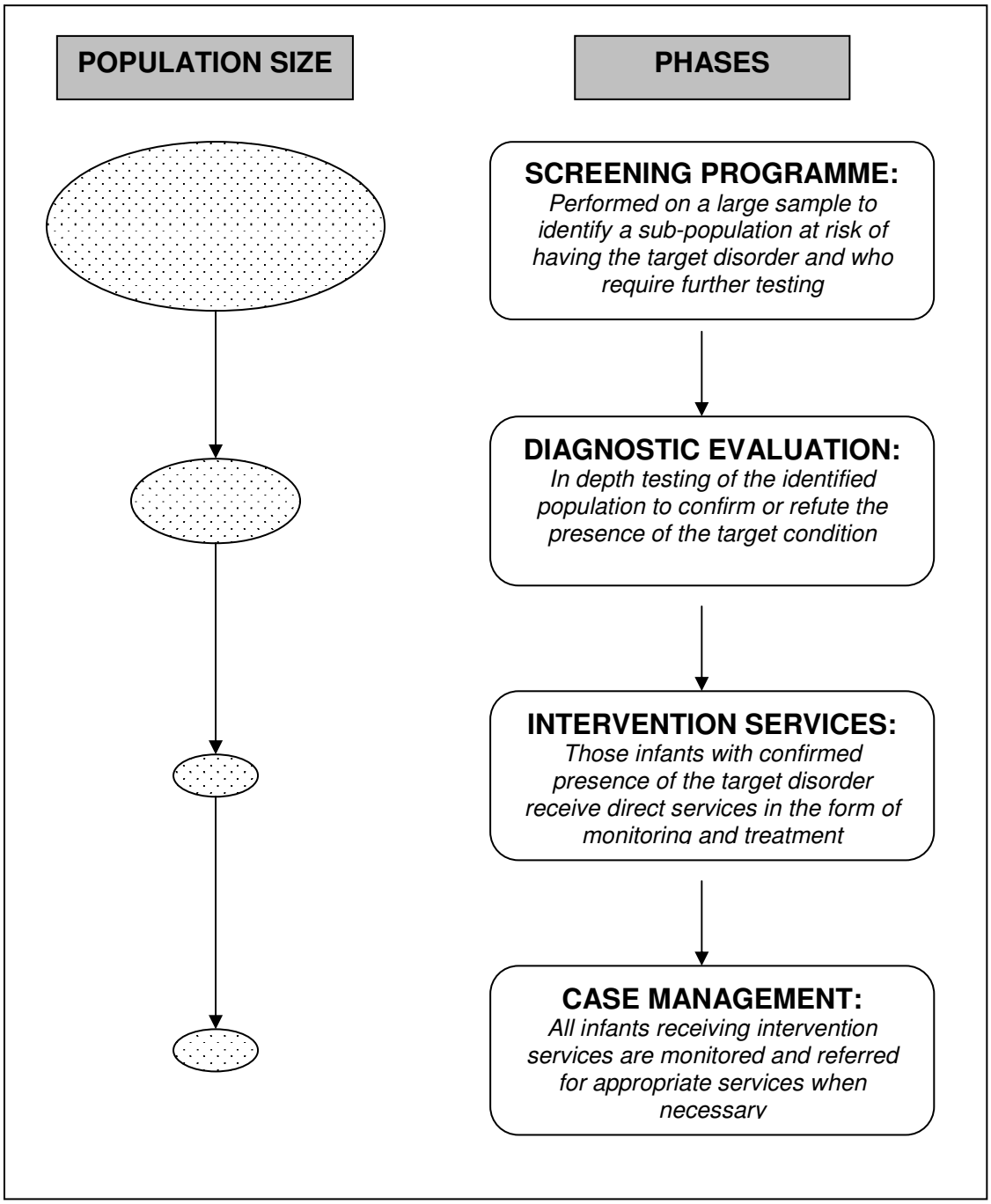


FIGURE 1.1 Phases in the Early Hearing Detection and Intervention (EHDI) process

The above process of early intervention commences with the screening of a target population, which provides a foundation on which the other components must build. Hearing screening is a filtering process that serves to divide a population into two groups. The one group has a sufficiently high probability of presenting with a hearing loss and warrants referral for diagnostic testing. The second group has a low probability of presenting with hearing loss and consequently does not merit the expense, inconvenience or risk of diagnostic testing (Lutman, 2000:367).

Public health programmes pertaining to infant hearing aim to optimise the provision of treatment for infants with hearing loss as well as for their families (Lutman, 2000:367). However, to sustain such a process of screening within a comprehensive EHDI system requires a consistent and substantial amount of funding to meet the multiple needs of a programme (White et al., 1995:12). The question that beckons is whether the expenditure of resources is justified by the outcome and benefit of EHDI programmes for the individual and society.

1.3. IMPORTANCE OF EARLY DETECTION OF AND INTERVENTION FOR HEARING LOSS

Newborn hearing screening (NHS) programmes have been established throughout the United States of America and are being implemented in many countries worldwide (Yoshinaga-Itano, 2002:61). The expenditure of financial, technological and human resources involved in the implementation of widespread infant hearing screening programmes such as UNHS can be justified by three basic facts emerging from a wealth of research (White, 2002:1). Firstly, hearing loss occurs more frequently than any other birth defect. Secondly, undetected hearing loss has serious negative consequences for the infant involved, and thirdly, there are dramatic benefits associated with the early identification of hearing loss. The importance of these facts is elucidated in the following paragraphs.

Hearing loss occurs more frequently than any other birth defect, with a prevalence of newborn and infant hearing loss estimated at 1.5 to 6.0 per 1 000 live births (Northern & Downs, 2002:267). Mehl and Thomson (1998:3) compare the incidence of bilateral hearing loss in newborn infants in Colorado with other existing screening programmes in the United States. Their findings indicate that the incidence of phenylketonuria, combined immunodeficiency disease, maple syrup urine disease, neonatal hyperthyroidism, cystic fibrosis and hemoglobinopathy varies between 0.3 and 50 in 100 000 live births, compared to bilateral sensori-neural hearing loss which occurs in 260 of 100 000 live births. Hearing screening does not only yield the highest returns among these diseases, but is also more responsive to intervention once the problem has been identified (Northern & Downs, 2002:267). If unilateral and conductive losses had been included, the prevalence of hearing loss would have risen even more significantly. Furthermore, not all hearing losses in children manifest at birth, and hearing loss due to progressive types of impairments and as a result of postnatal diseases such as meningitis account for further hearing losses among infants and young children (Fortnum et al., 2001:1). Another type of hearing loss involves conductive hearing losses of varying degrees caused by otitis media. The latter constitutes the most common childhood disease, with 75% to 95% of children presenting with at least one episode before they reach school age (Klein, 1994:133; Curotta, 1997:27) and most common during the first two years of life (Northern & Downs, 2002:65). The occurrence of hearing loss, therefore, is frequent enough to warrant mass screening.

Apart from the high incidence of hearing loss among infants as compared to other birth defects and diseases, **undetected hearing loss has serious negative consequences**. Hearing loss holds substantial morbidity for the individual, both economically and socially, for the family, and for society in its productivity and socialisation (Mauk & White, 1995:6; Carney & Moeller, 1998:64; Diefendorf, 1999:45). Delays in diagnosis and intervention of hearing loss in infants may result in children failing to keep up pace with their normal hearing peers in language, cognition and social-emotional development. It may ultimately even lead to fewer employment opportunities in adulthood (Gallaudet University

Center for Assessment and Demographic Study, 1998:75). According to Diefendorf (1999:45), failure to detect hearing loss at an early stage has a negative impact on the cognitive, communicative, academic, social and literate development of a child. The negative consequences of late identification do not only have an impact on social-personal development, but also places an economic burden on families and ultimately on the government. In the United States the average deaf person's income after high school is reported to be 30% lower than the average hearing person's, and the combined expense of deaf education and loss of productivity results in an average lifetime cost of more than $1 million per severe to profoundly deaf individual (Mohr, Feldman & Dunbar, 2000:1).

Early identification of hearing loss can significantly reduce the negative consequences of hearing loss for the individual, the family and society (Bamford & Davis, 1998:1; Yoshinaga-Itano, Coulter & Thomson, 2001:527; Diefendorf, 1999:45). **The dramatic benefits of early detection and intervention for infants with hearing loss** have been demonstrated convincingly. Numerous research studies clearly indicate that infants who are identified with hearing loss soon after birth have an important and measurable advantage over later identified peers (Yoshinaga-Itano, 1995:118; Yoshinaga-Itano & Apuzzo, 1995:124; Yoshinaga-Itano et al., 1998:1170; Carney & Moeller, 1998:67 Moeller, 2000:8). Language is the key to communication and the acquisition and production of language are perhaps the most important achievements in any child's development (Northern & Downs, 2002:127). This becomes even more relevant in the case of a child with a hearing loss. According to Yoshinaga-Itano et al., (1995:118) the language abilities of hearing-impaired children, identified before 6 months of age, are significantly improved compared to children identified after 6 months of age. Infants identified early with a hearing loss have the opportunity to develop language and maintain language skills within the normal range of development commensurate with their cognitive development during early childhood, whilst late-identified children indicate persistent 2 to 4-year delays in language development (Yoshinaga-Itano, 2000:311; Yoshinaga-Itano, 1995:118).

The high incidence of hearing loss and its devastating effects, if left undetected, weigh heavily in light of the proven advantages that early detection holds for the individual and the community. This has provided the impetus for changing legislation in the USA (and elsewhere in the world, for example in the UK (Russ, 2001:525)) to allow for the implementation of UNHS as part of a comprehensive EHDI programme. Unfortunately the momentum for implementing such widespread EHDI programmes has not carried over to the developing world. Although governmental and non-governmental agencies throughout developing countries have begun to initiate programmes to prevent childhood hearing loss or to offer rehabilitation (McPherson & Swart, 1997:3), little and slow progress toward addressing hearing loss has been reported in Third World countries (Olusanya, 2000:167; Newton et al., 2001:230; Rao et al., 2002:105). Prevalence and epidemiological data on hearing loss is scarce and a comparison of available studies is difficult due to significant variations in methodologies (Bastos et al., 1995:2; Gopal et al., 2001:100).

In general, non-life-threatening diseases such as hearing loss and deafness are neglected in terms of institutional support, research funding and political advocacy (Olusanya, 2000:167). This is despite an ethical obligation of society to provide early intervention for young children with disabilities and those at risk for developmental delays (Kritzinger, 2000:4). South Africa faces these difficult realities as it endeavours to comply with one of the basic responsibilities of the audiologist: that of implementing widespread screening of infant hearing.

1.4. INFANT HEARING SCREENING IN SOUTH AFRICA: A NEW DIRECTION

The last decade has witnessed large-scale changes in the South African socio-political arena. These developments have not only been political but have also brought about changes in national health, education and welfare policy (Kritzinger, 2000:86). An ongoing paradigm shift in the profession of speech-

language therapy and audiology in South Africa has mirrored these political changes in order to address an imbalanced service delivery, redress teaching programmes and focus its research endeavours on the specific needs of the context (Hugo, 1998:5; Uys & Hugo, 1997:24). The shift has not only reflected the national changes in South Africa, but has also been stimulated by international trends and developments in healthcare, education for learners with special needs, and views on people with disability (Dennill, King & Swanepoel, 1999:2; Kritzinger, 2000:85).

The use of traditional institution-based models of service delivery in the field of speech-language therapy and audiology has proved ineffective in reaching the majority of vulnerable and disadvantaged communities of South Africa (Moodley, 1999:4). As a result, there is a trend to transform towards a community-based service delivery model for speech-language pathology and audiological services to meet the unique needs of the broader South African community (Uys & Hugo, 1997:27). This type of model fits the South African government's current policy for a comprehensive, equitable and integrated National Health System (Department of Health, 1997:5). The restructured National Health System mandates transition in service delivery from institution-based services to community-based services to provide for the health needs of the whole South African population (*White Paper on an Integrated National Disability Strategy*, 1997:22&26).

Currently, however, screening programmes for infants in general, as well as in the particular case of hearing, are not a common practice in South Africa and are not meeting the needs of the South African population (Swanepoel et al., 2004:634). To date, very little contextual, community-based research has been reported for infant hearing screening (McPherson & Swart, 1997:18-19; Swanepoel et al., 2004:634). In 1995, the Departments of Otolaryngology, Logopedics and Paediatrics at the University of Cape Town, South Africa, produced a consensus statement regarding the practicality of implementing hearing screening programmes similar to those in the USA (Prescott, 1995:7-8). At that time it was agreed that UNHS programmes would not be economically

feasible in South Africa because of the then relatively high number of false-positive results, which would lead to extensive numbers of diagnostic assessments. Three main recommendations were however made, namely to disseminate information to caregivers regarding developmental milestones; to train medical personnel regarding the implications of hearing loss; and to perform hearing screening at immunisation clinics using trained health workers (Prescott, 1995:8).

A survey conducted into neonatal hearing screening performed in six state-subsidised hospitals in 1997 revealed that there was an absence of standard procedures for performing screening; personnel were not sufficiently utilised; there was a lack of training programmes for personnel; few efforts were made to adapt screening procedures for better sensitivity; no control of follow-up cases occurred; and very little networking existed between audiologists and nurses (Höll, 1997:51). The survey indicated that 86% of responding hospitals used behavioural screening techniques, though in an inconsistent manner and with inadequate follow-up infrastructure (Höll, 1997:51).

Despite these hindrances, the necessity of developing and implementing screening programmes in developing contexts remains a very important objective (Prasansuk, 2000:211). The fact that the majority of children with hearing loss live in developing countries emphasises the necessity for effective and accountable screening programmes in these contexts (WHO, 1997:5). This is particularly true of South Africa, a country characterised by pockets of developed areas but where the majority of the population live in poverty in urban, peri-urban and rural areas (Fair & Louw, 1999:14). Although epidemiological data for developmental risk conditions in South Africa is incomplete and difficult to obtain, it is clear that there is an increased prevalence of risk conditions for infants and young children in developing communities (Kritzinger, 2000:13; McPherson & Swart, 1997:18-19). It is a growing concern, therefore, that relatively few infants with hearing loss are being detected early (Swanepoel et al., 2004:634).

In an effort to transform the South African health system and to promote health and development by preventing disease and disability, the South African government proposed a preventative approach in the *White Paper for the Transformation of the Health System in South Africa* (Department of Health, 1997:5-6). This prevention also includes preventing secondary complications, such as developmental delays in language for infants and children with hearing loss. In addition, this paper emphasises the need for Essential National Health Research (ENHR). The *White Paper on an Integrated National Disability Strategy* (1997:22&26) furthermore calls for "early identification of impairments and appropriate interventions" within the primary healthcare system, while it also announces "free access to assistive devices and rehabilitation services… to all children under the age of six". It is clear that South African governmental policy guidelines favour the philosophy of screening for hearing loss in infants – it is only the implementation of such policy that is left wanting (HPCSA, 2002:3).

The Professional Board for Speech, Language and Hearing Professions of the Health Professions Council of South Africa (HPCSA) is in accord with these ideals of government and has recently produced a Hearing Screening Position Statement (HSPS) Year 2002. In this statement it accepts the Year 2000 position statement of the Joint Committee on Infant Hearing (USA) as the definitive document on infant hearing screening (HPCSA, 2002:1). The South African position statement advocates the use of electrophysiological measures for targeted (risk-based) newborn/infant hearing screening as the first step toward further diagnostic assessments. It also advocates family-centred intervention programmes through integrated, interdisciplinary Provincial and District Health Systems (DHS). It poses targeted screening as an intermediate step towards UNHS of 98% of neonates/infants by 2010. Furthermore, by 2005 the necessary technology should be available at Maternal and Child Health (MCH) clinics in the community to enable infants who attend their first immunisation to have their hearing screened as part of the total service package (HPCSA, 2002:5).

This screening model proposes the use of electrophysiological techniques such as OAE and AABR to screen infants on the HRR. Although the Joint Committee

on Infant Hearing (USA) no longer recommended the HRR for screening purposes because such programmes would identify only 40% to 50% of infants with hearing loss, the committee did accept that it may be useful where lack of resources are limiting the development of UNHS (JCIH, 2000:21). An additional advantage of including risk indicators is that normal hearing at birth may not preclude delayed onset or acquired hearing loss. Risk indicators help identify infants who should receive on-going audiologic and medical monitoring and surveillance (JCIH, 2000:21). These statements have led the HPCSA's Professional Board for Speech, Language and Hearing Professions in South Africa to recommend in its position statement on screening that public sector institutions should invest in appropriate technology for risk-based NHS to ensure that all socio-economic levels of society have access to hearing screening and the benefits of early intervention. The Board recommends that hearing screening take place in well-baby nurseries, at discharge from the neonatal ICU, or at the 6-week immunisation clinic.

This position statement has provided the impetus and framework for guiding contextually relevant research for screening practice in South Africa. Although identification of hearing loss through screening is only the first step toward delivering services to infants with hearing loss, it provides the thrust for the implementation and maintenance of diagnostic, intervention and management components of EHDI programmes. Kenworthy (1990:328) aptly remarks that "…only through comprehensive identification will the need for early intervention programs be realized".

1.5. STATEMENT OF PROBLEM AND RATIONALE

"South Africa has the needs of a developing country whilst at the same time she possesses the potential and reach of a developed nation" (Whiston, 1994:234). It is this unique combination of First World benchmarks that can stimulate creative initiatives to produce contextually relevant solutions for the delivery of hearing services to South Africa's youngest and most vulnerable population: its neonates

and infants. South Africa should therefore follow in the footsteps of developed countries and act as a pioneer for developing countries.

This strive toward a first-class health service for all is reflected in the fact that the Hearing Screening Position Statement Year 2002 (published by the Professional Board for Speech, Language and Hearing Professions of the Health Professions Council of South Africa (HPCSA)) accepted the JCIH Year 2000 position statement as a definitive document for hearing screening in South Africa. The South African position statement embraces the same aim as the JCIH statement, namely: *The Early Hearing Detection and Intervention Programme (EHDI) for individuals identified with hearing loss is to ensure optimum, cost effective solutions to enable persons to communicate effectively, thereby allowing maximum habilitation or rehabilitation of the individual's capabilities and potential, to secure their full participation in, and contribution to, society and the country's economy* (HPCSA, 2002:1).

However, this type of programme has so far remained nothing but an ideal of the South African healthcare system, because very few programmes have previously been implemented to identify infants with hearing loss. As a result, only limited contextually relevant research has been conducted to steer the implementation of effective and accountable early hearing detection programmes in South Africa. The first step in developing such early detection and intervention services is to document the need within a specific context and to describe the population in need of these services (Mencher, 2000:178; Kritzinger, 2000:17; White et al., 1995:12). Knowledge regarding the epidemiology of congenital and acquired hearing loss, in addition to an understanding of the context and culture being served, forms the basis for the planning and provision of widespread paediatric hearing health services within current healthcare infrastructures (Parving, 2003:154; Mäki-Torkko, 2003:188; Fortnum, 2003:155). The South African government recognises the need for relevant research as one of the objectives for restructuring the health sector (Department of Health, 1997:28). Essential National Health Research (ENHR) as recommended in the *White Paper on the Transformation of the Health System* (Department of Health, 1997:28) must

provide a contextually relevant empirical foundation to serve as guiding framework concerning the practicality, validity and cost-efficiency of infant hearing screening within the South African context (Mencher, 2000:178; White et al., 1995:12; Fortnum, 2003:155).

The South African Hearing Screening Position Statement Year 2002 recommends three different contexts wherein screening should be implemented, namely the well-baby nursery, at discharge from the neonatal intensive care unit (NICU) or at MCH clinics, using as platform the 6-week immunisation clinics that form part of the MCH service delivery package. The well-baby nursery and NICUs are established and internationally recognised screening contexts abundantly reported on (e.g. Hess et al., 1998:81-89; Cox & Toro, 2001:99-104; Finitzo, Albright & O'Neal, 1998:1452-1460). MCH clinics, however, have not yet been investigated as a hearing screening context (Kennedy et al., 1998:1963). In terms of South African primary healthcare policy these clinics are established to provide accessible community-based services (Dennill, King & Swanepoel, 1999:36-39). The MCH 6-week immunisation clinic will therefore provide an integral and essential hearing screening context (National Health Plan for South Africa, 1994:19-20). Since many births in South Africa, especially in the rural areas, occur at MCH clinics or at home with the help of midwives, screening in the well-baby nursery or NICU ónly will fail to identify significant numbers of infants (Olusanya et al., 2004:299).

The investigation of the MCH clinic as a hearing screening context is a priority if the benchmarks stated by the South African Hearing Screening Position Statement Year 2002 are to be followed. It is therefore necessary to assess and describe a hearing screening programme at MCH clinics. This will provide empirical data to address the dearth of research on infant hearing screening in South Africa to contribute to future programmes being based on contextually applied research. The question that arises is:

Are early hearing detection programmes at MCH clinics in a developing peri-urban South African community a feasible option?

1.6. ADDRESSING THE PROBLEM

In an attempt to address the question about the feasibility of implementing early hearing detection programmes in South Africa, this study will conduct both a theoretical and an empirical investigation. Figure 1.2 illustrates this problem-solving process.

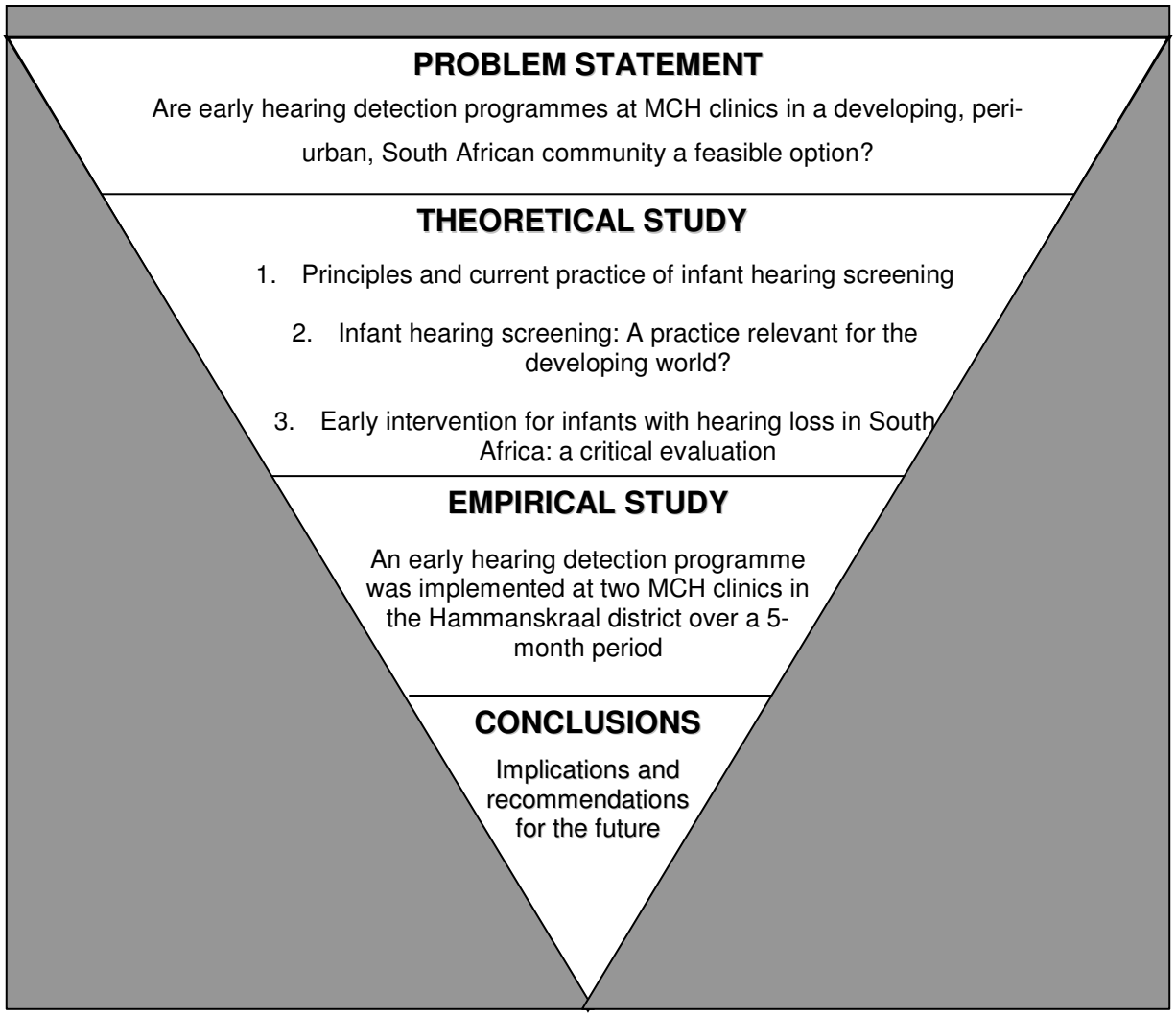


FIGURE 1.2 Problem-solving process used in the research project

The problem statement will be addressed in two phases, first a theoretical and then an empirical phase. The theoretical phase will assess the body of scientific knowledge as it pertains to the research question posed. This will occur in three stages with the first discussion establishing the principles of newborn hearing screening (NHS) and the status of current practice; the second evaluating the relevance of NHS in developing countries, and the third considering EHDI in South Africa. These sections will provide an overview of current literature indicating the standing of EHDI programmes world-wide and more specifically in South Africa, offering insight into areas requiring further study, and discussing the future direction of developments within the field.

The theoretical background will be followed by an empirical investigation based on an actual early hearing detection programme implemented at two MCH clinics in a peri-urban developing community in South Africa. This will provide empirical evidence of the feasibility of such programmes in developing communities in South Africa and serve as a basis from which recommendations regarding future directions can be made.

The objective of the current study is therefore to describe the feasibility of an early hearing detection programme at MCH clinics in a specific developing peri-urban South African community, using a theoretical as well as an empirical approach so that contextually relevant recommendations can be made.

1.7. ORGANISATION OF THE STUDY

A brief outline and description of the organisation of the sections included in this study is provided in Table 1.1.

TABLE 1.1 Outline and description of the sections comprising this study

CHAPTER 1	*The first chapter provides the background, rationale and statement of the problem identified by this study; the organisation of the content outlining the chapter contents; a clarification of terminology; and a list of abbreviations used.*
CHAPTER 2	*Chapter 2 provides the basic philosophy and principles related to widespread infant health screening, and assesses the current status of IHS in the developed world. The chapter supplies the background to and a framework for Chapter 3.*
CHAPTER 3	*This chapter provides an overview of infant health screening in the context of the developing world to finally conclude with an argument for its relevance in such contexts.*
CHAPTER 4	*Chapter 4 provides a critical review of the present South African context and the available infrastructure of audiological services for implementing early hearing detection and intervention on a large scale.*
CHAPTER 5	*This chapter provides a thorough description of the design, criteria, apparatus, collection procedures and analysis techniques implemented in the research methodology to acquire the data according to the sub-aims, in order to address the main aim of the study.*
CHAPTER 6	*A presentation of the empirical results is provided according to the sub-aims specified for the study. The results are subsequently discussed by integrating information from the current body of knowledge.*
CHAPTER 7	*This chapter presents conclusions from the theoretical and empirical aspects of the study and recommends a model for early hearing detection at MCH clinics. Finally, a critical evaluation of the study is provided along with recommendations for future research.*

1.8. TERMINOLOGY

The following terms are defined and motivated according to their application and meaning as used in this study:

- **Newborn Hearing Screening (NHS)**

  This is a general term referring to simple tests of auditory functioning, utilising rapid screening tests, usually AABR or OAE measures, to identify neonates who require additional diagnostic procedures to confirm or reject the

presence of a hearing loss (Stach, 2003:184). The term is used throughout the current study as a general description of any type of screening programme that aims to screen the hearing of newborns. It does not refer to either targeted or universal NHS programmes, unless so specified, but rather to any type of screening programme in which newborns are screened. Newborn refers to an infant in its first four days after birth. The term is used in a similar manner in other reports (Olusanya et al., 2004:288).

- **Infant Hearing Screening (IHS)**

  This general term, similar to NHS, refers to simple tests of auditory functioning, utilising rapid screening tests, usually AABR or OAE measures, to identify infants who require additional diagnostic procedures to confirm or reject the presence of a hearing loss. The term *infant,* as opposed to *newborn,* is used as a general term including newborns and also all children younger than 12 months of age. Since the study focuses on screening at MCH clinics, the term IHS is preferred in the text since most children assessed could not be adequately classified by the term *newborn* or *neonate*.

- **Targeted Newborn Hearing Screening (TNHS)**

  This term denotes a specific type of NHS programme that requires only a specified, targeted population to be screened. The target population consists of those newborns who exhibit a risk of having or developing a hearing loss (Olusanya et al., 2004:298). The list of risk factors for hearing loss has been compiled by the JCIH (2000:20) and although additional factors have been suggested (Kountakis et al., 2002:133), it serves as the definitive list. In the current study, this term is used of NHS practice in a range of contexts varying from NHS practice in a single hospital to a nationally legislated programme.

- **Universal Newborn Hearing Screening (UNHS)**

  In contrast to TNHS, this term refers to a NHS programme in which all newborns, both at-risk and non-risk, are to be screened for hearing loss (Olusanya et al., 2004:299). The JCIH (2000:15) recommends that UNHS programmes must screen a minimum of 95% of infants during their birth

admission or before one month of age. In the current study this term refers to NHS practice in a range of contexts, varying from a single hospital to a nationally legislated programme.

- **Early Hearing Detection and Intervention (EHDI)**

  The goal of EHDI services is to "maximise linguistic and communicative competence and literacy development for children who are hard of hearing or deaf" (JCIH, 2000:10). According to the National Center for Hearing Assessment & Management (NCHAM, 2004:1) EHDI refers to "the process of screening every newborn for hearing loss prior to hospital discharge, whereby infants not passing the screening receive appropriate diagnostic evaluation before three months of age and, when necessary, are enrolled in early intervention programs by six months of age". In the current study the term EHDI refers to this same process but is used in a broader sense, referring not only to screening of newborns but also of infants up to 12 months of age as well as diagnostic and intervention services which may exceed the specified cut-off ages. The recommended screening at 6-week immunisation clinics specified by the Year 2002 HSPS requires this broader definition of the term (HPCSA, 2002:5).

- **Developed countries**

  In the current study this term refers to countries that have achieved a high degree of industrialisation and that enjoy a high standard of living according to conventional indices of development, including factors such as per capita income, immunisation up-take, and under-five mortality rate (World Bank, 2004:251). This categorisation of countries is used by a variety of organisations such as the World Bank, International Monetary Fund, World Trade Organisation and United Nations (World Trade Organisation, 2004:1; World Bank, 2004:251; United Nations, 2003:1). The term *developed countries* is also synonymous with the term *First World*, which emerged during the rise of communism in the East but has fallen out of use since the demise of communist Russia (Knock, 2002:2). The developed countries are

therefore placed in contrast with the 164 developing countries of the world (World Bank, 2004:251; Olusanya et al., 2004:289).

- **Developing Countries**

  This term refers to countries that have not achieved a significant degree of industrialisation relative to their populations, that have a low standard of living, and that indicate a characteristically high population growth (World Trade Organisation, 2004:1; World Bank, 2004:251; United Nations, 2003:1). Other terms sometimes used for *developing countries* include le*ss developed countries*, *underdeveloped nations* and *undeveloped nations*. The term *Third World* was also used to refer to these countries during the rise of communism in the East, but has fallen out of use since the demise of communist Russia (Knock, 2002:2). A further classification of developing countries has been made by the United Nations for a group called the least-developed countries, which currently include 50 of the 164 developing countries in the world (United Nations, 2004:1; World Bank, 2004:251). This clearly demonstrates that the term *developing countries* does not refer to a homogenous group of countries, but that there are significant differences in development between these countries, and even within the same country (Olusanya et al., 2004:289). Despite these differences, however, this categorisation provides an objective basis that is readily available for comparing various economies of the world. In the current study this term provided a way of drawing comparisons between NHS in regions of the world based on their general socio-economic status (developed and developing countries).

  The present study considered South Africa a developing country according to the list of advanced economies specified by the International Monetary Fund (World Bank, 2004:251; United Nations, 2003:1). This is despite the fact that South Africa has a two-tiered economy – one rivalling other developed countries and the other having only the most basic of infrastructures (US Department of State, 2004:3). The reason for this is that the vast majority of South Africans live in developing contexts with a basic socio-economic infrastructure (Woolard & Baberton, 1998:15).

1.9. CONCLUSION

Early identification of hearing loss, which leads to early intervention, is becoming an accepted standard of healthcare in developed countries like the USA. This is primarily due to the high prevalence of congenital hearing loss and the dramatic benefits of early intervention compared to the negative consequences of the late identification of hearing loss. In developing countries like South Africa, however, IHS is not a common practice and very little contextual data is available regarding childhood hearing loss and available screening programmes. A recent position statement by the Health Professions Council of South Africa has attempted to give priority to the practice of NHS. Unfortunately, a dearth of relevant local research to direct the implementation of NHS and a lack of resources are making progress slow. The aim of this study is therefore to provide much needed empirical evidence regarding the status and feasibility of early hearing detection in developing South African communities through MCH clinics.

1.10. SUMMARY

This chapter argued the importance of conducting contextual research regarding the practice of NHS in South Africa. The importance of NHS was explained within an EHDI service delivery model whilst the serious lack of contextual research in South Africa was highlighted. A case was made for urgent contextual research by referring to health priorities set by the government and initiatives launched by the HPCSA. Finally, a research question was formulated for investigation of MCH clinics in a developing peri-urban South African community and a description was given of how the study poses to address the question. Finally, a list was supplied of the terminology used in the study, followed by a conclusion to the chapter.

CHAPTER 2

PRINCIPLES AND CURRENT PRACTICE OF INFANT HEARING SCREENING

Aim: This chapter evaluates the principles of newborn hearing screening as a societal responsibility and assesses the current practice thereof in the developed world

2.1. INTRODUCTION

It is estimated that every day, on average, 33 babies are born with congenital hearing loss in the USA, making it the most prevalent major birth defect in that country (White, 2003:79). The fact that these hearing-impaired infants miss out on critical periods of exposure to adequate auditory and language stimulation creates a sense of urgency, emphasising the need for early intervention. Although it is only over the last 20 years that early intervention has developed into an internationally accepted means of delivering services to infants and toddlers with special needs, audiologists have been intent on early identification of hearing loss for at least the past 60 years (Northern & Downs, 2002:259; Widerstorm et al., 1997:17). This commitment to the identification of hearing loss as early as possible was based on the premise that the earlier habilitative/ rehabilitative measures could be implemented, the better the outcomes would be.

In recent years the above sentiment has been proved correct by various research reports (Yoshinaga-Itano, 2003:205). Infants who are identified with hearing loss soon after birth and who receive early intervention have an important and measurable advantage over later-identified peers and many children with hearing loss who receive comprehensive early intervention services

before six months of age achieve language abilities similar to hearing peers (Yoshinaga-Itano, 1995: 129; Yoshinaga-Itano & Apuzzo 1995:124; Carney & Moeller, 1998:78-79; Moeller, 2000:6-7).

The continued growth in research evidence that reports the importance and benefits of early intervention for hearing loss has resulted in neonatal hearing screening becoming the *de facto* medical/legal standard of care in the USA (White, 2003:85). The UK and increasing numbers of European countries have also introduced universal newborn hearing screening (UNHS) and are in the process of implementing it as standard practice for newborn healthcare (Parving, 2003:154; Davis & Hind, 2003:194). These large-scale healthcare initiatives to provide early intervention services to very young hearing-impaired infants represent a major, but welcome challenge to paediatric audiological services (Parving, 2003:154). According to the International Society on Early Intervention (1999:1), addressing this challenge should be one of the most important priorities for contemporary societies.

Although the principles underlying this practice appear to be universal, the practices across countries vary greatly (Mencher et al., 2001:8). **The purpose of this chapter is therefore to evaluate the principles of Infant Hearing Screening (IHS) as a societal responsibility and to assess current practice in the developed world as a background to considering IHS in the developing world (Chapter 3).** This chapter provides two constructs, one theoretical and one practical (as depicted in Figure 2.1), which provide the foundation for Chapter 3. The philosophy, theory and principles of screening are investigated to ensure its validity as a societal practice. In a more practical sense, the current status of such programmes in developed nations, such as the USA, is assessed to determine the accountability and direction of these initiatives.

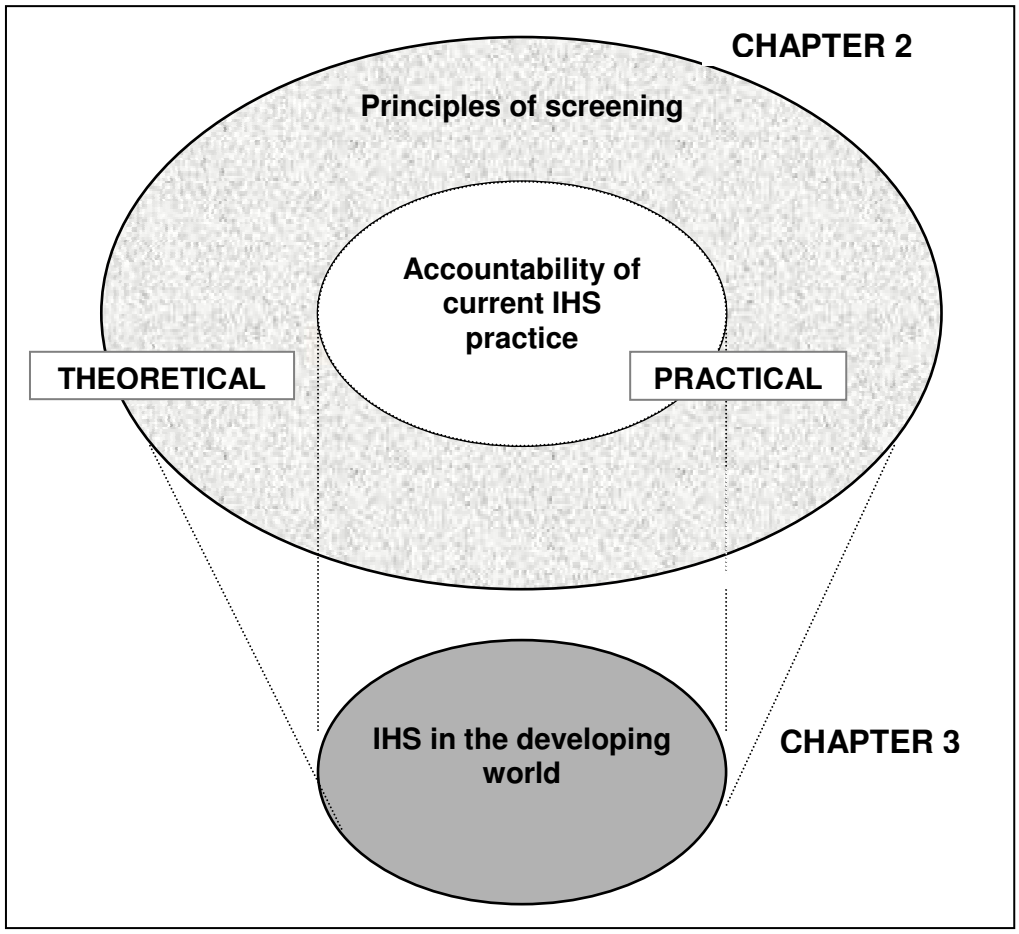


FIGURE 2.1 Theoretical and practical construct (Chapter 2) for evaluating IHS in the developing world (Chapter 3)

2.2. PHILOSOPHY OF SCREENING

Defined in general terms, screening may be considered as a process of filtering cases into two groups. The first group has an adequately high probability of having a given disease or condition to warrant referral for further testing. The second group has an adequately low probability of having the disease or disorder and therefore does not merit the expense, inconvenience or risk of diagnostic testing (Lutman, 2000:367). The goal of a screening programme is therefore to identify asymptomatic individuals with an increased likelihood of presenting with the target disorder, so that diagnostic testing procedures can be applied only to that subset of individuals (Roush, 2001:33).

Screening for disorders is an important component of all the health sciences, and general principles serve to guide an accountable screening process. For the audiologist, identification through screening has been identified as a primary professional role by the HPCSA (Hugo, 2004:7). The American Speech-Language-Hearing Association (ASHA) provided an outline of essential elements to be considered in any screening programme (ASHA, 1995:26-27). These elements are summarised in Table 2.1.

TABLE 2.1 Elements of a screening programme (ASHA, 1995)

1. PURPOSES OF SCREENING	*To separate from among apparently healthy individuals those for whom there is a greater probability of having a disease or condition and then refer them for appropriate diagnostic testing.*
2. IMPORTANCE OF THE DISEASE	*Every disease has a cost to society; the greater the burden to society, the greater the reason to screen for the disease. Factors that must be considered include the prevalence, morbidity and duration of the disease, as well as the cost of screening, diagnosis and treatment.*
3. DIAGNOSTIC CRITERIA	*For a screening programme to be successful, there must be a clear and measurable definition of the disease being screened for. In addition, measurable and acceptable criteria for diagnosis must be available.*
4. TREATMENT	*Before a screening programme is implemented, it is necessary to demonstrate that treatments are available, effective and shown to alter the natural history of the disease. It should also be shown that treatment early in the disease process results in greater benefits than when treatment is begun in the symptomatic patient.*
5. THE PROGRAMME MUST REACH THOSE WHO COULD BENEFIT	*It is important that screening programmes be administered so that those who would most likely benefit from early identification are included easily. Mechanisms for outreach to the targeted population should be in place. Education and public policy can influence how well screening programmes succeed in reaching those it should reach.*

TABLE 2.1 Continued

6. AVAILABILITY OF RESOURCES AND COMPLIANCE OF THOSE IDENTIFIED	*Diagnostic and treatment resources appropriate for the population being served must be available before a screening programme can be managed successfully. After identification, those identified must comply with follow-up components of the screening programme. Diagnostic and treatment resources must be able to accommodate the influx of clients who are referred after the screening.*
7. APPROPRIATENESS OF THE TEST	*A screening test should be simple and preferably easy to administer, comfortable for the patient, short in duration and inexpensive. It must also meet performance criteria. It must be sensitive, specific, precise and accurate.*
8. SCREENING PROGRAMME EVALUATION	*Screening programmes must be evaluated. Protocols must be based on data that demonstrates that individuals identified through screening have better outcomes than those not screened. Direct monetary costs can be computed and such costs can be modified through administrative decisions.*

According to Roush (2001:24), these elements set benchmarks against which screening initiatives should be evaluated. A disorder to be screened for must first be a problem that is significant to the individual and to society. There must be good evidence of effective treatment once the problem is detected and the screening test must be properly evaluated and shown to be acceptable in the setting where screening is to be performed. It is also essential that there be evidence that a screening programme resulting in treatment is of greater benefit than waiting until symptoms develop. Cost issues should furthermore be considered and judged to be reasonable. Lastly, care must be taken to ensure that there are plausible strategies and sufficient resources to facilitate implementation (Roush, 2001:24).

Deciding on whether or not to screen for a disorder is an important societal and public health priority that requires careful consideration. A useful outline for evaluating a disorder according to the principles of screening philosophy is summarised from Northern and Downs (2002:260-265) and the American

Academy of Pediatrics (AAP, 1999:527-528). These criteria are summarised in Figure 2.2 below.

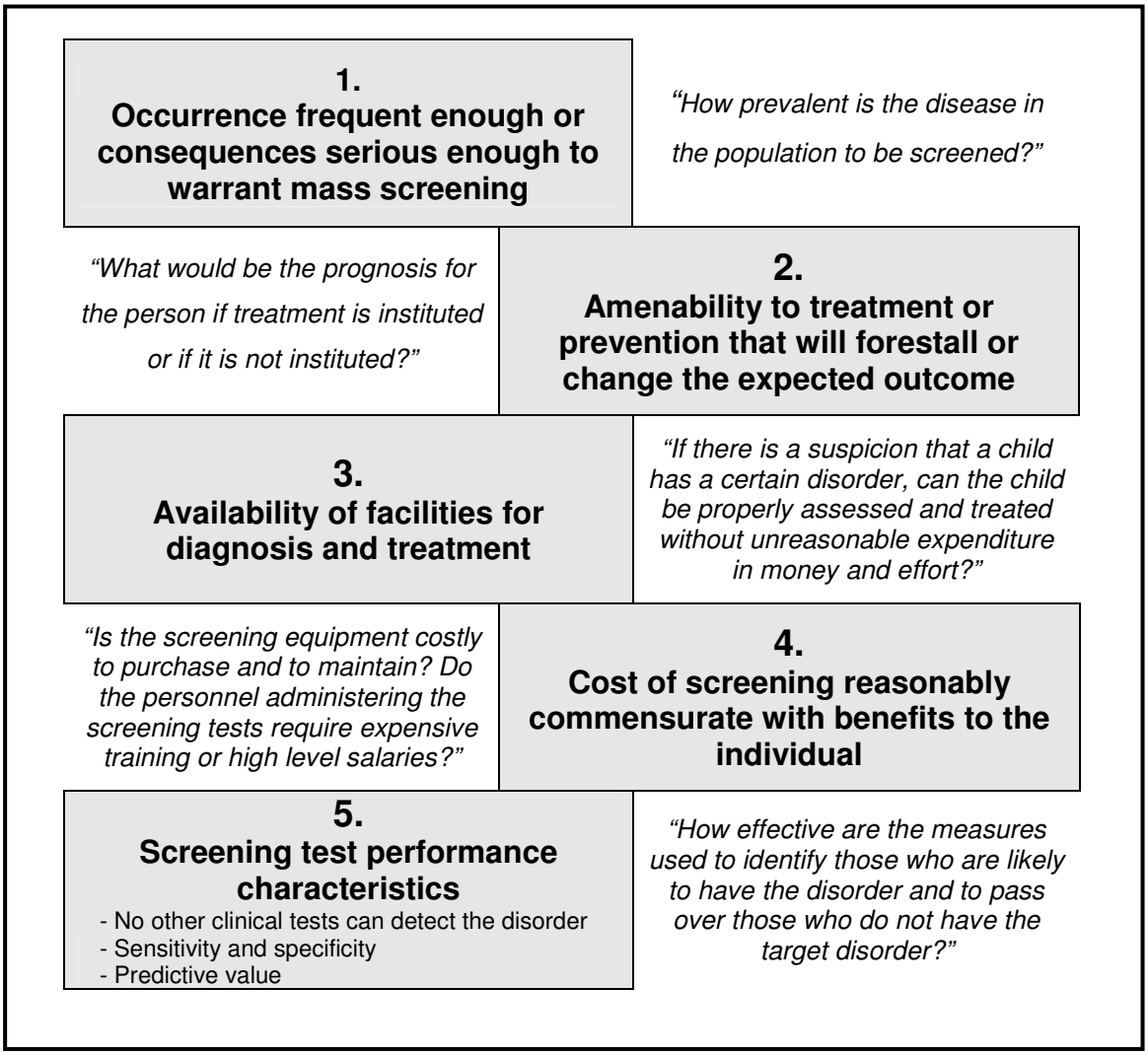


FIGURE 2.2 Criteria for evaluation of a disorder according to principles of screening *(based on Northern & Downs, 2002:260-265 and AAP, 1999:527-528)*

The above criteria are essential in determining if screening is warranted and, if so, for which type of disorder or disability. They may also assist in determining which screening procedures and protocols are to be used for specific disorder types. Consideration of these criteria constitutes the cornerstone for the development of a screening programme. An accountable process of screening

must therefore be measured within the general philosophy of screening against the specified principles thereof.

2.3. PRINCIPLES OF INFANT HEARING SCREENING

The implementation of newborn hearing screening programmes worldwide has led to the development and refinement of screening principles. The latter adhere to the general screening philosophy and criteria but should be specifically stated for the population to be screened (ASHA, 1995:27-29). It is therefore logical that the first aspect that requires consideration and that influences the entire screening process, is what type of hearing loss to screen for. In other words, the specified or targeted condition needs to be defined (Davis et al., 2001:4). The target hearing loss to be screened for should be selected based on whether it proves to be a significant health problem (Davis et al., 1997:8). Distinguishing between hearing losses that may lead to a significant health problem and those that do not, is very difficult and has led to a number of different target disorders having been specified.

The European Consensus Development Conference on Neonatal Hearing Screening (Lutman & Grandori, 1999:95) recommended the targeted hearing loss in terms of "a permanent bilateral hearing impairment of at least 40 dB averaged over the frequencies 0.5, 1, 2, and 4 kHz". The Joint Committee on Infant Hearing (JCIH, 2000:11) defined the targeted hearing loss for screening programmes as "permanent bilateral or unilateral, sensory or conductive hearing loss, averaging 30 – 40 dB or more in the frequency region important for speech recognition (approximately 500 through 4000 Hz)." The American Academy of Pediatrics specifies a more simplistic target disorder of bilateral hearing loss, namely ≥35 dB HL (AAP, 1999:527). Despite differing statements regarding which hearing losses constitute significant health problems, once an operational objective of specifying the target hearing loss has been clearly defined, an evaluation of the justification of screening can be performed (Lutman, 2000:368).

Davis et al. (1997:8) provide a comprehensive set of screening principles for evaluating the justification that underlies screening for congenital hearing losses (see Appendix A). These principles, although thorough, are lengthy and a simpler yet comprehensive list could be evaluated more readily. A shorter comprehensive list that condenses a number of specific principles into fewer general principles has subsequently been compiled from the literature reviewed (Davis et al., 1997:8; White, 2002:1; Mehl & Thomson, 1998:3; Northern & Downs, 2002:260-267; Bamford, 2000:359-365; Mencher et al., 2001:1-10).

Six principles that underlie the practice of IHS have been identified as inclusive of the major aspects necessary for the justification of the screening procedure. These principles can be divided into two broad categories – principles relating to the disorder and those relating to the screening process. Principles relating to the disorder involve aspects such as the prevalence of the disorder, the effect of the disorder on development and the effect of intervention on development. The principles that concern the screening process include aspects such as accuracy of screening methods, efficiency of screening programmes and the costs involved. The disorder-related principles are fundamental in the justification of screening by investigating the need for and effect of screening for the disorder. The principles pertaining to the screening process, on the other hand, are more concerned with the accountability of the screening process to make it a justifiable healthcare practice.

The six principles extrapolated from the literature that constitutes the foundation of IHS as a justified healthcare practice are listed in Table 2.2.

TABLE 2.2 Principles underpinning the practice of IHS

DISORDER-RELATED PRINCIPLES
1. Prevalence of congenital hearing loss
2. Consequences of neonatal hearing loss
3. Effects of earlier versus later identification and intervention
PROCESS-RELATED PRINCIPLES
4. Accuracy of infant hearing screening methods
5. Efficiency of early identification programmes
6. Costs of infant hearing screening

(Extrapolated from Davis et al., 1997:8; White, 2002:1; Mehl & Thomson, 1998:3; Northern & Downs, 2002:260-267; Bamford, 2000:359-365; Mencher et al., 2001:1-10).

Evaluating IHS to determine its status as an accepted healthcare practice requires a framework such as the principles listed in Table 2.2. These principles will be used as an outline for the evaluation of IHS as a justified healthcare practice in the following section. Since NHS programmes are the main source of research reports on infant hearing screening, the discussion is primarily based on data from NHS programmes.

2.3.1. Disorder-related principles of infant hearing screening

As indicated earlier, the three principles underpinning IHS from a disorder-related perspective are prevalence of the disorder, effect of the disorder on development, and effect of intervention on development. These principles are of crucial importance in the justification of hearing screening as they investigate both the need for and the effect of screening. The following paragraphs will not only summarise the findings discussed in Chapter 1 regarding the rationale for

IHS based on the disorder-related principles, but will also focus on providing additional supportive information.

2.3.1.1. Prevalence of congenital hearing loss

The prevalence of hearing loss is significantly higher than that of other birth defects (Mehl & Thomson, 1998:2). According to Mehl and Thomson (1998:2), screening for bilateral sensori-neural hearing loss will identify 260 out of 100 000 afflicted newborns compared to 50 out of 100 000 with congenital hypothyroidism – the most common congenital condition routinely screened for in the USA.

The prevalence of newborn hearing loss was reported to be 1 in 1 000 live births for many years. This figure, however, referred only to congenital bilateral profound hearing loss (Carney & Moeller, 1998:63). Neither hearing loss of mild, moderate or severe degrees, nor unilateral hearing losses were then taken into consideration because it was so difficult to accurately characterise hearing loss in infants prior to the advent of OAE and ABR screening (Northern & Downs, 2002:266). Furthermore, early surveys did not include newborns at risk for developmental disabilities in which the presence of hearing loss is now known to be significantly higher than in the well-birth infant population (Northern & Downs, 2002:266). More recent studies have estimated a bilateral permanent newborn and infant hearing loss of 1.5 to 6 per 1 000 live births (Vohr et al., 2001a:238; Northern & Downs, 2002:267; Finitzo et al., 1998:1452). Apart from bilateral hearing loss, studies also indicate a significant prevalence of unilateral hearing loss. While Brookhauser, Worthington and Kelly (1991:1269) state that 37% of sensori-neural hearing loss is unilateral, Watkin et al. (1990:849) maintain that this figure is 35%. Whatever the case may be, it means that unilateral hearing loss affects a significant number of individuals, which further increases the prevalence of hearing loss.

Table 2.3 provides a summary of prevalence rates reported for bilateral permanent childhood hearing loss in population-based studies with children

between 6 and 12 years of age to demonstrate the prevalence of hearing loss when different target hearing losses are specified.

TABLE 2.3 Prevalence rates reported for bilateral permanent childhood hearing loss in population-based studies

Author and number of subjects	Threshold criterion for hearing loss (dB HL)	Prevalence per 1 000
Martin (1982), n=4 126 268	50 dB	0.9
Davis and Wood (1992), n=29 317	50 dB	1.1
Hadjikakou and Bamford (2000), n=188 583	50 dB	1.6
Feinmesser et al. (1986), n=62 000	40 dB	1.7
Kankkunen (1982), n=31 280	40 dB	1.3
Parving (1985), n=82 265	35 dB	1.4
Sehlin et al. (1990), n=63 463	30 dB	2.4
Sorri and Rantakallio (1985), n=11 780	30 dB	2.1
Fitzland (1985), n=30 890	25 dB	1.9

Increasing numbers of research studies are under way to provide further answers aimed at establishing the true prevalence of hearing loss in newborns and children (Northern & Downs, 2002:266). The answer is not a simple one, due to confounding factors such as the specific description of the target population; the definition of the hearing loss in terms of type, degree, bilateral and unilateral presence; protocols used; pass/refer criteria; and the success of follow-up and diagnostic procedures (Stein, 1999:103). A recent review of prevalence literature for permanent childhood hearing losses larger than or equal to 40 dB indicated a range of 0.78 to 1.8 per 1 000 (Fortnum, 2003:157). Other reports from UNHS programmes, however, suggest a prevalence of 2 to 4

babies with congenital permanent hearing loss (Barsky-Firsker & Sun, 1997:E4; Prieve, 2000:105; Mehl & Thomson, 1998:2; Finitzo et al., 1998:1456; Johnson et al., 1997:354). If unilateral hearing losses of 30 dB or greater are included, the prevalence will be closer to 4 per 1 000 live births, which significantly increases the prevalence of congenital hearing loss.

Although little is known about late-onset hearing loss within the first year of life, the JCIH (2000:21) estimated that only 2% of children with permanent hearing loss by 12 months of age had normal hearing at birth, based on data from a large multi-centre longitudinal study reported by Norton et al. (2000a). According to Davis et al. (1997:83), an estimated 10% of permanent childhood hearing loss is either progressive or *late-onset*. In a recent multi-centre study among 81 children who were survivors of neonatal respiratory failure (with or without diaphragmatic hernia) and who passed neonatal hearing screening at the time of hospital discharge, a high incidence of sensori-neural hearing loss was reported at 4 years of age. Altogether 53% of the children presented with sensori-neural hearing loss, of whom 70% had hearing loss at the age of 2 and of these, 60% was progressive between 2 and 4 years of age (Robertson et al., 2002:355).

The prevalence of hearing loss in newborns and infants is therefore adequately high to justify hearing screening, especially when compared to existing screening programmes with much lower prevalence rates.

2.3.1.2. Consequences of neonatal hearing loss

When the second disorder-related principle is considered, it is clear that undetected hearing loss leads to irreversible language, speech and cognitive delays, with far-reaching social and economic ramifications (Yoshinaga-Itano & Gravel, 2001:62; JCIH, 2000:10; Yoshinaga-Itano et al., 1998:1161-1162; Mohr et al., 2000:3). Hearing loss in children impacts significantly on aspects such as language and literacy development, speech perception and production, and on socialisation and family dynamics (Carney & Moeller, 1998:63-S64).

Significant delays in language development and academic achievement have been reported widely for the majority of children with sensori-neural hearing losses, including those with mild degrees (Carney & Moeller, 1998:63). These delays are documented for numerous aspects such as vocabulary development, grammatical skills, concept attainment, social conversational skills and development of literary skills. Children with congenital bilateral severe-to-profound hearing loss who leave the educational system at the age of 18 years demonstrate an average middle-third to middle-fourth grade reading level and language abilities that are 50% to 90% of their chronological age, equivalent to a 9 and 10-year-old (Yoshinaga-Itano & Gravel, 2001:62). On overage, children with a hearing loss who are identified late (after 12 months) exhibit a discrepancy of 40 to 50 points between nonverbal performance test scores and language ability. Even for the children who score in the top 10% of this distribution, the nonverbal/language discrepancy average is 20 points (Yoshinaga-Itano, 2003:200). These reports provide conclusive evidence of the serious negative effect of late identification of a hearing loss.

Mild or moderate degrees of hearing loss are also more likely to cause academic difficulties that can create significant delays in literacy development such as reading comprehension and other language-based academic skills (Davis et al., 1986:59; Bess et al., 1998:347). Bess et al. (1998:342) studied children with minimal sensori-neural hearing loss, which included children with unilateral hearing loss, bilateral sensori-neural hearing loss between 20 and 40 dB and high frequency hearing loss of greater than 25 dB at two or more frequencies above 2 kHz. The results indicated that 37% of these children had failed at least one grade and that they exhibited significantly greater dysfunction than children with normal hearing on aspects such as behaviour, energy, stress, social support and self-esteem (Bess et al., 1998:339). The deduction that is made from these results is that even minimal hearing loss categories have a significant impact on development and performance.

Speech perception ability is significantly reduced for children with all degrees of hearing loss, with increasing reduction as the hearing loss increases (Carney &

Moeller, 1998:64). This can cause difficulties in using their hearing in simple daily-life situations. The decreased ability to perceive differences in sound typically leads to a significant delay in speech production. For children with severe-to-profound hearing losses, all the aspects of speech may be disrupted – including articulation, voice, prosody, and timing of speech – whilst children with mild degrees of hearing loss may suffer far less disruption (Carney & Moeller, 1998:64).

Self-esteem and socialisation are other aspects that can be affected severely by early delays in communicative development. Davis et al (1986:55) report that half of the deaf or hard-of-hearing school-aged subjects expressed concerns about making friends or being accepted by classmates, compared to a 15.5% incidence of such problems among hearing grade-mates. These children also scored significantly higher than the norm on scales of aggression and somatisation, and parents rated them to have difficulties in the areas of aggression, impulsivity and immaturity (Davis, 1986:56). Family adjustment is also a challenge, which often leads parents to experience grief reactions and feelings of "a loss of control" when a child is diagnosed with a hearing loss. A considerable amount of evidence indicating the negative consequences of such parental stress on child development is available (Carney & Moeller, 1998:64).

It is clear that undetected hearing loss in infants has serious negative consequences that impact on language, speech, academic and social spheres, even in the case of children with minimal losses.

2.3.1.3. Effect of earlier versus later identification and intervention

Analysis of the third principle proves that IHS yields dramatic benefits, since infants whose hearing loss is identified before 6 months of age have significantly better language abilities compared to those whose hearing loss was identified later (Yoshinaga-Itano et al., 1998:1164-1166; Moeller, 2000:5; Calderon & Naidu, 2000:53). The reason for this is that intervention (hearing aid fitting and supportive services) before the age of 6 months, enables infants to develop and

maintain normal language skills on a par with their cognitive development (Yoshinaga-Itano et al., 1998:1169). This is in stark contrast with the persistent language delay of two to four years for infants identified after 6 months of age (Yoshinaga-Itano et al., 1998:1169).

Theoretical arguments on auditory and cognitive plasticity have suggested that earlier auditory stimulation is better for developing the individual child's auditory and cognitive potential (Davis et al., 1997:83-84). These arguments have been supported by a number of more recent reports (Moeller, 2000:5; Yoshinaga-Itano, 2003:199-206). A study in the Trent Regional Health Authority UK, lately reported by Davis and Hind (2003:194), produced substantial data on the cognitive performance of children with moderate to severe permanent hearing loss and quality of life indicators. Results were based on linear regressions controlling for potentially confounding variables (e.g. age, severity, presence of other disabilities, etc.) and indicated that the age of first hearing aid fitting was a significant predictor of verbal and non-verbal reasoning as well as overall IQ. Age at diagnosis was identified as a significant predictor of working memory. The most important outcomes associated with early identification as described by Yoshinaga-Itano (2003:199-204) are summarised in Table 2.4.

TABLE 2.4 Compelling benefits of early identification versus later identification (Yoshinaga-Itano, 2003:199-204)

COMPELLING BENEFITS OF EARLY IDENTIFICATION VS LATER IDENTIFICATION
- Children with hearing loss born in UNHS hospitals had an 80% probability of having language development within the normal range of development.
- Children with hearing loss born in UNHS hospitals were 2.6 times more likely than children with hearing loss born in non-screening hospitals of having language development within the normal range of development.
- 76% of children with hearing loss in the screened group had language quotients that were 70 or greater – whilst only 32% of the non-screened group had language quotients of 70 or greater.

TABLE 2.4 Continued

- Early-identified children in the screened group had a 10-point discrepancy between their language and cognitive quotients – whilst later-identified children in the non-screened group displayed a 35-point discrepancy.

- The vocabulary of children at the 75th percentile of the non-screened group contained fewer words than that of the children at the 25th percentile of the screened group.

- The 75th percentile of the screened group had speech that was "always or almost always understandable" – whilst the 75th percentile of the non-screened group had speech that was "hard to understand".

- Early-identified children maintained language development in the same vein as their non-verbal cognitive symbolic play development, while later-identified children demonstrated a greater than 20-point discrepancy between their non-verbal cognitive development and their language development.

- Children with additional disabilities who were identified early and provided with immediate early intervention services also had symbolic play quotients that were similar to their language quotients – whilst children with additional disabilities who were identified later displayed significant discrepancies between their cognitive and language quotients.

- Early-identified children with hearing loss had significantly higher personal-social skill development than children whose hearing losses were identified later.

- The first six months of life appear to be a particularly sensitive period in early language development as young children identified with hearing loss and placed in intervention by 6 months of age present with significantly higher language development than later-identified children with hearing loss.

It is also important to mention that reports demonstrate that UNHS programmes do succeed in identifying hearing loss early. This provides the opportunity for timely intervention so that access may be gained to the benefits of early auditory stimulation. In its first four years, the UNHS programme in Rhode Island decreased the mean age at which hearing loss was detected from 20 months (prior to implementing UNHS) to 5.7 months (by year four) (Vohr et al., 1998:355). The Hawaii UNHS programme reduced the average ages of identification and amplification from 12 and 16 months to 3 and 7 months respectively (Johnson et al., 1997:354). In Colorado, the average age for hearing aid fitting is 5 weeks (Yoshinaga-Itano, 2004:454). Research outcomes provide evidence that hearing screening programmes reduce the age of hearing loss identification, lower the age of intervention initiation, and produce significantly

improved outcomes for both the child and his/her family (Yoshinaga-Itano, 2004:464).

It is clear that there are enough examples in the literature demonstrating the benefits of NHS programmes toward early identification and intervention (which provide infants with an opportunity to reach optimal outcomes) to justify its role as an important part of neonatal care.

The disorder-related principles provide a strong case for IHS by indicating the need for screening because of the number of affected infants, the detrimental effect of late identification and the dramatic benefits of early identification. The discussed evidence provides adequate justification for implementing IHS as it significantly improves the disorder outcomes. However, accountability with regard to the means of conducting the screening is still called into question – and will be addressed by evaluating principles pertaining to the screening process to ensure that the identified disorder can indeed be addressed in an accountable manner.

2.3.2. Process-related principles of infant hearing screening

Whilst disorder-related principles are fundamental to the identification of the need for and effect of screening, the principles pertaining to the screening process are concerned with the accountability of the practice and process of screening. Thus far evidence of the need for IHS has been provided and the discussion in the following paragraphs will focus on the accountability of IHS as healthcare and societal practice from a screening-process perspective. The three principles related to the process of screening accuracy, efficiency and costs, are explored in the following section.

2.3.2.1. Accuracy of infant hearing screening methods

The accuracy of screening methods is measured in how precise they are able to differentiate between normal-hearing and individuals with hearing loss. It

therefore involves two categories of accuracy, namely – how precise can the screening method identify normal-hearing persons, and how precise can the screening method identify hearing-impaired individuals. These two categories of accuracy measures are referred to as specificity and sensitivity (Davis et al., 2001:3). Sensitivity refers to the ability of the screening method to correctly identify the target disorder, whilst specificity refers to the ability of the screening method to correctly identify individuals without the target disorder (Jacobson & Jacobson, 1987:134). If a group of normal-hearing infants all pass a hearing screening, the specificity is 100% and if a group of infants with hearing loss all fail a screening test, the sensitivity is 100%. In practice there is always a trade-off between specificity and sensitivity, with higher sensitivity usually achieved at the expense of lower specificity and *vice versa* (Lutman, 2000:369). A screening procedure that frequently passes infants who are impaired or too often misclassifies normal-hearing infants as abnormal, renders the screening test invalid and economically unfeasible (Jacobson & Jacobson, 1987:133).

Due to the inherent differences in biomedical investigation, it is highly unlikely that any screening test can separate all individuals with and without the disorder (Northern & Downs, 2002:264). At present the hearing screening procedures of choice are automated auditory brainstem response (AABR) and oto-acoustic emission (OAE) devices (Stach & Santilli, 1998:249-250; Mason & Herrmann, 1998:221; Lutman, 2000:371-373; Watkin, 2003:168-169; JCIH, 2000:14). These procedures are preferred because of their accuracy, time-efficiency and non-invasiveness (Hahn et al., 1999:86-89; Watkin, 2003:168-169; JCIH, 2000:14; Meier et al., 2004:927).

A large multi-centre study, sponsored by the National Institutes of Health, was conducted to evaluate the accuracy of AABR, transient-evoked (TE) OAE and distortion product (DP) OAE screening test measures (Norton et al., 2000a:348-355). The study involved a cohort of 7 179 infants who were also followed up by visual reinforcement audiometry at 8 to 12 months corrected age. The study confirmed that all three methods were accurate screening tools, robust with

respect to infant state, test environment and infant medical status (Norton et al., 2000b:508-509).

Kennedy et al. (1991:1126) evaluated 370 infants (271 from the NICU) with TEOAE, ABR and AABR at 1 month, followed by behaviourally confirmed hearing at a mean age of 8 months. The results indicated that TEOAE identified the same three infants with sensori-neural hearing loss as the ABR and AABR. The specificity of TEOAE screening for bilateral and unilateral hearing loss in the Whipps Cross screening programme was >97.5% and is representative of many TEOAE screens established in the USA (Watkin 2003:168). The Whipps Cross screening programme that has been conducted since 1992, with 47 790 infants enrolled over the last decade, proved the TEOAE screening sensitivity to be 94% as established through longitudinal follow-up evaluations (Watkin, 2003:168).

Mehl and Thomson (2002:5) reported specificity for AABR testing as part of the Colorado screening programme to be 98.5%, with a positive predictive value for having a hearing loss when referred for diagnostic testing of 19%. In a cohort of 41 796 newborns screened in Colorado, as reported by Mehl and Thomson (1998:4), no evidence of a single false-negative test result was discovered and the sensitivity of newborn screening was estimated at or near 100%. Since the inception of newborn hearing screening in Colorado, the cumulative false-positive rate was ~6%, but advances in technology has allowed for a false-positive rate of 2% in more recent years (Mehl & Thomson, 1998:4; Mehl & Thomson, 2002:5). In another study, Hermann et al. (1995:11) reported a 96% sensitivity and 98% specificity rate for AABR testing as measured against conventional ABR evaluations. The Rhode Island Hearing Assessment Project screened 1 850 infants prior to discharge with TEOAE and ABR, and re-screened those referring either test at 3 to 6 weeks. An analysis of the two-stage screening protocol based on heads revealed a sensitivity of 100% and a specificity of 95% (White et al., 1994:215).

The sensitivity and specificity of current OAE and AABR screening methods have proved to produce low false-positive rates of 2-3%, with some reports of

less than 1% (Lutman, 2000:376; Spivak et al., 2000:100; Iwasaki, 2004:1099; Lutman & Grandori, 1999:95, Prieve & Stevens, 2000:87), and false-negative rates of between 6-15% as determined by studies with follow-up procedures for the entire cohort (Vohr et al., 1998:355; Kennedy et al., 1998:1963; Watkin, 1996:F16). According to Lutman (2000:367), both OAE and AABR techniques can achieve specificity in excess of 95%, and Colorado and Rhode Island UNHS programmes suggest screening protocols can achieve sensitivity approximating 100%.

The literature reviewed provides convincing evidence that the accuracy of these procedures is sufficient to justify IHS as a healthcare practice for all newborns and infants. The evidence has been so compelling that both the JCIH (2000:14) and American Academy of Pediatrics (1999:528) have recommend the use of either OAE or AABR screening devices, or both, in the implementation of UNHS programmes.

2.3.2.2. Efficiency of early identification programmes

The efficiency of early identification programmes will be presented according to three outcome measures (White, 2002:1). Firstly the coverage and referral rates obtained in UNHS programmes; secondly, the effects of screening on parents; and lastly, the effectiveness of the follow-up system. These outcome measures will be discussed in the following paragraphs.

- **Coverage and referral rates**

Once a target population is identified for screening, an important measure of the efficiency is the number of individuals who actually receive the screen (coverage). A second important measure is to ascertain how many individuals are referred for diagnostic testing based on the screen result (referral rate).

In a summary of 120 AABR and OAE UNHS programmes in the USA, the average reported coverage was 95.5% (White et al., 1997:227). It is widely

accepted that most of the hospital-based screens achieve an acceptable coverage of >95% (Watkin, 2003:168). An average coverage of 95% is reasonable, but variability has also been reported. A recent Japanese UNHS study conducted in two hospitals over a two-year period reported coverage of 99.8% of infants (Iwasaki et al., 2004:1100). It must be noted, however, that healthy newborns were only discharged 7 days after birth, allowing adequate time for screening all infants (Iwasaki et al., 2004:1100). The Wessex trial in the UK reported a coverage of 87%, but attributed this decreased coverage to several factors such as difficulties obtaining informed consent and an initial run-in period for screening where coverage was low (Kennedy et al., 1998:1963). Programmes that follow efficient protocols are able to obtain an almost complete coverage and on average the rates are sufficient to justify their implementation.

The referral rates for different screening technologies do differ, though not significantly. The multi-centre study of the National Institute for Deafness and Other Communication Disorders (NIDCD) that was conducted to evaluate the accuracy of AABR, TEOAE and DPOAE screening test measures confirmed that all three methods were efficient screening tools, with no significant variation in performance between the different screening methods that demonstrated pass rates ranging from 82% to 86% (Norton et al., 2000b:508-509). The screening test criterion affects the referral rate; for example, a more stringent pass criterion will increase the referral rate. The NIDCD study used a stringent pass criterion of 30 dB for AABR and similarly stringent criteria for OAE protocols that decrease pass rates. When these results are considered together as a screening protocol using AABR and an OAE technique, the pass rate increases to between 97% and 98% (Norton et al., 2000c:532). The multi-centre study in New York State confirmed that a two-technology protocol significantly lowered fail rates with Prieve and Stevens (2000:87), reporting a 0.9% refer rate for diagnostic testing. In an analysis of three UNHS protocols the referral rates at discharge were 3.21%, 4.67% and 6.49% for AABR, two-step (TEOAE and AABR for TEOAE referrals) and TEOAE protocols respectively (Vohr et al., 2001a:242). Consideration of these referral rates according to the benchmark of 4% specified

by the JCIH (2000:15), indicates adequate or near adequate referral rates across the different protocols.

Invariably different referral rates are reported, but according to a recent report the typical referral rates for NHS protocols in the USA vary between 2-6%, depending on which type of protocol is used (White, 2003:84). A one-stage inpatient OAE and AABR screening protocol is the most efficient, with a typical referral rate of 2%, whilst a one-stage AABR inpatient protocol typically presents with a 4% referral rate. When a two-stage OAE protocol is followed with the first screen being inpatient and the referred patients being screened as outpatients, it typically produces a 6% referral rate (White 2003:84). Careful protocol development and selection can provide referral rates that are sufficient to ensure an efficient screening process.

The coverage and referral rates are within or near the recommended rates and demonstrate the efficiency with which NHS programmes are conducted. This efficiency contributes to the justification of IHS as an important and attainable healthcare priority.

- **Effects on parents**

Although parental anxiety is an important cost that can potentially interfere with maternal infant attachment and cause abnormal parenting behaviour and communication, the potential for it to have such an effect is fortunately small and manageable (Watkin, 2003:170). In a study of parents of severely deaf children, 96% indicated that they would have wanted neonatal identification. Only a small portion indicated that they would have preferred to have waited because of the anxieties caused (Watkin et al., 1995:259). Clemens et al. (2000:5) in a study of 5 010 infants report that 90% of the mothers indicated UNHS to be a “good” idea, while Hergils and Hergils (2000:321) indicate that 95% of the parents in a study in Sweden had a positive attitude towards NHS.

Yoshinaga-Itano (2003:204) reports that neonatal identification of hearing loss through UNHS programmes does not result in greater parental stress than later-identification of hearing loss when the intervention programme contains a comprehensive counselling content. In a study of 184 parents of children with hearing loss, the parents of early-identified children were not more likely to present with stress than parents of late-identified children (Yoshinaga-Itano, 2003:204). Colorado data indicates that 10% of parents of infants referred for follow-up after NHS report negative emotions (Yoshinaga-Itano & Gravel, 2001:63). The reported stress of parents who pass the hearing screening does not prove to be significantly different from the stress reported by parents of children who have been referred for diagnostic testing. (Yoshinaga-Itano & Gravel, 2001:63). In a study investigating 288 mothers whose babies had received a neonatal screen, less than 1% were made very anxious by the test (Watkin et al., 1998:27). Vohr et al. (2001b:18) reported that 88-89% of mothers indicated none or very mild worry at the time of neonatal screen. The Wessex trial study also reported that families of infants who underwent neonatal screening were less anxious than those of unscreened infants (Kennedy et al., 1998:1963). Barringer and Mauk (1997:19) reported on parental attitudes in respect of 169 infants, indicating that 98% of these parents would give permission to have their infants' hearing screened and 88% believed that anxiety caused by their baby not passing the hearing screening would be outweighed by the benefits of early detection if hearing loss was to be found. To date there has been no evidence that newborn hearing screening causes parental harm (Yoshinaga-Itano, 2004:462).

The reports are uniform in their conclusions that parental anxiety due to screening programmes is negligible and does not differ significantly from that of parents whose infant did not receive screening. In addition to this, parents of children with hearing loss demonstrate emotional availability similar to parents of children with normal hearing (Yoshinaga-Itano, 2003:205). Preliminary data also indicates that resolution of grief by families with early-identified children occurs faster than for families with later-identified children, as long as their children develop strong language and communication skills (Yoshinaga-Itano, 2003:205).

In general, parents report that UNHS programmes have improved their awareness of the importance of hearing, language and speech development and as a result of this exposure they can pay more attention to their child's communication skills (Yoshinaga-Itano & Gravel, 2001:63).

In the light of the negligible costs of NHS programmes in terms of parental anxiety and the possible benefits of faster resolution of grief revealed from the literature reviewed, the importance of conducting NHS as standard neonatal procedure is accentuated. This supports other compelling evidence for IHS as an efficient healthcare practice.

- **Follow-up**

According to the US Preventative Services Task Force (USPSTF) (2001:96) between 13 and 31% of infants referred for further diagnostic testing in existing UNHS programmes do not return for follow-up. Data from the Colorado NHS project (1992 to 1999), which screened 148 240 newborns and identified 291 infants with congenital hearing loss, indicates a 76% documented follow-up rate for referred infants (Mehl & Thomson, 2002:1). This is a significant increase from a follow-up rate of 48% during the first five years of screening. Nine of the participating hospitals were able to achieve a follow-up rate of 95% or more for infants failing the initial screening tests (Mehl & Thomson, 2002:1). When only the 2002 Colorado data is considered, a follow-up rate of 85% is reported (Yoshinaga-Itano, 2004:463). The New York State multi-centre statewide screening project showed a similar follow-up rate of 72%, with increasingly better results for successive years of programme operation (Prieve et al., 2000:104). Follow-up return rates from the Rhode Island and Hawaii UNHS programmes indicated better follow-up rates of 85% and 82% respectively (Vohr et al., 1998:353; Johnson et al., 1997:354), while the more recent report on the Hawaii UNHS programme reflected an 87% follow-up return rate (Prince et al., 2003:1202). Although reports indicate high follow-up return rates for established programmes, room for improvement still remains.

Most operational programmes identify difficulties in the tracking and follow-up of infants referred for diagnostic evaluation as the biggest challenge pertaining to early identification. It is therefore not surprising that programmes with the highest prevalence rate are also those that are most successful at tracking and following infants through to conclusive diagnosis (White, 2003:85). Gravel et al. (2000:132) and Finitzo, Alrbright, and O'Neal (1998:1459) specify the rate of return for follow-up (leading to confirmation of hearing loss) to be one of the primary indices of both the efficiency and effectiveness of screening programmes. Although work still needs to be done, the follow-up rates have improved considerably to acceptable percentages in most UNHS programmes in the USA. New programmes elsewhere may expect initial difficulties in attaining high follow-up return rates.

The results indicate that acceptably high follow-up return rates for NHS programmes can be attained, but may take time to realise and require continued tracking efforts. Thus, although the efficiency of NHS programmes may be compromised by poor follow-up return rates, attaining acceptable rates is a real possibility that need not detract from screening protocol efficiency.

2.3.2.3. Costs of infant hearing screening

A number of different studies have reported on the costs of NHS. Costs differ due to variability in the factors that impact on the screening cost, such as capital costs, operating expenses, screening technique, follow-up costs, the number of babies, and assumptions regarding the prevalence of hearing loss (Gorga & Neely, 2003:103). A comparative study that investigated the costs of screening by using three different protocols demonstrated similar results across protocols. According to Vohr et al. (2001a:242), estimates of costs were $28.69, $32.81 and $33.05 for TEOAE, AABR and two-step protocols respectively. Mehl and Thomson (1998:4) estimated the true cost for each infant screened to be $25, which includes labour cost, disposable supplies and amortised capital equipment. The cost of screening per infant ranged from $18.30 when performed by supervised volunteers, to $25.60 when performed by a paid technician, and to

$33.30 when performed by an audiologist. Maxon et al. (1995:271) estimated costs per infant screened to be $26.05. A volunteer-based UNHS programme reported similar costs of $27.41 per infant screened (Messner et al., 2001:123). Thus, initial screening costs have been demonstrated by recent studies to be cost-effective (Baroch, 2003:424).

Kezirian et al. (2001:363) compared OAE and AABR screening protocol costs and subsequently estimated costs per screen to vary between $13 and $25. The most cost-effective screening was performed with OAE screening with an estimated total cost of $5 100 per infant identified with congenital hearing loss. Estimated costs for the AABR reached $25, with a total cost of $9 500 per infant identified with hearing loss (Kezirian et al., 2001:363). The principle finding was that an OAE/OAE protocol demonstrates the lowest cost and is the most cost-effective by a large margin (Kezirian et al., 2001:364). The Colorado UNHS statewide programme reports a cost of approximately $9 600 for identifying congenital hearing loss and $12 600 for identifying bilateral hearing loss (Yoshinaga-Itano & Gravel, 2001:64).

Even though the cost of screening individual infants for other birth defects may be lower, the prevalence of hearing loss is much higher. This leads to cost comparisons indicating that costs for identifying hypothyroidism is similar to the cost for identifying hearing loss (at $10 000), and higher for cases of hemoglobinopathy ($23 000) and phenylketonuria ($40 000) (Mehl & Thomson, 1998:5). Johnson et al. (1993:114) report similar cost comparisons. The above statistics provide an important justification of NHS as an accepted screening practice alongside previously existing programmes.

The case for early identification is also supported by long-term cost benefits for families and society. For every child who will not need special educational services, there will be an annual savings of more than $10 000 and for each child who will require a less intensive educational programme, annual savings may amount to $5 000 (Yoshinaga-Itano & Gravel, 2001:64). According to Johnson et al. (1993:115), the annual cost for an infant with hearing loss in a regular

classroom will be $3 383 compared to $35 780 in residential programmes. Yoshinaga-Itano and Gravel (2001:64) report similar figures and state an annual cost difference of between $25 000 and $35 000 for education in the local educational agency and a residential school for the deaf respectively. It is also probable that the higher the educational outcomes for children with significant hearing loss, the more likely that they will become adults employed to their full potential and contributing to society (Yoshinaga-Itano & Gravel, 2001:64).

The evaluation of initial IHS costs has revealed that IHS can be justified on the grounds of long-term economic benefit for families and society, as well as on the grounds of a significant improvement in quality of life for individuals and families.

The six principles discussed clearly demonstrate that the validity of IHS as a valid healthcare practice is no longer a question in debate. The current issues in the developed world have moved beyond the question of validity and now rather concern best practice (Hall, 2000a:396).

2.4. INFANT HEARING SCREENING PRACTICE IN THE DEVELOPED WORLD

During the past 15 years, the entire developed world and especially the USA and UK have seen a dramatic growth in newborn hearing screening, diagnosis and intervention programmes (White et al., 2003:79). Reports of UNHS programmes have also come from all over the developed world including diverse countries like Taiwan, Belgium, the Netherlands, Singapore and Israel (Lin et al., 2002:209; Pratt et al., 2004:28; Stappaerts & Van Kerschaver, 2004:9; Hanneke de Ridder-Sluiter et al., 2004:9; Low et al., 2004:29). The majority of reports, however, came from the USA and UK (Mencher et al., 2001:4-5). This growth is the culmination of more than a hundred years of striving to identify hearing loss in the infant to allow early access to auditory and language stimulation (Mencher et al., 2001:3-4). Over these years the notion of early auditory deprivation and the

desire among clinicians to intervene as early as possible have been confirmed by decades of research, which provides the foundation of current IHS practice.

UNHS has become a powerful professional and technological movement with widespread influence within the USA (Hall, 2000b:113). Early Hearing Detection and Intervention (EHDI) programmes were clearly established as part of the public health system by the end of 2001 with all US states having identified a state EHDI coordinator (White, 2003:81). It was recently reported that 42 states and the District of Columbia have EHDI laws or voluntary compliance programmes (Gracey, 2003:309). Of these states, 37 have legislation pertaining to UNHS, with the first state, namely Hawaii, having obtained legislation as far back as in 1990 (White, 2003:81). More than 70% of all newborns in all US states are screened for hearing loss before their discharge from hospital (White, 2003:87). It is clear that in the USA NHS has become the *de facto* medical/legal standard of care (White, 2003:85).

The Department of Health in the UK also commissioned a national NHS programme in 2001 following a systematic review of the role of neonatal hearing screening in the identification of hearing impaired and deaf children in 1997 (Davis et al., 1997:1-177; Davis & Hind, 2003:194). Recommendations were provided for implementing a national UNHS programme (Bamford & Davis, 1998:3) and the initial phase involves 23 sites. These sites are linked to a systematic evaluation that will provide feedback for the development of NHS in all areas of England and other regions of the UK by April 2005 (Davis & Hind, 2003:195). The implementation of UNHS programmes has subsequently commenced nationwide in the UK.

UNHS programmes are also in the process of being implemented in Australia on a national basis at the recommendation of the Australian Consensus Statement on Universal Neonatal Hearing Screening produced by the Australian National Hearing Screening Committee (ANHSC) (ANHSC, 2001:2). These recommendations have been in response to the international move toward UNHS in developed countries such as the USA, UK, Canada and Europe (Wake,

2002:172). Pilot studies have already been conducted and are providing guidelines and recommendations for the future of UNHS in Australia (Bailey et al., 2002:184). The momentum of UNHS programmes is rapidly swaying developed countries such as Australia to follow the example of countries like the USA and UK. It is clear that widespread support for UNHS programmes is a growing reality.

To summarise, numerous authoritative and well-respected bodies with an interest in early detection of hearing loss have supported the implementation of widespread UNHS (Hall, 2000b:113; White 2003:86). In 1993 a National Institute of Health Consensus Development Panel recommended universal screening for hearing loss prior to 3 months of age in order to allow for the identification of and intervention for infants with hearing loss by 6 months of age (NIH, 1993:1-24). The American Academy of Pediatrics produced a statement endorsing the implementation of UNHS in 1999 (AAP, 1999:527). Building upon the recommendations by the NIH consensus statement and the American Academy of Pediatrics statement, the Joint Committee on Infant Hearing 2000 position statement was developed and approved by the American Academy of Audiology; the American Academy of Otolaryngology - Head and Neck Surgery; the American Academy of Pediatrics; the American Speech-Language-Hearing Association; the Council on Education of the Deaf; and Directors of Speech and Hearing Programmes in State Health and Welfare Agencies. The position statement endorses early detection of and intervention for infants with hearing loss through integrated, interdisciplinary state and national systems of UNHS, evaluation and family-centred intervention (JCIH, 2000:9-10). This multi-disciplinary consensus regarding NHS demonstrates the recognition of infant hearing loss as an important healthcare priority that requires early intervention services through early identification.

The Center for Disease Control and Prevention in the USA also supports UNHS through the EHDI programmes by assisting states in implementing screening and intervention programmes and conducting research on EHDI programmes (USPSTF, 2001:97). The Maternal and Child Health Bureau of the Health

Resources and Services Administration (HRSA) supports UNHS and has provided funding to assist states in developing such programmes. It has also produced a publication promoting the early identification of hearing loss (USPSTF, 2001:97).

A European consensus statement supporting UNHS was produced at a consensus conference on neonatal screening held in Milan in 1998 (Lutman & Grandori, 1999:95-96). The British National Coordinating Centre for Health Technology Assessment also supports UNHS, which has led to the implementation of UNHS services by the Department of Health (Davis et al., 1997:87; Davis & Hind, 2003:194). It is therefore clear that numerous international groups and committees have recommended the implementation of UNHS on the grounds of the research evidence available.

To date there is only one group, the USPSTF (Thompson et al., 2001:2008) that has considered the evidence related to UNHS and has not unequivocally endorsed it. Their conclusions have been widely misunderstood and whilst they conclude that there is not yet clear evidence regarding whether NHS truly does result in better language outcomes, they clearly state that UNHS is feasible to implement, results in earlier identification of hearing loss and can be done with equipment that is accurate, practical to use and economical (White, 2003:86). In a recent report, Yoshinaga-Itano (2004:451-465) provides an excellent address to the conclusions of the USPSTF. The author highlights several inaccurate and unsupported statements made by the USPSTF and states that all studies investigating outcomes demonstrated the same result, a robust and repeatable impact of early identification and initiation of intervention on developmental outcomes. Yoshinaga-Itano subsequently (2004:463) concludes that "[a]lthough the USPSTF believes that statistical analysis and experimental group statistical control are not sufficient, the effects were so significant that statistical analysis was unnecessary to demonstrate the impact". The benefits of UNHS toward earlier identification and early intervention, which lead to improved outcomes, are therefore undisputable.

Evaluation of the current status of IHS in the developed world reveals that UNHS has become the standard of care for newborns and that services are becoming a widespread and encompassing reality. Attaining this sought-after goal, however, requires a comprehensive system of service provision measured against clearly specified benchmarks and standards.

2.4.1. Benchmarks and standards for hearing screening

Early intervention for hearing loss has become an increasingly essential aspect of audiological service delivery. The development and refinement of screening and diagnostic equipment has enabled the extension of audiological scope of practice to include newborns as a significant population for receiving services. This shift in audiological practice has led to the need for establishing standards and guidelines so as to provide effective and accountable services.

The visionary ideal of Marion Downs during the 1960s to introduce widespread newborn hearing screening led to the formation of a national surveillance committee on newborn screening – The Joint Committee on Infant Hearing (JCIH) (Northern & Downs, 2002:267). The establishment of this committee was the single greatest factor that influenced the course of newborn screening in the USA, as it represented the American Academy of Pediatrics, the American Academy of Otolaryngology, the American Academy of Audiology, and the American Speech-Language-Hearing Association (Downs, 2000:291; Mehl & Thomson, 1998:4). Since its first meeting in 1969 it has gathered several times to monitor scientific investigations and to provide guidelines and standards for audiological service delivery to the population of newborns and young infants (Downs, 2000:291). The succession of statements from 1970 right through to the new millennium has provided a review of the progression of expertise and attitudes on newborn screening (Downs, 2000:291).

The recommendations by the JCIH have been the driving force behind the enthusiasm and commitment toward the early identification of infants with hearing loss in the USA and elsewhere in the world. These recommendations

have indeed steered NHS from a targeted to a universal screening approach over the past four decades.

2.4.1.1. From targeted to universal newborn hearing screening

During the 1950s and 1960s the Hardy Group in the USA focused on the development of a list of etiological factors for sensori-neural hearing loss that eventually became known as the High-Risk Register (HRR) for Hearing Loss (Mencher et al., 2000:4). In 1973 the JCIH recommended that mass newborn behavioural screening be continued in favour of testing only those infants determined to be at-risk according to five identified risk criteria on the HRR (Mahoney & Eichwald, 1987:156). The JCIH revised this statement in a 1982 statement when it updated the recommendations and added two more criteria to the original five high-risk indicators (JCIH, 1982:1017). After that a number of developments led to the JCIH producing a 1994 position statement in which it changed its goal of targeted high-risk screening and endorsed "the goal of universal detection of infants with hearing loss as early as possible. All infants with hearing loss should be identified by three months of age, and receive intervention by six months of age" (JCIH, 1994:6).

The two main reasons for the evolution of recommended NHS practice from targeted to universal were advances in technology and poor yield of infants with hearing loss by high-risk screening. The discovery of the ABR in 1971 (Jewett & Williston, 1971:681) and OAE in 1978 (Kemp, 1978:17) paved the way for quasi-automatic electrophysiological NHS devices becoming available near the end of the 1980s and early 1990s (Hall, 2000b:112; Mencher et al., 2001:5). Pilot projects and continued improvements in technology demonstrated these techniques to be a fast and accurate means of screening newborns (Vohr et al., 1998:343; Hall, 2000b:112; Northern & Downs 2002:268; Roizen, 1998:237). These new screening devices made UNHS a feasible possibility for the very first time.

The second reason for the development of UNHS as the standard of care above Targeted NHS is the fact that only a limited number of infants with hearing loss actually present with high-risk indicators. Targeted NHS is based on the principle that screening a small number of infants will produce a large number of infants with hearing loss. This type of screening however existed in the USA for decades and failed to identify a large cohort of children in the first year of life (Yoshinaga-Itano, 2004:462). In a large study of 283 298 newborns by Mahoney and Eichwald (1987:161), approximately 9% of newborns presented with at least one risk indicator for hearing loss. Mason et al. (1997:91) reported a similar value of 10%. A number of different studies have reported that this at-risk population only accounts for approximately 50% of infants with congenital hearing loss (Chu et al., 2003:584; Davis & Wood, 1992:77; Watkin et al., 1991:1130; Mauk et al., 1991:312). Furthermore, the children identified in their first year of life through targeted NHS have a significantly higher incidence of secondary abilities (~66%) than the children identified through UNHS in well-baby nurseries (~30%). This means that the children presenting only with hearing loss, who have the highest potential for success, are most likely to be missed (Yoshinaga-Itano, 2004:462).

These two reasons are convincing factors that explain the replacement of targeted NHS with UNHS as the standard of care in developed countries. The most recent JCIH position statement (JCIH, 2000:10) reflects the realisation of UNHS as the standard of care and emphasises not only the process of screening, but also the system of providing comprehensive intervention services to infants – of which screening is only the initial component. Effective and efficient systems of service provision are essential to ensure successful NHS programmes.

2.4.1.2. Early hearing detection and intervention systems

The Year 2000 position statement of the Joint Committee on Infant Hearing (JCIH, 2000) is a landmark for all professionals concerned with hearing loss in young infants (Downs, 2000:292). The position statement highlights six important guidelines for hearing detection and intervention programmes that fit into the

model of early intervention service delivery. Figure 2.3 illustrates the JCIH (2000) guidelines and areas to be included in programme design as suggested by Bamford (2000:359) and fitted into the basic model of early intervention service delivery.

Early intervention for children with hearing loss not only emphasises the early identification of hearing loss, but also entails the fitting of sound-enhancing devices like hearing aids or cochlear implants, the implementation of support and counselling services to caregivers, as well as the provision of aural rehabilitative services (Northern & Downs, 2002:150). The purpose of EHDI programmes is the identification, management and support of children with these hearing losses, as well as their families (Bamford, 2000:359). The programmes must therefore cover "screening and surveillance, audiologic assessment, audiologic intervention, family support, developmental assessment and monitoring, early educational support, and linkage with other health, medical, educational, and social services" (Bamford, 2000:359). According to English (1995:117), "audiologists who serve infants and toddlers with hearing loss and their families should consider themselves early interventionists and, therefore, part of an early intervention team".

These services, however, are primarily dependant on the detection of hearing loss, followed by an accurate diagnosis of the type, degree and configuration of hearing loss for both ears (Gorga, 1999:29). In other words – successful determination of hearing ability is the basis of all early intervention programmes for children with hearing loss.

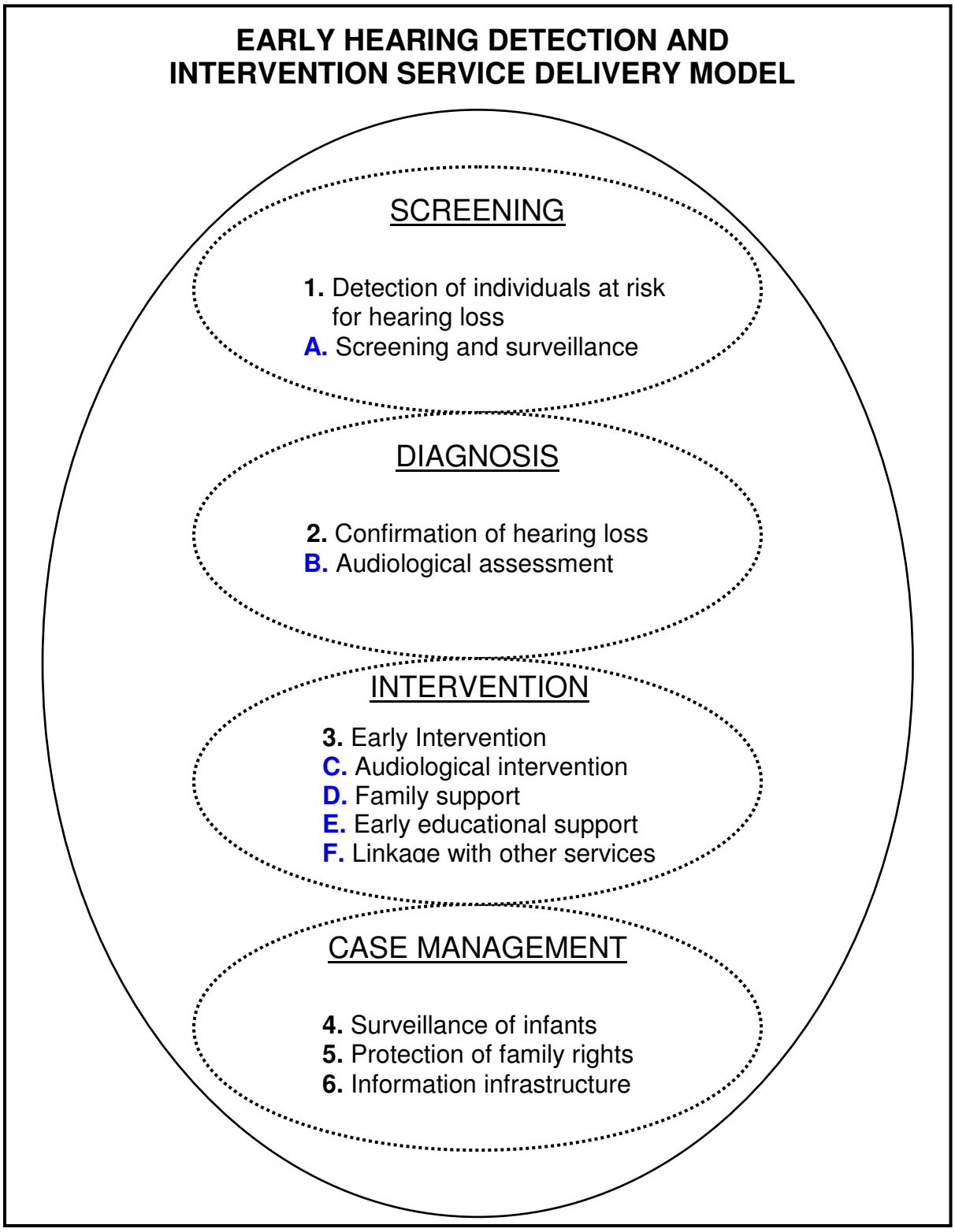


FIGURE 2.3 Early hearing detection and intervention model

Basic 4-component service delivery model for early intervention. Guidelines for EHDI programmes specified by JCIH (2000) are listed under each section from 1 to 6. Areas to be included as specified by Bamford (2000:359) for each component are listed from A to F.

The first step in the initiation of the early intervention process is identification and screening. This involves the process of locating infants who might be eligible for early intervention (Widerstorm et al., 1997:216). If an infant is identified as at-risk, he/she is referred for an in-depth assessment to professionals in the area or areas failed. The assessment component is a diagnostic facility that establishes whether the presence of developmental delay or disability is present and that decides whether a subject is eligible for services or programmes (Fair & Louw, 1999:15; Widerstorm et al., 1997:218). As mentioned earlier, all early intervention services involve an initial detection of hearing loss, after which the type, degree and configuration of hearing loss for both ears have to be diagnosed accurately (Gorga, 1999:29). This diagnostic assessment information serves as basis for deciding whether early intervention is necessary and should be followed by the planning of appropriate services (Rossetti, 1996:79). The final step is the case management, which involves the continuous surveillance of infants and toddlers, protection of infants' and families' rights and the establishment and maintenance of an infrastructure for managing data. The early intervention process is a structured progression of step-wise procedures with the ultimate aim of assisting the high-risk infant to develop his/her full potential by facilitating age-appropriate developmental skills by means of a family-centred approach.

The development and implementation of high quality services to respond to the numerous possible combinations of child and family needs is a major challenge which, for the most part, has been poorly met (Bamford, 2000:359). It is for this reason that the JCIH Year 2000 position statement has been a landmark for establishing standards and quality indicators for the development and implementation of EHDI services (Downs, 2000:292). The position statement should be used as a guiding document for all stakeholders in an EHDI programme.

2.4.1.3. JCIH Year 2000 position statement

The JCIH Year 2000 position statement is a ”masterful statement concerning the status and future direction of infant hearing screening” (Northern & Downs, 2002:269). The multi-disciplinary committee endorses the ”early detection of, and intervention for infants with hearing loss (EHDI) through integrated, interdisciplinary state and national systems of universal newborn hearing screening, evaluation, and family-centered intervention” (JCIH, 2000:10). The aim of endorsing these services is to ensure the maximum linguistic and communicative competence and literacy development for children who are deaf or hard of hearing (JCIH, 2000:10). The committee provided eight principles as the foundation for effective EHDI systems with benchmarks and quality indicators specified for these principles. The benchmarks are quantifiable goals or targets that can be used to monitor and evaluate an EHDI programme and that serve to point toward the next needed steps in achieving and maintaining a quality programme. The quality indicators reflect a result in relation to a specific benchmark and should be monitored using well-established practices of statistical process to control and determine the programme consistency and stability (JCIH, 2000:11-12). These principles and their components, as well as the specified benchmarks and quality indicators for each, are summarised in Table 2.5.

TABLE 2.5. Summary of the JCIH Year 2000 Position Statement

PRINCIPLES (1-8)	COMPONENTS	BENCHMARKS	QUALITY INDICATORS
1 HEARING SCREENING	1. PERSONNEL *Teams of professionals involved in establishing UNHS component of EHDI programme* 2. PROGRAMME PROTOCOL DEVELOPMENT *Comprehensive review needed of hospital infrastructure before implementation of screening. Development must consider technology, screening protocols, availability of screening personnel, acoustically appropriate environments, follow-up referral criteria, information management, and quality control* 3. SCREENING TECHNOLOGIES Objective physiologic measures must be used. Currently OAE and ABR screening procedures 4. SCREENING PROTOCOLS A variety of UNHS screening protocols have been successfully implemented	1. Minimum of 95% of infants < 1 month, screened within 6 months of programme initiation 2. Referral rate less than 4% within 1 year of programme initiation 3. Document efforts to obtain follow-up on a minimum of 95% of infants who do not pass the hearing screening. Ideally a return-for-follow-up of 70% of infants or more	1. Percentage of infants screened during the birth admission 2. Percentage of infants screened before 1 month of age 3. Percentage of infants who do not pass the birth admission screen 4. Percentage of infants who do not pass the birth admission screening who return for follow-up services 5. Percentage of infants who do not pass the birth admission/outpatient screen(s) who are referred for audiological and medical evaluation 6. Percentage of families who refuse hearing screening on birth admission
2 CONFIRMATION OF HEARING LOSS IN INFANTS REFERRED FROM UNHS	1. AUDIOLOGIC EVALUATION *Purpose is to assess the integrity of the auditory system, to estimate hearing sensitivity (ear-specific estimates of type, degree, and configuration of hearing loss), and to identify all intervention options. Requires test-battery to cross-check both physiologic and behavioural measures.* 2. MEDICAL EVALUATION *Every infant with confirmed hearing loss and/or middle ear dysfunction should be referred for otologic and other medical evaluation. Purpose is to determine the etiology, identify related physical conditions and provide recommendation for medical treatment and other services. Pediatrician or primary care physician, Otolaryngologist and other medical specialists may be included*	1. Comprehensive services coordinated between infant's medical home, family, and related professionals 2. Infants referred from UNHS begin audiologic and medical evaluations before 3 months of age or 3 months after discharge for NICU infants 3. Infants with evidence of hearing loss on audiologic assessment receive otologic evaluation 4. Families and professionals perceive the medical and audiologic evaluation process as positive and supportive 5. Families receive referral to coordinating agencies, appropriate intervention programmes, parent/consumer and professional organizations, and child-find coordinators if necessary	1. Percentage of infants and families whose care is coordinated between the medical home and related professionals 2. Percentages of infants whose audiologic and medical evaluations are obtained before 3 months of age 3. Percentage of infants with confirmed hearing loss referred for otologic evaluation services 4. Percentage of families who accept audiologic and medical evaluation services 5. Percentage of families of infants with confirmed hearing loss that have a signed IFSP by the time the infant reaches 6 months of age

TABLE 2.5. Continued

PRINCIPLES (1-8)	COMPONENTS	BENCHMARKS	QUALITY INDICATORS
3 EARLY INTERVENTION	1. EARLY INTERVENTION PROGRAMME DEVELOPMENT *Services designed to meet individualized needs of infant and family which addresses acquisition of communicative competence, social skills, emotional well-being, and positive self-esteem.* 2. AUDIOLOGIC HABILITATION *Selection and fitting of some form of personal amplification or sensory device in a timely fashion* 3. MEDICAL AND SURGICAL INTERVENTION *Process whereby a physician provides medical diagnosis and direction for medical and/or surgical treatment options for hearing loss and/or related medical disorder(s) associated with hearing loss* 4. COMMUNICATION ASSESSMENT AND INTERVENTION Assessment of oral, manual, an/or visual mechanisms as well as cognitive abilities followed by intervention addressing these aspects with a particular focus on supporting families in developing communication abilities of their infants and toddlers who are hard of hearing or deaf	1. Infants with hearing loss are enrolled in a family-centred EI programme before 6 months of age 2. Infants with hearing loss are enrolled in a family-centred EI programme with professional personnel who are knowledgeable about the communication needs of infants with hearing loss 3. Infants with hearing loss and no medical contraindication before use of amplification when appropriate and agreed on by the family within 1 month of confirmation of the hearing loss 4. Infants with amplification receive ongoing audiologic monitoring at intervals not exceeding 3 months 5. Infants enrolled in EI achieve language development in the family's chosen communication mode that is commensurate with the infant's developmental level that is similar to that of hearing peers of comparable developmental age 6. Families participate in and express satisfaction with self-advocacy	1. % of infants with hearing loss who are enrolled in a family-centred EI programme before 6 months of age 2. % of infants with hearing loss who are enrolled in an EI programme with professionals who are knowledgeable about over-all child development as well as the communication needs and intervention options for infants with hearing loss 3. % of infants in EI who receive language evaluations at 6 month intervals 4. % of infants and toddlers whose language levels, whether spoken or signed, are commensurate with those of their hearing peers 5. % of infants and families who achieve the outcomes identified on their IFSP 6. % of infants with hearing loss and no medical contraindication who begin use of amplification when agreed on by the family within 1 months of confirmation of the loss 7. % of infants with amplification who receive ongoing audiological monitoring at intervals not to exceed 3 months 8. No. of follow-up visits for amplification monitoring and adjustment within the 1st year following amplification 9. % of families who refuse EI services 10. % of families who participate in and express satisfaction with self-advocacy

TABLE 2.5. Continued

PRINCIPLES (1-8)	COMPONENTS	BENCHMARKS	QUALITY INDICATORS
4 CONTINUED SURVEILLANCE OF INFANTS AND TODDLERS	1. RISK INDICATORS FOR NEONATES (BIRTH THROUGH AGE 28 DAYS) *List of 5 risk indicators for use in neonates where universal hearing screening is not yet available* 2. RISK INDICATORS FOR NEONATES OR INFANTS (29 DAYS THROUGH 2 YEARS) *These indicators place an infant at risk for progressive or delayed-onset sensorineural hearing loss. Any infant who passed the birth screen but demonstrate one of these risk indicators should receive audiologic monitoring every 6 months until age 3 years*	None specified	None specified
5 - 6 PROTECTION OF INFANTS' AND FAMILIES' RIGHTS	Each agency or institution involved in the EHDI process shares the responsibility for protecting infant and family rights. These rights include access to UNHS, information in the family's native language, choice, and confidentiality. The information should cover the prevalence and effects of hearing loss, the potential benefits and risks of screening and evaluation procedures, and the prognosis with and without early identification and intervention. Families have the same right to accept and decline hearing screening or any follow-up care for their newborn. The results of the screening are to be communicated verbally and in writing to families by health care professionals knowledgeable about hearing loss and the appropriate interpretation of results.	None specified	None specified
7 – 8 INFORMATION INFRASTRUCTURE	Recommends development of uniform state registries and national information databases incorporating standardized methodology, reporting, and system evaluation. Information management should be used to improve services to infants and their families; to assess the quality of screening, evaluation, and intervention; and to facilitate collection of data on demographics of neonatal and infant hearing loss.	None specified	None Specified

Benchmarks and quality indicators are specified only for the first three principles – screening, diagnosis and intervention – which are also the most prominent, and to date, the most studied aspects of EHDI service delivery. Benchmarks and quality indicators were not specified for principles 4 to 8, probably because these principles are not defined as clearly as the first three and also due to a dearth of research into these aspects. Currently there is also no mechanism to enforce application of these standards and no formal measurement of their use in the USA (Mencher & DeVoe, 2001:19). According to the position statement, "to achieve accountability, individual community and state, health and educational programmes should assume responsibility for coordinated, ongoing measurement and improvement of EHDI process outcomes" (JCIH, 2000:10). Thus the improvement of EHDI services is an ongoing process that requires the support and feedback from all role-players in the EHDI system.

2.4.2. Current infant hearing screening issues

A century of reported research on identifying hearing loss in the newborn has culminated in the ability to identify and diagnose hearing loss for this population. This has been reflected in the recommendations throughout the last decade by several international organisations to diagnose hearing loss by the age of 3 months and initiate intervention before 6 months of age (NIH, 1993:1-24; JCIH 2000:9-29; Grandori, 1998:1219; AAP, 1999:527-530). The fact, however, that it is now possible to identify and diagnose hearing loss at birth does not mean that all the issues have been addressed sufficiently.

The following discussion will highlight some current issues of NHS programmes in the developed world. Although healthcare models in the United Kingdom, United States, Canada and most of the countries in Western Europe differ, a measure of services in one of these countries does offer an insight into comparable services in the rest of the developed world (Mencher et al., 2001:9). The majority of issues identified and to be discussed are based on literature findings from the USA and UK.

The most important issue concerns the *target disorder* to screen for. In the United Kingdom, based on current evidence of outcome benefit for early identification, the target disorder to be screened for is a child with 40 dB HL or greater permanent bilateral hearing loss (0.5 - 4 kHz) (Bamford, 2000:360). The JCIH in turn defines the targeted hearing loss for UNHS programmes as permanent bilateral or unilateral, sensory or conductive hearing loss, averaging 30 to 40 dB or more in the frequency region important for speech recognition (approximately 500 through 4000Hz) (JCIH, 2000:11). These differences in specified target disorders raise a number of additional questions that must be addressed:

- The question of *unilateral versus bilateral hearing loss* detection becomes a compromise between the effectiveness of the treatment and the costs involved. Although research indicates that unilateral hearing loss affects developmental and emotional outcomes in children (Bess et al., 1998:339), limited resources inevitably place a larger emphasis on identifying bilateral hearing loss above the more expensive identification of unilateral hearing loss (Lutman, 2000:368). It therefore becomes a matter of selecting a target disorder within the context of available resources. The UK has selected to screen for bilateral hearing loss while the USA has opted for unilateral and bilateral hearing loss identification. It is clear that deciding upon an appropriate option depends on the context and available resources.

- A more complicated question regards the *types of hearing loss* to be screened for and has important implications for the choice of screening device and protocols. The JCIH (2000:11) specifies screening for sensory and conductive hearing losses. Sensory hearing losses can be identified with OAE and ABR devices but no mention is made of neural hearing losses such as Auditory Neuropathy (AN). The latter can be identified only by using a neural-based test such as an ABR (Berlin, 1999:309; Sinninger, 2002:197). Although it is difficult to determine how common AN is, a recent study reported from a large cohort of clinical findings indicates that the incidence of AN was 1 in 433 infants with risk factors for hearing loss (Rance et al.,

1999:238). Sinninger's (2002:197) summary of reports proposes an incidence of 10.3 per 100 paediatric patients with hearing loss. The prevalence of the disorder therefore seems to be higher than previously expected (1 in 10) and if a priority is placed on identifying these children, recommendations may need to be revised and screening protocols need to be adjusted to include an ABR or some form of auditory evoked potential.

- Transient *Middle-Ear Effusion* (MEE) and other middle-ear factors further complicate the issue of the target disorder to screen for. Infants with mild transient conductive hearing loss refer hearing screenings, which results in higher false positive rates and leads to added expenses and increased chances of anxiety for parents (Mencher & DeVoe, 2001:17; Thornton et al., 1993:322). Even though significant efforts have been made to reduce the number of false-positives by protocols (Prieve & Stevens, 2000:85; Spivak et al., 2000:92; Gravel et al., 2000:131), the question of transient MEE is not addressed. Clear statistical information is needed regarding the number of false-positives due to transient MEE and the implications for diagnostic agencies, funding resources, and the children and their families (Mencher & DeVoe, 2001:17). MEE is not uncommon among infants, and newborns from the NICU are especially prone to the condition (Engel et al., 2001:142). Studies indicate that OAEs are severely diminished and even obliterated by MEE, whilst ABR screening is less affected by it (Yeo et al., 2002:798; Koivunen et al., 2000:214; El-Refaie et al., 1996:7; Taylor & Brooks 2000:54). Unfortunately it is difficult to diagnose transient MEE in the newborn and young infant after referral on a screening test, as conventional immittance evaluations of middle-ear functioning are unreliable for infants younger than 7 months of age (Holte et al., 1991:1; Hunter & Margolis, 1992:33; McKinley et al., 1997:218).

  The JCIH (2000:23) identifies the need for rapid screening methods to differentiate between conductive and other hearing losses and suggests that middle-ear reflectance measures may in future contribute to determining whether middle-ear dysfunction contributes to the screen outcome. Recent

reports have demonstrated promising results for the use of high frequency tympanometry using a 1000Hz probe tone to assist in detecting middle-ear dysfunction in neonates (Kei et al., 2003:27; Margolis et al., 2003:383; Purdy & Williams 2000:22; Meyer et al., 1997:194). A reliable test that is able to distinguish between sensori-neural hearing loss and middle-ear pathology for neonates and young infants is important for a) identifying screening fails caused by transient middle-ear conditions; b) determining the need for medical management of middle-ear pathology; and c) determining the need and timing of follow-up procedures such as an ABR evaluation with and without sedation (Margolis et al., 2003:384). Continued research in this area is required to ensure that a reliable procedure is established for referring infants with middle-ear dysfunction or MEE.

- Another issue concerns the identification of *acquired, late-onset, and progressive hearing losses* as early as possible. These hearing losses will not be identified by newborn hearing screening and can be the result of (a) an acquired loss later in life after a traumatic event such as infection, ototoxic therapy, or chemo therapy, (b) a loss of insufficient severity to be detected by a screening procedure at birth but which progresses as the child grows, (c) a genuine late-onset loss that develops without any obvious causative factor (Fortnum, 2003:155). The true prevalence of such disorders is still elusive. Initial reports, based on cohorts mostly from the 1970s and 1980s in Europe, indicate that 14.5% to 27.9% of hearing-impaired children exhibit these types of hearing losses. The large range probably reflects differences in definition (Fortnum, 2003:157). Reports also indicate a higher prevalence of such disorders among NICU-discharged infants (Kawashiro et al., 1996:35). These delayed-onset hearing losses require protocols that will ensure early identification despite having passed a newborn hearing screen. The JCIH has specified a list of risk factors for delayed-onset hearing loss to monitor infants with those risk factors for possible delayed-onset hearing loss (JCIH, 2000:20-21). As UNHS programmes continue to develop, it will become possible to determine the proportion of hearing losses in infants that are truly congenital and those that occur postnatally (JCIH, 2000:23). This will allow

for accurate and comprehensive infant hearing screening programmes that identify congenital and delayed-onset or progressive hearing losses efficiently.

Substantial progress has been made in addressing many of the initial issues involved in the implementation of UNHS programmes in the USA (White 2003:83). A number of current issues identified by White (2003:87) however need to be addressed, and they are summarised in Table 2.6.

TABLE 2.6 Current EHDI issues in the USA (White 2003:79-88)

ISSUE	DESCRIPTION
• **Number of paediatric audiologists**	A nationwide shortage of paediatric audiologists has been identified as the most serious challenge in implementing successful EHDI programmes. Only 56% of infants referred from UNHS screening programmes actually received a diagnostic evaluation before the prescribed age criterion of 3 months, most probably due to this shortage of paediatric audiologists (White, 2003:84).
• **Tracking and data management**	Making sure that infants referred from screening programmes receive appropriate and timely intervention remains a significant challenge (White 2003:85).
• **Programme evaluation and quality assurance**	The need for implementing quality assurance evaluations is left wanting. There is little evidence that most state EHDI programmes have yet had time or resources to implement such systematic evaluation and quality assurance programmes (White, 2003:85).
• **Availability of early intervention programmes**	State EHDI coordinators report that appropriate educational intervention programmes for infants and toddlers with hearing loss are not as widely available as they should be. Most programmes were developed before hospital-based NHS programmes became widespread (White, 2003:84).
• **Linkage with medical home providers**	State EHDI coordinators report that the name of the primary care physician who will care for the infant with hearing loss for the first 3 months is known only by approximately 75% of newborns discharged from the hospital. In many cases these physicians are not well-informed about issues related to early identification of hearing loss (White, 2003:85).

Unlike during the early 1990s there is now a firm research and experiential basis for addressing all of the issues listed in Table 2.6. However, White (2003:87) remarks that "it will continue to require the commitment and resources of state health officials, hospital administrators, healthcare providers (particularly physicians and audiologists), and parents".

2.5. CONCLUSION

"Universal infant hearing screening is a noble goal, and the world is well down the pathway toward achieving it" (Mencher et al., 2001:10). The last 10 years witnessed UNHS becoming the *de facto* medical/legal standard of care in a developed country such as the USA, with other countries following suit (White, 2003:85; Davis & Hind, 2003:193). The ground swell of research reports, the technological advances enabling easier and more cost-effective identification, and the growing evidence in support of significant benefits of early intervention for hearing-impaired infants have asserted NHS as an increasingly important aspect of neonatal care (Roizen, 1998:237; Vohr et al., 2000a:295; White, 2003:87). The practice of NHS has established itself as a screening priority against the criteria specified for the justification of widespread screening programmes and has become an important component of preventative public healthcare (Vohr et al., 2000a:295).

To ensure that accountable services are part of an EHDI programme, important guidelines have been developed to weigh NHS practice against quality standards and performance benchmarks (JCIH, 2000:9-29; AAP, 1999:527-530). These standards and benchmarks are continually assessed to include more comprehensive recommendations that extend beyond screening and diagnosis to audiological service delivery (Culpepper, 2004:162). The trends noted in recommended procedures for infant assessment and amplification in the USA are compared to those developed in Canada, the UK and Australia in order to compile encompassing guidelines for all aspects of audiological service delivery (Culpepper, 2004:162).

It is clear that the course of IHS, spanning across the major part of the last century, has paved its way into developed countries around the world (Downs, 2000:292-293). The principles that justify IHS as a valid healthcare and societal practice in developed countries, as well as the current status of these programmes, provide an important framework for the critical consideration of IHS in developing contexts. This matter will be addressed in Chapter 3.

2.6. SUMMARY

Chapter 2 provided the basic philosophy and principles pertaining to widespread IHS and assessed the current status of NHS in the developed world. Principles were selected from the literature and divided into a discussion of disorder-related and screening-process related principles. The practice of IHS was justified by evaluating it against these principles, which underlie the rationale for widespread screening. The discussion was followed up by an assessment of the current status of IHS in the developed world. Screening options, EHDI systems and the JCIH Year 2000 position statement were discussed and the current issues of NHS practice evaluated. The chapter was concluded with final remarks to focus the reader's attention on the framework of current IHS practice provided during the discussion of Chapter 2. The latter serves as background to Chapter 3.

CHAPTER 3

INFANT HEARING SCREENING: A PRACTICE RELEVANT FOR THE DEVELOPING WORLD?

Aim: This chapter will evaluate the justification for and the current status of IHS in developing countries to provide an argument for IHS in this context

3.1. INTRODUCTION

A continuous influx of reported data regarding the growth of universal newborn hearing screening (UNHS) and the benefits of early intervention for infants with hearing loss has characterised the audiology literature over the last number of years (Moeller, 2000:1). These reports, however, have primarily originated from developed countries such as the USA and UK, and have revealed a dearth of information regarding hearing screening and intervention in the developing world (Mencher & DeVoe, 2001:20). Apart from a small number of recent exceptions, NHS has been a practice almost exclusively reserved for the developed world (Mencher & DeVoe, 2001:19; Chap-Chap & Segre, 2001:34; Rouev et al., 2004:805; Olusanya et al., 2004:288). Fortunately a growing global awareness is currently shedding more light on this hidden health concern in the developing world. There has been an increased focus, particularly in the last decade, on the development of effective prevention programmes in developing countries (Prasansuk, 2000:208; Mencher & DeVoe, 2001:19).

The introduction of Infant Hearing Screening (IHS) programmes in developing countries is, however, still widely viewed as unattainable due to numerous socio-economic, cultural and healthcare barriers (Olusanya et al., 2004:288). Recently a renewed call was made upon developed nations to assist developing countries

with the introduction and implementation of IHS programmes (Downs, 2000:293; Swanepoel et al., 2004:634). *The question that arises is whether such a practice will be relevant for developing nations in the light of the many barriers inherent to the developing world.* This chapter therefore aims to evaluate the relevance of IHS to the developing world.

A critical evaluation of the relevance of IHS requires that it be considered within the framework of IHS principles and current practice in the developed world as discussed in Chapter 2. In a theoretical sense, it is necessary that IHS in the developing world adhere to the philosophy and principles of screening to ensure its validity as a societal practice. In a more practical sense it is important to consider the current status and accountability of IHS programmes in developed nations such as the USA, in order to develop appropriate benchmarks that may steer the process in developing countries to benefit the infants with hearing loss. A general overview of the developing world in Chapter 3 will serve as the background to Chapter 4, which will provide an in-depth evaluation of IHS in the developing context of South Africa.

It is the purpose of Chapter 3, therefore, to evaluate the justification for and the current status of IHS in developing countries. The chapter starts off with an overview of hearing loss within a healthcare perspective that is familiar to the developing world. This immediately places IHS in developing countries within a global perspective. A consideration of the challenges to and assets available for implementing such programmes is provided, followed by a concluding argument toward the implementation of IHS in developing countries.

3.2. HEALTHCARE PERSPECTIVE IN DEVELOPING COUNTRIES

The developing world consists of 164 countries with an estimated population of 5 billion people spread over six major regions (World Bank, 2004:251; Olusanya et al., 2004:289). These regions and the number of countries in each are presented in Table 3.1.

TABLE 3.1 Developing regions and countries of the world (World Bank, 2004:251)

REGION	NUMBER OF COUNTRIES
Sub-Saharan Africa (SSA)	46
Middle East & North Africa (MEN)	21
South Asia (SOA)	8
East Asia & Pacific (EAP)	29
Latin America & Caribbean (LAC)	33
Central/Eastern Europe & Baltic State Countries (CEE)	27

The countries in these regions are classified according to various indicators of development such as per capita income, immunisation up-take and under-5 mortality rates. It is important to note therefore that this is not a homogenous group of countries. Although two-thirds of the least developed nations are situated in sub-Saharan Africa (McPherson & Swart, 1997:2), there are significant differences in development between these countries and even within the same country in different geographical regions (Olusanya et al., 2004:289). Despite these differences, this categorisation provides an objective basis for comparing various economies of the world.

Only 20% of the global population live in the developed countries, compared to 80% in developing countries. However, there is a gross misdistribution of wealth and healthcare expenditures between the developed and developing world. The developed world, 20% of the global population, controls 80% of the gross domestic product and this same 20% spends 87% of the total global healthcare funds (Alberti, 1999:1). In comparison, developing countries such as China and India, which comprise 40% of the global population, spend only 2% of the global healthcare budget (Alberti, 1999:3). In a survey of hearing aid possession in

different countries this discrepancy was obvious, as the possession of a hearing aid was directly related to the wealth of that particular country as reflected in the per capita Gross National Product (Stephens et al., 2000:184).

It is clear that this misdistribution of resources is due to and creates many challenges in developing countries, including low socio-economic levels and high child mortality and morbidity rates (McPherson & Swart, 1997:2). Healthcare priorities of developing countries are clearly focused on saving lives rather than on improving quality of life (Olusanya, 2000:167). This has led to a general neglect of non-life-threatening conditions such as hearing loss and deafness (Olusanya, 2000:167; Madriz, 2001:91), despite the fact that at least two-thirds of the world's population of persons with disabling hearing loss reside in developing countries (Olusanya, 2000:167; WHO, 2001a:1).

It is therefore not surprising that hearing loss is referred to as the silent and overlooked epidemic of developing countries. It may be viewed as an epidemic, because even though hearing loss is not a life-threatening condition, failure to intervene in time renders it a severe threat to essential quality of life indicators. The adverse affects of hearing loss on language and cognitive development, as well as on psychosocial behaviour are widely reported against the established benefits of early intervention (Moeller, 2000:5; Yoshinaga-Itano, 2003:199-206; Davis & Hind, 2003:194). Society is also severely burdened by hearing loss due to the huge economic costs associated with it. A recent study in the USA suggests that the cost of communication disorders in that country (due to rehabilitation, special education and loss of employment) is almost 3% of the gross national product (WHO, 2001a:1). Hearing loss affects an individual's ability to obtain, perform in and keep a job, and it causes people to be isolated and stigmatised during the entire course of their lives.

The World Health Organisation (WHO) has in recent years recognised that deafness is not only one of the most neglected disabilities, but also that it is worse in developing countries (Kumar, 2001:219). This realisation emerged in 1981 when the WHO adopted a new health perspective declaring that health is

not simply the absence of disease or infirmity but a state of complete physical, mental and social well-being (Olusanya, 2000:168). This change in healthcare perspective has shifted the emphasis from disease management to total well-being. According to Olusanya (2000:168) this new perspective justifies good hearing as a fundamental human right. Thus, intervention for an individual with hearing loss is an important health concern, since it impacts severely on quality of life.

Following this change in emphasis, the WHO has increased its efforts to stimulate action plans for the prevention and management of hearing loss in developing countries (WHO, 1997:5). In 2001 the organisation published guidelines related to hearing aids and services for developing countries that provide detailed requirements for the manufacturing of affordable and appropriate hearing aids, provision of services and training of personnel in developing countries (WHO, 2001b:2). The WHO estimates that developing countries need more than 32 million hearing aids per year and at present they are receiving only three-quarters of a million (Kumar, 2001:219). It is reported that current hearing aid manufacturers provide less than 10% of the annual need for hearing aids and that only one in 40 hearing aids needed in developing countries is actually supplied (WHO, 2001a:1). For this reason, the WHO is joining forces with hearing aid manufacturers, charities and aid agencies in an attempt to drastically reduce the price of hearing aids (WHO, 2001b:7; WHO, 2001a:1).

Despite these efforts, progress has been slow and doubts have been voiced about the feasibility of implementing large-scale hearing detection programmes such as IHS in developing countries (Olusanya, 2001:142; Mencher & DeVoe, 2001:19). Objections have been raised against the enthusiastic spread of IHS programmes from developed to developing countries due to a lack of reliable follow-up services once the children are identified with hearing loss. Failure to deliver the services may produce a negative environment for parents, teachers, administrators and legislators (Mencher & DeVoe, 2001:20). It is in light of these

concerns that it becomes important to evaluate the relevance of IHS in developing countries.

3.3. RELEVANCE OF INFANT HEARING SCREENING IN DEVELOPING CONTEXTS

The six principles (grouped into disorder-related and process-related categories) that underpin the justification of a screening procedure and that were identified and discussed in Chapter 2 (paragraph 2.3), will now be reviewed within the context of developing countries. This discussion will precede an evaluation of a context-based decision-making approach toward IHS implementation in these countries.

3.3.1 Disorder-related principles in developing countries

In contrast to developing countries, epidemiological data for hearing loss is available for the vast majority of developed countries (Uus & Davis, 2000:192). This attests to an extreme dearth of data due to factors such as limited resources, poor motivation for/high resistance to epidemiological research and low priorities within health systems to deal with hearing loss (Mencher, 2000:178; Madriz, 2001:85). As a result the prevalence of hearing loss in developing countries is largely unknown (Olusanya et al., 2004:289). For the few prevalence studies that have been reported, comparison is difficult due to significant differences in methodology, categorisation and definition of hearing loss (Prasansuk, 2000:178; Uus & Davis, 2000:192; Bastos et al., 1995:1; Jacob et al., 1997:133; Rao, 2002:105; Swart et al., 1996:95; McPherson & Swart, 1997:3).

The World Health Organisation estimates that 250 million people worldwide have disabling hearing loss and that two-thirds of them live in developing countries (Kumar, 2001:219). Based on a review of reported prevalence rates in the paediatric population of developing countries, it was concluded that the

prevalence is not less than one to five live births per 1 000 generally reported in the developed countries where NHS has been introduced (Olusanya et al., 2004:293). In fact the prevalence of congenital hearing loss has been associated with deprivation and therefore it will not be surprising to find higher prevalence data for developing than for developed countries. A recent study reports that this association of hearing loss with deprivation can be attributed to two main reasons (Kubba et al., 2004:125). The first reason is related to the greater incidence of prematurity and low birth weight in deprived families. This places neonates at risk of suffering hearing loss as a result of hypoxia, jaundice and aminoglycoside treatment. The second reason concerns the fact that hearing-impaired individuals are disadvantaged both educationally and in their employment prospects. This means that families with many hearing-impaired members will tend to be in a lower socio-economic bracket (Kubba et al., 2004:125).

The reported prevalence of congenital hearing loss in developed countries has proved to be sufficiently high to warrant mass NHS (Mehl & Thomson, 1998:5). It is expected therefore that mass NHS in developing countries can also be justified on the grounds of equivalent or even higher prevalence figures. Even though almost all the studies reporting the negative consequences of neonatal hearing loss and the effect of early versus later identification of hearing loss has been forthcoming from developed countries, it is more than reasonable to expect similar consequences and effects on neonates born in developing regions of the world. In fact, the consequences of late-identified hearing loss would certainly be more pronounced in most developing countries owing to the lack of available support services that can help these children to become active participants in their community (Olusanya et al., 2004:301). It is therefore realistic to deduce that the consequences of neonatal hearing loss and the positive effect of early identification in developing countries are at least as significant as in developed countries and treatment is therefore equally justified in both contexts.

The disorder-related principles of IHS considered in the developing countries of the world justify the philosophy of also screening newborns and infants in these regions.

3.3.2 Process-related principles of infant hearing screening in developing countries

The process-related principles of IHS concern aspects such as accuracy of screening methods, efficiency of screening programmes and costs. The accuracy of screening methods has been well established during the last decade (Watkin, 2003:168) and this will not differ for neonates and infants in developing countries as long as screening personnel are adequately trained and periodical monitoring is implemented. Ensuring high quality training for personnel involved is therefore an important priority (Gopal et al., 2001:106). The small number of available reports of IHS in developing countries indicates that the accuracy of OAE and AABR screening methods are similar to those in developed countries (Chapchap & Segre, 2001:34; Rouev et al., 2004:808; Radziszewska-Konopka & Owsiak, 2004:30). The use of IHS is therefore equally justifiable in developing countries considering the accuracy of available screening methods.

The efficiency of early identification programmes is considered according to three outcome measures. Firstly the coverage and referral rates obtained in IHS programmes; secondly, the effects of screening on parents, and lastly, the effectiveness of follow-up. Once again, the extreme dearth of IHS programmes makes it very difficult to provide indicators for efficiency of early identification programmes in developing countries. The only report of a national UNHS programme in a developing country has been from Poland (Radziszewska-Konopka & Owsiak, 2004:30). This programme, established by a charity foundation in 2002, reports a national coverage of 98%, which is similar and even better than results in developed countries like the USA and UK. Referral rates reported from other UNHS programmes in developed countries have also suggested similar figures to the developed world, ranging between 1.8 and 12%

(Chapchap & Segre, 2001:34; Rouev et al., 2004:808; Radziszewska-Konopka & Owsiak, 2004:30).

An important aspect that requires investigation is the effect of IHS on parents in developing countries. All studies reporting on these factors have been forthcoming from developed countries. The strong influence of cultural, religious and unrealistic expectations borne out of poor education may change the way IHS affects parents in developing countries (Stephens et al., 2001:184). The results from developed countries suggest, however, that parents believe that the benefits of detecting a baby with a hearing loss outweigh any anxiety about IHS itself (Hergils & Hergils, 2000:325).

Follow-up is a challenge even in the developed world. Although there seems to be great variability, reports of follow-up figures in developing countries suggest that this is a global challenge for implementing effective IHS programmes. High follow-up rates were reported for a UNHS programme in Brazil, indicating an 82% follow-up rate (Chapchap & Segre, 2001:34). For a hospital-based UNHS programme in Bulgaria, however, a follow-up rate of only 54% was reported (Rouev et al., 2004:808). It must be kept in mind that as programmes develop and mature, better tracking procedures are implemented, which increases the follow-up rate. In one of the most successful state-wide screening programmes in the USA, the initial follow-up rate was 48% for the first five years and has now improved to 76% with 9 hospitals achieving a 95% follow-up rate (Mehl & Thomson, 2002:1). Ensuring high follow-up rates are therefore to be viewed as a process that requires continuous effort toward improvement.

The limited number of UNHS studies reported from developing countries suggest that IHS is a feasible and inexpensive practice, but the actual costs are not disclosed (Olusanya et al., 2004:300; Chapchap & Segre, 2001:34; Rouev et al., 2004:808). No studies are reported from Africa and the only study that provides a cost figure comes from a UNHS programme in Bulgaria. The calculated cost for UNHS in Bulgaria was 2.41€ (euro) per newborn infant screened or 1407€ per case identified (Rouev et al., 2004:809). These costs compare favourably to

costs reported in developed countries and the authors consequently concluded that the programme was cost-effective. It is important to remember, however, that in developing countries such as Thailand or Nigeria, where the Gross National Product per citizen is often lower than the price of a screening device, the costs associated with IHS programmes can be staggering to their economy (Mencher & DeVoe, 2001:19). The figures are even more daunting when costs from developed countries are merely transposed onto developing countries. In actual fact, as the Bulgarian study shows (Rouev et al., 2004:809), the actual costs in developing countries will be much lower because the costs are generated within the context of that country's economic infrastructure.

The overview of disorder-related and process-related principles justifying IHS when assessed within the context of developing countries, indicates that the implementation of IHS is just as relevant, if not more so, than in the developed world. Justification for a practice, however, does not mean that it is possible to implement the necessary programmes. Yet, the justification of this screening practice in developing countries, even though unaffordable to many governments, creates a motivation and an urgency to pursue ways to realise it.

3.3.3 Context-dependent implementation of infant hearing screening

The marked disparities between the socio-economic status of developing countries preclude a single judgement about the relevance of IHS implementation for the entire developing world (Olusanya et al., 2004:296). The conditions for each country must therefore be considered to determine how prepared it is for taking such action. Certain high-income countries in the developing world like Saudi Arabia and Cyprus are more likely to be ready than low-income countries like Somalia and Bangladesh (Olusanya et al., 2004:296). It is therefore essential that each country, community or local health authority determines the desirability, scope and timing of an IHS programme on a rational basis *according to their own situation.*

Mencher and DeVoe (2001:19) add another dimension to this argument that must be considered. The authors state that "[i]f we are only able to offer scientifically valid programs in the rich nations, and in the poorer nations where limited healthcare and environmental issues significantly increase the probability of a child being born with a hearing loss, the same programs…we will continue to be faced with health, ethical, moral and professional issues which will need to be resolved" (Mencher & DeVoe, 2001:19). In a practical sense it is therefore necessary to consider each context in order to evaluate whether its socio-economic situation allows for IHS. From an ethical point of view, it is every child's fundamental human right to have good hearing (Olusanya, 2000:168) through IHS programmes providing early detection of and intervention for hearing loss, whether he/she lives in the developed or the developing world. Although this dilemma does not have any immediate or obvious solution (Mencher & DeVoe, 2001:19), it deserves the attention of healthcare professionals, charity foundations and governments so that the benefits of IHS may be extended to developing countries.

3.4. STATUS OF INFANT HEARING SCREENING IN DEVELOPING COUNTRIES

IHS reports originating from developing countries are scarce. This silence reflects the absence of such programmes due to socio-economic, cultural and healthcare barriers, as well as an absence of trained audiologists and other hearing healthcare personnel (Gopal et al., 2001:106). Poor prevalence and aetiological data for hearing loss in developing countries remains an obstacle. Furthermore, data reporting the mean age of hearing loss detection and intervention is virtually non-existent due to the absence of systematic or routine screening programmes in developing countries. The initial detection of hearing loss is primarily passive and results from parental concern about observed speech and language delays, unusual behaviour or otitis media complications. The detection period can start from two years old and extend well into the adolescent years (Olusanya, 2001:142; Russo, 2000:203). These facts also

attest to the shortage of trained audiologists and economic infrastructure to support IHS programmes and related research endeavours.

Inventories of resources and services available for early detection of hearing loss in developing countries are also extremely difficult to find (Madriz, 2001:85). Reports from developing countries are typical of hearing screening programmes for young school-aged children (Mencher 2000:179). Discrepancies also exist between reports from different regions in developing countries. Recent studies reporting on hearing loss in developing countries include reports from regions such as Asia, South America and Eastern Europe, but none from Africa (Prasansuk, 2000:207-211; Uus & Davis, 2000:192-197; Russo, 2000:202-206; Madriz, 2000:212-220; Hadjikakou & Bamford, 2000:198-201). The lack of insight into the status of IHS in developing countries emphasises the need for contextual research in these regions.

According to Uus and Davis (2000:195) the current age of identification and management of hearing loss for children in developing countries, such as Estonia, is comparable to that of developed Western countries approximately 20 years ago. This is generally true for the majority of developing countries. Reports have even suggested that questionnaire type screening at school entry is currently the only viable option for “early identification” of hearing loss in developing countries (Olusanya, 2001:146). With the first 6 to 18 months postulated to be the critical phase for speech and language development it is clear that identification after 18 months is not early enough and cannot be considered as “early identification” (Yoshinaga-Itano & Apuzzo, 1998:380).

Apart from a few exceptions such as Poland (Radziszewska-Konopka & Owsiak, 2004:30), reports from countries in the developing world generally agree that very few systematic early identification programmes are being conducted to identify hearing loss. In Poland, however, countrywide UNHS was initiated in 2001 by a charity organisation, which has established an effective programme with coverage of 98% of all births (Radziszewska-Konopka & Owsiak, 2004:30). Reports from other regions such as Bulgaria have also testified to UNHS in

certain hospitals (Rouev et al., 2004:806). Thus exceptions are emerging that indicate the potential of attaining widespread IHS in developing contexts.

A study conducted on audiological services in Latin America and the Caribbean concluded that very few early identification programmes for hearing loss are being conducted systematically (Madriz, 2001:88). Some small projects appear to be taking place in central hospitals or paediatric centres in major cities, but the existence of structured programmes for early identification of hearing loss in high-risk newborns does not seem to be the rule (Madriz, 2000:217). Panama, Cuba and Brazil were the only countries reported to show any kind of formal and stable screening programme (Madriz, 2001:88; Russo, 2000:203, Chapchap & Segre, 2001:33).

An extreme shortage of information regarding IHS from Southeast Asia and Africa is evidenced by the absence of research reports (Prasansuk, 2000:207; McPherson & Swart, 1997:3; Rangasayee, 2004:30). A recent study pointed to initiatives in India aiming to identify hearing disabilities in the age range 0 to 6 years, whilst programmes are being implemented to develop manpower to handle children with hearing loss ranging between 0 to 2,5 years of age (Rangasayee, 2004:30). A study reporting on early identification of hearing loss in Mauritius also reported concerns regarding the late identification of affected infants as no IHS programmes are in place (Gopal et al., 2001:106). In South Africa, there has also recently been a call toward targeted IHS as a first step toward UNHS programmes (HPCSA, 2002:2; Swanepoel et al., 2004:634).

The current body of knowledge clearly indicates that IHS is not a common practice in developing countries and the lack of basic data needed to plan such initiatives emphasises the need for comprehensive contextual research initiatives. The implementation of widespread IHS programmes in developing countries is widely considered to be unattainable due to number of reasons. These reasons will be considered in the following section.

3.5. CHALLENGES TO INFANT HEARING SCREENING IN DEVELOPING COUNTRIES

Screening for hearing loss is a low priority in developing countries as the result of an overwhelming burden of infectious diseases in many of these countries. It is not uncommon to find that healthcare needs in most of these countries are ranked into high and low priorities with emphasis on life-threatening conditions and diseases such as diptheria, tetanus, meningitis and HIV/Aids, whilst conditions perceived as non-life-threatening such as hearing loss are neglected (Olusanya, 2000:167). Although hearing loss is indeed not a life-threatening condition, it becomes a severe threat to essential quality of life indicators unless intervention occurs early in infant development. The adverse effects of hearing loss on cognitive-linguistic skills and psychosocial behaviour are well established in contrast to the established benefits of early intervention (Moeller, 2000:5; Yoshinaga-Itano, 2003:199-206; Davis & Hind, 2003:194).

In developing countries, where health priorities are aimed at saving lives rather than at improving quality of life, the motivation for addressing an invisible non-life-threatening condition such as hearing loss is very limited (Olusanya, 2000:168). The planning or implementation of any hearing screening programme will be met with a natural resistance. This is further complicated by the invisible nature of hearing loss, which encourages complacency in addressing the disability (Olusanya, 2001:168; Louw & Avenant, 2002:146). Cultural differences in perception of disabilities may also result in inaction, since a characteristic of African families, for example, is often a fatalistic outlook that leads to an accepting passive attitude toward hearing loss (Louw & Avenant, 2002:146). These factors make it difficult to attract resources towards the effective management of hearing loss in infants. Even when resources become available, ongoing commitment to prevention programmes is uncertain because the consequences of inaction may not seem as frightening as in other epidemics (Olusanya, 2001:145).

Developing countries such as those in Latin America continue to spend more money on treatment than it does on prevention, with a general attitude of "damage control" rather than in-depth searching to investigate the root of problems experienced (Madriz, 2000:218). Madriz (2000:218) makes four conclusions regarding hearing healthcare in the developing nations of Latin America. Firstly, that deafness and hearing loss receive a very low priority status from most governments and national health systems. Secondly, that material and human resources continue to be very limited, and their distribution very irregular. Thirdly, that accessibility is limited due to dispersed populations, large distances and the immense surface areas of some countries. This makes not only the implementation of disability registers and national epidemiological and demographic studies, but also medical and audiological services for special needs populations very difficult. Fourthly, technology continues to be very costly by Latin American standards. According to Newton et al. (2001:229), a lack of trained personnel and testing equipment to facilitate early detection of hearing loss also constitutes significant barriers for developing countries.

Challenges to IHS service delivery in developing countries according to Olusanya et al. (2004:300-302), Gopal et al. (2001:102-106) and Louw and Avenant (2002:146-147) are highlighted in Table 3.2.

There are significant challenges that must be faced when the implementation of IHS is considered in developing countries. However, according to Olusanya (2000:170), the "perennial hurdle has always been how to achieve reasonable balance in priorities in the face of competing needs and limited resources". Despite the fact that developing countries must deal with challenges such as absence of proper equipment, staff and facilities in addition to common cultural and linguistic differences between professionals and communities, the desire to implement widespread IHS for children is no less intent, humane or appropriate (Mencher & DeVoe, 2001:19).

TABLE 3.2 Challenges to IHS implementation in developing countries

CHALLENGE	DESCRIPTION
Manpower shortages	Acute shortage of ear-care professionals in the developing world. Developed countries have ~320 otolaryngologists per million children under 15, while developing countries are estimated to have less than 1 per million children. Formal full-time training for audiologists is also lacking in most tertiary institutions in developing countries.
Tracking and follow-up	Completing the screening process through to diagnosis and appropriate/timely intervention may be racked with difficulty. Geographical location and socio-economic circumstances of parents play a vital role in this regard. Some parents may simply not be interested in continuing screening after the initial fail.
Provision of support services	Hearing aids are usually expensive, trained dispensers are scarce and ear mould laboratories are few or non-existent. The lack of formal training for speech language pathology contributes to few available early interventionists who are appropriately trained to provide suitable intervention services.
Attitudes, cultural and religious beliefs	Little or no attention is often paid to persons with disabilities in developing countries compared to those in developed countries. Special provision for disabled persons is not common in public facilities and the social stigma associated with hearing loss often results in a disposition to withdraw from people. It is therefore not uncommon to see parents delaying the acceptance of using hearing aids because they are noticeable. The strong influence of cultural, religious and unrealistic expectation of parents may also lead to the outright rejection of Western intervention options.
Awareness among health workers	Awareness amongst health professionals regarding hearing loss in young infants is very limited and even more so in developing countries where a larger emphasis is placed on life-threatening conditions. Health professionals are heavily relied upon for opinion on medical conditions and they wield considerable influence on parents who may be in denial or are simply reluctant to accept prescribed intervention.
Economic burden of prevailing fatal diseases	This problem prevails specifically in low and middle-income communities in developing countries. The challenge is to initiate and sustain the momentum for IHS while the burden of fatal diseases persists. Resources may have to be diverted to meet emergencies and child survival issues, thereby curtailing public funding for IHS.

(Compiled from: Olusanya et al., 2004:300-302; Gopal et al., 2001:102-106; Louw & Avenant, 2002:146-147)

3.6. IMPORTANCE OF INFANT HEARING SCREENING IN DEVELOPING COUNTRIES

The most important benefit of IHS is that it allows the identification of hearing loss early enough to obtain optimal speech and language outcomes from timely intervention. To date there has been no other proven method that can produce comparable outcomes for children with permanent hearing loss (Yoshinaga-Itano, 2004:463-464). This makes IHS the procedure of choice for ensuring optimal outcomes for infants with hearing loss, whether they live in a developed or developing country. It is for this reason that the implementation of IHS in developing countries justifies serious consideration.

3.6.1. Benefits of infant hearing screening in developing countries

The benefits of implementing IHS programmes in developing countries are multiple and far-reaching. Previously, hearing screening programmes in developing countries were mainly applied during the school-going period, which is not early enough. The introduction of widespread IHS programmes in the face of the challenges inherent to a developing context could result in many positive outcomes such as the following (Olusanya et al., 2004:296):

- *Compilation of epidemiological data*
  Epidemiological data on hearing loss is essential for the development of strategies that will form the basis of national programmes of prevention and management (Mencher, 2000:178). This type of data on the prevalence and pattern of congenital hearing loss is difficult to obtain without IHS (Olusanya et al., 2004:296). Risk factors may vary across communities, especially in developing countries where environmental factors are much more prominent. Thus IHS programmes will be helpful in identifying and characterising these risks (Gopal et al., 2001:102-103; Olusanya et al., 2004:296). Accurate epidemiological data is also needed to justify the allocation of funds from already limited budgets and IHS programmes may provide this much needed information (Mencher, 2000:178).

- *Parental empowerment*

  Early identification of hearing loss through IHS empowers parents to seek appropriate and timely assistance for their hearing-impaired child (Clemens et al., 2000:5; Hergils & Hergils, 2000:321; Olusanya et al., 2004:297). This early detection of hearing loss confers the right to make informed choices, without prejudice to their economic situation, to the parents (Olusanya et al., 2004:297). Parents may become alienated if their physicians deny them this empowerment, especially where the services for assistance are available.

- *Growth and development of audiological services*

  Contextual epidemiological data demonstrating the actual widespread extent of hearing loss point to the need for developing audiological services to address this silent epidemic. In addition to this, parents of children who are identified with hearing loss through IHS will naturally desire to help these children as soon as possible. This desire to take prompt action after confirmation of hearing loss could stimulate the development of essential and appropriate intervention services that are scarce in developing countries at present (Olusanya et al., 2004:297). In turn, this should encourage governmental and private sector involvement in the management of infants with hearing loss and could lead to a review of primary healthcare programmes to incorporate primary ear care services (Olusanya et al., 2004:297). The predominant system of sign language for children with profound hearing loss would be reformed to more oral approaches, allowing the children's better integration and inclusion.

- *Integration and inclusion for children with hearing impairment*

  The cultural and social stigma attached to childhood disabilities, especially in developing countries, generally precludes the integration of hearing impaired children into the community. The inability to acquire the native language of a community isolates an individual (Louw & Avenant, 2002:145). NHS has proved to produce native language skills in hearing impaired children that are within the normal range of development – something that no previous method has ever been able to demonstrate

(Yoshinaga-Itano, 2004:455). Management following detection by NHS could therefore facilitate rapid integration and inclusion into the extended family and society. This type of outcome has the potential to generate a positive cultural change toward hearing impaired persons over time.

The benefits of IHS programmes in developing countries are clear and have the potential to provide accurate data, empower parents, stimulate development of audiological services and most importantly, allow children with hearing loss the opportunity to be included into society as actively contributing members. These positive outcomes emphasise the need for investigating healthcare platforms that may be used to implement IHS programmes.

3.6.2. Healthcare platforms for infant hearing screening

Despite the many prevailing challenges to implementing IHS in developing countries, there are existing structures in these countries that must be investigated as possible platforms from which such programmes can be launched. Although IHS is most effective in birthing centres before the neonate is discharged, it is also true that in developing countries a significant number of births occur outside the big hospitals (Olusanya et al., 2004:297). Many parents and infants are also lost to follow-up, and persuading them to attend a centre specifically for the purposes of hearing screening may be difficult. It is therefore practical and easier to use existing healthcare platforms that are integrated into primary healthcare services (Olusanya, 2001:142). This means that existing healthcare programmes that are well established must be evaluated to determine whether they will be suitable for incorporation into IHS programmes. IHS programmes have a primary goal of identifying hearing loss within the first 3 months and ensuring initiation of intervention by 6 months of age, and this will have to serve as a guide in selecting possible platforms. Selection of appropriate healthcare platforms that can be used for IHS will rely on the characteristics of each context and the type of infrastructure available. Suggestions of such platforms are summarised in Table 3.3. (Olusanya et al., 2004:297-298; Solarsh & Goga, 2004:109-110).

TABLE 3.3 Healthcare platforms for IHS

POSSIBLE HEALTHCARE PLATFORMS FOR IHS
EXPANDED PROGRAMME ON IMMUNISATION (EPI)
This is a global initiative of UNICEF to deliver vaccinations against tuberculosis, diphtheria, pertusis, tetanus, measles and hepatitis B in infants. Vaccines are given at birth, before the age of 4 months and after 6 months. Latest updates indicate fairly high coverage rates of 70-78% for vaccines in the developing region. The immunisation structures in many of these countries are well established and constitute a ready platform from which IHS programmes can be promoted. Repeated visits for the multi-dose vaccines often spaced 4-weeks apart and completed on or before the age of 6 months offer a good chance for the promotion of IHS and subsequent follow-up of positive cases.
BABY-FRIENDLY HOSPITAL INITIATIVE (BFHI)
The BFHI is a global WHO/UNICEF-sponsored effort to promote exclusive breast-feeding from birth to age 6 months. The unique advantage is that it provides regular contacts for healthcare professionals to encourage, educate and support nursing mothers to breast-feed babies through a series of ten steps. Breast-feeding is culturally acceptable in many developing countries and has made the BFHI campaign quite popular with women. Hospitals and community health centres have incorporated this programme into ante-natal clinics and introducing IHS alongside this initiative may prove to be cost-effective with a high prospect of good coverage in the target population.
INTEGRATED MANAGEMENT OF CHILDHOOD ILLNESS (IMCI)
A strategic initiative by the WHO/UNICEF originally designed as an integrated case management of the five most important causes of childhood mortality (acute respiratory infections, diarrhoea, measles, malaria and malnutrition). The key objectives are to reduce death, the frequency and severity of illness or disability. The generic guidelines and Adaptation Guide have identified ear disorders as one of the conditions to be addressed. The IMCI is designed to be adapted to a country's needs in terms of prevention of diseases, curative care interventions, and measures that promote healthy growth and development in children. It should be possible to include the introduction of IHS under this strategy in any of the over 60 developing countries that have so far adopted the strategy.
NATIONAL EAR CARE PROGRAMME (NECP)
National efforts to promote the development of ear care services in countries like Nigeria and Costa Rica have established full-fledged governmental agencies specifically for this purpose. These agencies have the responsibility of producing a national ear care policy and this practice is actively encouraged by the WHO in developing countries. Such a platform would be valuable in the planning and implementation of IHS programmes, either independently or in collaboration with relevant agencies. Population-based surveys and the experience gained from the field in the process would be useful in planning the introduction of IHS in respective countries.

(Compiled from: Olusanya et al., 2004:297-298; Solarsh & Goga, 2004:109-110)

There has also been a recent increase in professional bodies in developing countries recommending guidelines and standards for IHS in their countries in an attempt to provide benchmarks in a world where none previously existed (Mencher & DeVoe, 2001:19; HPCSA, 2002:1). The South African NHS Position Statement 2002 (HPCSA, 2002:1-8) is one such an example that provides context specific standards and benchmarks. Another critical factor to consider, however, is the fact that there are different options of IHS programmes that must be carefully investigated for implementation in developing countries.

3.6.3. Targeted and universal newborn hearing screening

Screening of both at-risk and non-risk newborns under UNHS programmes results in improved yields compared to Targeted Newborn Hearing Screening (TNHS). This makes UNHS the programme of choice and the final benchmark for the implementation of any NHS programme. The underlying drive is an ideal not to miss any newborns with hearing loss and its justification has been largely predicated on the limitations of TNHS and the availability of fast and reliable screening instrumentation (Olusanya et al., 2004:299). The reality of the situation in developing countries, however, probably makes TNHS the more suitable screening option as acknowledged by the JCIH (2000:20). TNHS can be implemented as a first but intermediate step toward a long-term goal of UNHS.

The advantage and limitation of TNHS is that it is able to detect approximately 50% of infants with hearing loss by screening just less than 10% of the births (Mahoney & Eichwald, 1987:161; Mason et al., 1997:91). The advantage lies in the fact that a reasonably small-sized sample of the birth cohort with risk factors for hearing loss could be screened to identify a large number of infants, thus requiring fewer resources. The limitation is that 50% of infants with hearing loss will still be missed. According to Yoshinago-Itano (2004:462) these children who are missed are also those who have the highest potential for success with early intervention, since they have a significantly lower incidence of secondary disabilities. It is therefore not a simple matter, but what is clear is that UNHS is the final goal for all programmes since every child deserves the opportunity to

develop optimally. TNHS can therefore be considered as an intermediate step toward more comprehensive programmes. Related to the issue of cost is the option of selecting to identify bilateral or unilateral hearing loss. Even though unilateral hearing loss does influence developmental and emotional outcomes in children (Bess et al., 1998:339), limited resources inevitably place a larger emphasis on identifying bilateral hearing loss above the more expensive identification of unilateral and bilateral hearing losses (Lutman, 2000:368).

The general rule should therefore be that each country, community or local health authority needs to determine its individual readiness for the different options according to its own situation. TNHS or other contextual screening protocols in the developing world may be suitable intermediate steps towards more comprehensive screening in the form of UNHS due to a lack of IHS services in the vast majority of developing countries.

3.7. CONCLUSION

It is clear that the goal of the Joint Committee on Infant Hearing, namely to provide UNHS to all children (JCIH, 2000:10), is reaching beyond the borders of developed countries such as the United States and the UK, and is now also becoming evident in the developing parts of the world (JCIH, 2000:10). If the committee's premise of providing NHS for all infants is valid, then efforts should be mobilised to put screening programmes in place in less affluent countries (Mencher & DeVoe, 2001:19). If such mechanisms are not supported, a double standard of healthcare will be promoted which will continue to produce ethical and moral dilemmas regarding the identification and treatment of debilitating hearing loss in infants and young children.

Childhood hearing loss is recognised as a significant health problem by the World Health Assembly who revealed its serious intent by urging governments in developing countries to implement specific actions to address this problem (WHO, 1995:9). The principle thrust of existing UNICEF programmes in

developing countries is to ensure that every child is afforded a good start in life as a fundamental human right. This principle fully includes NHS, which improves the quality of life of early-identified infants and allows inclusion and integration into communities. There are a growing number of international initiatives such as those mentioned above, which provide developing countries the opportunity to initiate, develop and implement action plans for identifyng childhood hearing loss (Olusanya et al., 2004:302).

Implementation of these programmes is largely dependent on accurate epidemiological data regarding congenital and childhood hearing loss. Unfortunately, however, consistent and comparable data in the developing regions of the world are scarce. This fact and the reported lack of support services for identified infants with hearing loss are often presented as reasons for not implementing IHS in developing countries (Mencher & DeVoe, 2001:20). These reasons, although they are valid, will not stimulate the development of services or the acquisition of necessary data. As Kenworthy (1990:328) noted, “only through comprehensive identification will the need for early intervention programs be realized”. Pilot studies at the community, state or national level, or even as non-governmental initiatives, should therefore be encouraged to provide needed empirical evidence that will elucidate the need for IHS and stimulate the development of appropriate services (Olusanya et al., 2004:302). Pilot studies are necessary to provide a framework that will guide the choice of suitable and affordable IHS protocols for each individual country, since there is no single answer for every context (White, 2004:28).

The benefits of IHS programmes in developing countries are significant and will serve a number of important healthcare and societal priorities. The implementation of these programmes does however face many challenges such as widespread disease, poverty, inequality and violation of human rights in developing countries. But these challenges and the high standards set by developed countries should not deter efforts to encourage IHS in low- and middle-income countries. Despite the challenges of developing contexts and despite the high benchmarks stated for IHS programmes in developed countries,

the case for IHS in less affluent contexts is clear. Initiatives must be promoted as a foundation for further development even if the initial results are not promising. Such programmes entail a continual period of growth and as was recently reported at the International Conference on Newborn Hearing Screening Diagnosis and Intervention held in Cernobbio, Italy, the "greatest enemy of good is excellent" (White, 2004:28). *The developing world must start where it can; the developed world should help where it can, so that we may provide the best outcomes for infants with hearing loss as widely as we can.*

3.8 SUMMARY

This chapter provided an overview of issues pertaining to IHS in the developing countries of the world. An initial discussion was devoted to present the current healthcare perspective toward hearing loss in developing countries. This was followed by a justification of the relevance of IHS as a practice in developing contexts as well as in developed settings. The status of IHS practice in developed countries was provided as a precursor to an investigation of the challenges to IHS in developing countries. A case was subsequently made for implementing IHS in developing countries by presenting the benefits of such a programme and posing possible platforms for launching such initiatives. Finally, the argument was brought to a close by answering the question posed at the beginning of the chapter.

CHAPTER 4

EARLY INTERVENTION FOR INFANTS WITH HEARING LOSS IN SOUTH AFRICA: A CRITICAL EVALUATION

Aim: This chapter provides a critical review of the present South African context and the infrastructure of audiological services for implementing widespread EHDI

4.1. INTRODUCTION

A review of the accumulated knowledge in a field of study is an essential step in the research process. It serves to delineate a study from the existing body of knowledge and to integrate the contribution into a wider framework of relevant theory (Neuman, 1997:88). In the current study, examining different knowledge domains pertaining to early identification of hearing loss in South Africa will provide a path of prior research and should stimulate new ideas in developing strategies for establishing effective and relevant systems.

Early detection of, together with intervention for infants with hearing loss is rapidly being established as the standard of care for infants with hearing loss in developed countries (JCIH, 2000:11; Lin et al., 2002:217; Olusanya et al., 2004:288). It is clear, however, that developing countries may not be able to follow this trend and will have to be resourceful in finding ways for providing contextually relevant services in an effective and accountable manner through local research and systematic planning (Gopal et al., 2001:100; Mencher & DeVoe, 2001:20). The wealth of international research and expertise provides an indispensable body of knowledge for implementing Early Hearing Detection and Intervention (EHDI) systems, but the unique characteristics and challenges of

developing countries demand that contextual research be done in conjunction with these international resources.

The South African Government recognises this need for contextually relevant health research when it states that the "lack of reliable health information is one of the major obstacles to the effective planning of health services in South Africa" (Department of Health, 1997:25). The government furthermore identifies health systems research as an essential research field that should be aimed at informing health planning, effective delivery, management and policy (Department of Health, 1997:25). Developing EHDI services in South Africa should therefore embrace evidence-based decision making, guided by established international practice and directed by the specific context.

The Professional Board for Speech, Language and Hearing Professions of the HPCSA (HPCSA, 2002:3) recently accepted the international benchmark specified by the Joint Committee on Infant Hearing (JCIH, 2000:10) for delivering services to infants with hearing loss through the implementation of UNHS programmes as part of an EHDI system. Acceptance of this benchmark, however, has placed an important responsibility on the hearing healthcare profession in South Africa. A priority has been created to analyse the broader South African context and assess service delivery models in the healthcare system to ensure evidence-based contextual implementation of EHDI services.

The purpose of this chapter is therefore to critically review the present South African context and the infrastructure of audiological services for implementing widespread EHDI programmes as proposed by the South African Hearing Screening Position Statement (HSPS). Figure 4.1 provides an outline and flow of the chapter contents.

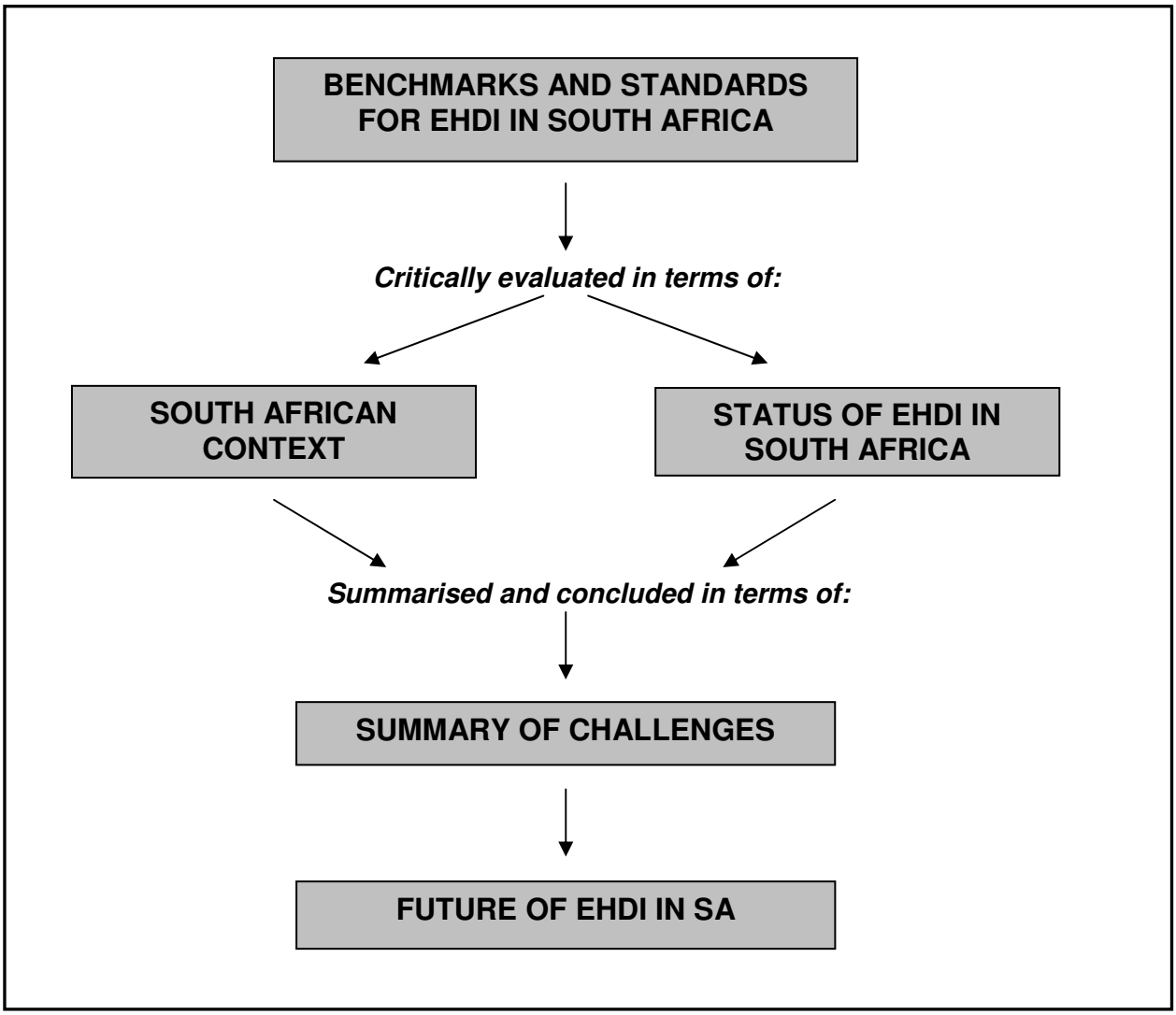


FIGURE 4.1 Outline of Chapter 4

4.2. BENCHMARKS AND STANDARDS FOR EHDI IN SOUTH AFRICA

The goal of providing UNHS to all children recommended by the JCIH year 2000 position statement is reaching beyond the borders of developed countries such as the USA and UK, and is now also becoming evident in developing regions of the world (Mencher & DeVoe, 2001:19). It is also apparent in South Africa through the recent release of a Hearing Screening Position Statement by the HPCSA in which it acknowledges the JCIH Year 2000 position statement as the

definitive document in delivering services to the infants and children with hearing loss in South Africa (HPCSA, 2002:1). In developing countries, like South Africa, where there are currently no standards for delivering services to infants with hearing loss (Mencher & DeVoe, 2001:19), a statement like the JCIH Year 2000 Position Statement provides a standard of care that can serve as a benchmark against which to measure existing services. This provides a body of knowledge that will serve as a point of departure for the implementation of future contextual research in countries like South Africa.

The South African position statement advocates early detection of infants with hearing loss by using objective electrophysiological measures for Targeted Newborn Hearing Screening (TNHS). This is followed by early intervention consisting of a diagnostic evaluation and family-centred intervention programmes provided through integrated interdisciplinary healthcare services by the Provincial and District Health Systems (DHS) (HPCSA, 2002:1). The rationale underlying these recommendations for EHDI programmes is to ensure optimum, cost-effective solutions for individuals identified with hearing loss. It is to "enable persons to communicate effectively, thereby allowing maximum habilitation or rehabilitation of the individual's capabilities and potential, to secure their full participation in, and contribution to, society and the country's economy" (HPCSA, 2002:1). The programmes are intended to reduce the average age of identification, diagnosis and intervention.

An evaluation of the South African HSPS in terms of the principles, as well as the roles and responsibilities specified, will be presented next, followed by a discussion regarding the importance of contextually relevant benchmarks and standards.

4.2.1. Principles of the South African Hearing Screening Position Statement

The principles specified by the SA position statement are summarised from the JCIH Year 2000 Position Statement and provide direction for the development

and implementation of successful EHDI programmes (JCIH, 2000:11). The position statement contains eight principles that support the goals of universal access to hearing screening, evaluation and intervention for newborns and infants embodied in Healthy People 2000 and 2010 produced by the US Department of Health and Human Services (US Department of Health and Human Services, 1990 in JCIH, 2000:11; US Department of Health and Human Services, 2010, in JCIH, 2000:11).

The South African year 2002 HSPS document summarises the goals for EHDI programmes in four statements (HPCSA, 2002:3,4). First, screening for hearing loss should identify infants who are at risk for hearing loss that impacts on development. Secondly, the types of hearing loss targeted by these programmes are unilateral or bilateral, conductive or sensori-neural, and greater than 30 dB in the speech frequencies (0.5 – 4 kHz). Thirdly, through developmental screening programmes at Primary Healthcare clinics, all infants should receive ongoing monitoring of the development of auditory behaviour and communication skills, as well as other sensory and motor milestones. The last guideline specifies that quantifiable goals and quality indicators need to be determined for the monitoring and evaluation of EHDI programmes with periodic reviews to assure the quality of such programmes.

The Professional Board for Speech, Language and Hearing Professions of the HPCSA assessed and compiled the principles and benchmarks for each principle specified by the JCIH year 2000 position statement in such a way that it is suited to the South African primary healthcare system. The principles, as well as a critical assessment of the limitations thereof, are summarised in Table 4.1.

TABLE 4.1 Summary and evaluation of principles and benchmarks specified by the South African HSPS

PRINCIPLES	SOUTH AFRICAN BENCMARKS	LIMITATIONS
1 ACCESS TO HEARING SCREENING	- Neonatal hearing screening of all "at-risk" infants should take place prior to discharge from a hospital or other facility - Objective electrical and electrophysiological methods (OAE's and AABR) are the only acceptable tests. Acknowledge that test protocols for combinations of procedures that are appropriate for the local context need to be developed - Strongly recommend use of nurses and lay volunteers as personnel trained to conduct hearing screening. Training should take place according to SAQA accredited training modules and should be presented by audiologists or speech therapists - Audiologist should supervise screening programmes in any context in the capacity of programme manager - Public institutions should invest In appropriate technology for targeted neonatal hearing screening to ensure all socio-economic levels of society have access to hearing screening and the benefits of early intervention - Hearing screening should take place in the well-baby nursery, at discharge from the NICU or at 6-week immunisation clinics - By 2005 there should be technology at MCH clinics in the community to enable infants who attend for their first immunisation to have their hearing screened as part of the package of services at that time - By 2010 – 98% of neonates/infants should be screened for hearing loss - All babies not previously screened should be screened at the 6 week immunisation clinics - Diagnosis of hearing loss should take place by age 3 months - Parent education regarding options for communication should take place by age 3-months. This should occur within a multiprofessional team framework of parents and professionals in collaboration with the designated case manager. - Referral and intervention should take place by age 6 months - Regardless of prior hearing screening outcomes, all infants who are at risk for delayed onset or progressive hearing loss should receive ongoing audiological and medical monitoring for 3 years and at appropriate intervals thereafter to ensure prompt identification and intervention - High risk questionnaires and behavioural observation audiometry are not recommended as stand-alone screening methods but must only be used in conjunction with electrophysiologic tests such as OAE and AABR - Use of noise-emitting devices such as rattles, whistles or other instruments are not endorsed and should be discontinued if currently being used	No mention or consideration is given to home-births Specify follow-up at 'appropriate' intervals but do not specify what these intervals are Clarity regarding multidisciplinary or interdisciplinary or transdisciplinary teamwork is needed. The terms seem to be used interchangeably. Best practice should consist of a transdisciplinary service-delivery model (Fair & Louw, 1999:14).

TABLE 4.1 Continued

PRINCIPLES	SOUTH AFRICAN BENCMARKS	LIMITATIONS
	- Community based developmental screening incorporating communication milestones should be implemented at primary care level within the District Health Services model. Results should be recorded on the Road to Health Card. Follow-up systems should be aggressively instituted to ensure that hearing-impaired infants are enrolled in appropriate rehabilitation programmes. Road to Health Card lends its self to utilization as first level record of hearing screening and districts should be encouraged to adapt it to meet local needs - There should be adequate supporting infrastructure and services at regional levels for diagnostic audiological assessments and therapeutic interventions. There should be access at this level to the necessary assistive device technology: selection, prescription, delivery and maintenance	
2 CONFIRMATION OF HEARING LOSS IN INFANTS BEFORE 3 MONTHS OF AGE	- Infants who fail a hearing screening should be referred for comprehensive audiologic assessments and specialist medical evaluations - Benchmarks and quality indicators need to be developed	No recommendations is made for a generally accepted diagnostic protocol
3 EARLY INTERVENTION BEFORE 6 MONTHS OF AGE FOR CONFIRMED HEARING LOSS	- Goal: facilitation of developmentally appropriate language skills and empowerment of families to assume the prime role in the habilitation process - Principles expressed in the integrated National Disability Strategy, National Rehabi litation Policy, DEAFSA's Early Intervention Policy and relevant policies for inclusive education are endorsed - These are: Early intervention should be family oriented; Assistive device technology should be readily and immediately accessible; Medical and surgical intervention for otitis media and cochlear implantation should be available; primary focus of early intervention should be development of a communication mode suited for the individual - "Free health care for children under six year old" must also include rehabilitation and provision of assistive devices - Without prompt intervention neonatal hearings screening is unethical and should not be undertaken	Responsibilities are not specified for aspects of early intervention service-delivery. No early intervention protocol or standard procedure is recommended.

TABLE 4.1 Continued

PRINCIPLES	SOUTH AFRICAN BENCMARKS	LIMITATIONS
4 CONTINUED SURVEILLANCE OF INFANTS AND TODDLERS WITH RISK INDICATORS	- Continued surveillance of infants and children under the age of six years specifically those presenting with known risk indicators and in environments where neonatal hearing screening is not yet available - Risk indicators, both those present at birth and those that may develop later, should be widely publicised especially in the Primary Health Care context - It is equally important to detect and monitor progressive and delayed onset hearing loss	Continued surveillance is recommended but the mechanism for conducting this is not specified.
5 - 6 GUARANTEED INFANTS' AND FAMILIES' RIGHTS	- The right to choose a preferred communication mode is protected by the SA constitution. - Various charter and bill protect the rights of children and the rights of persons with disabilities - Client and parent autonomy should be respected at all times	Right to preferred communication mode is granted but no guideline for ensuring unbiased sharing of information is stated.
7 – 8 INFORMATION INFRASTRUCTURE; AND QUALITY ASSURANCE PROGRAMS	- A national database should be developed which requires the implementation of a standardized methodology, reporting, and program evaluation - Each province should report the number of live births and the number of newborns that have been screened for hearing loss during birth admission - Important information to collate include: number of birthing hospitals in each province; number of live births in each province; number of infants screened for hearing loss before discharge; number of infants referred for audiologic evaluation before one month of age; number of infants whose hearing has been evaluated before 3 months; number of infants with permanent congenital hearing loss; mean, median, and minimum age of diagnosis of hearing loss for infants identified in a newborn hearing screening program; number of infants with permanent hearing loss receiving intervention by 6 months - Development of a mechanism for further identification and follow-up of infants who are missed in the screening programme who may then be included in the data set - Ongoing monitoring of high risk infants will make identification of late onset congenital hearing loss or those losses that are associated with meningitis and tuberculosis - This data will provide for estimations of hearing loss prevalence by province and region which will provide national benchmarks and quality indicators	A national database is recommended but the mechanisms for developing and implementing this is not specified nor are any suggestions made.

The principles and benchmarks presented in Table 4.1 demand an active response from the audiological profession in South Africa. The pursuit towards hearing screening for all neonates/infants in the footsteps of developed nations such as the USA and the UK is marked with challenges in a developing country like South Africa. An important step toward reaching this goal is the establishment of a national database for contextual research regarding Infant Hearing Screening (IHS) programmes and the prevalence of hearing loss. This type of data will provide scientific support for the development and implementation of widespread IHS programmes.

4.2.2. Roles and responsibilities of EHDI role players in South Africa

Another essential aspect of an EHDI programme, which requires careful consideration in the initial phases of its implementation, is the different role players involved in the process. The success of a programme relies heavily on the role players and their individual and team responsibilities. A description of the suggested roles and responsibilities involved in implementing EHDI programmes in South Africa has been proposed by the HSPS. These roles and responsibilities are summarised in Table 4.2.

According to Bamford (2000:365) multidisciplinary teamwork between the different role players is vital to ensure satisfied families and confident children. Although other authors specify a transdisciplinary approach to be more effective especially in primary healthcare contexts, the important emphasis is on collaborative teamwork as a key to successful programmes (Fair & Louw, 1999:16; Moodley et al., 2000:37).

TABLE 4.2 Roles and responsibilities of role players in EHDI programmes (HPCSA, 2002:4)

ROLE PLAYERS	ROLES AND RESPONSIBILITIES
Families and Professionals	- Key partners in a family-centred, transdisciplinary team model. - Members include families, paediatricians, audiologists, otolaryngologists, speech-language therapists, educators and other early intervention professionals. - Case manager should coordinate services in consultation with family. - Individualised family plan should be designed to meet unique needs of infant and family.
Institutes and Agencies	- Those involved in hearing screening should assume responsibility for particular components. - A lead agency should be appointed to coordinate the various components. - Performance of hearing screening programmes should be audited through the formally commissioned evaluation of a designated pilot programme. - Community-based projects should be explored in order to implement and comply with Primary Healthcare objectives.
Provincial Directorates of Finance	- Accept full responsibility for ensuring that an adequate, dedicated allocation of funds is made to enable screening to take place, using appropriate technology. - Allocation of funds to ensure that "free healthcare for children under six years", as specified by the Government, includes rehabilitation and the provision of assistive devices is an urgent priority. - Funding must also be made available to train personnel in the use of equipment and in the administration of screening programmes at hospitals and in the community.

Although the list provided by the HPCSA is comprehensive, some important role players are omitted. Nurses and lay volunteers are not mentioned although they are reported to play an important part in many screening programmes internationally (Messner et al., 2001:123). The HSPS does, however, recognise their role in recommending that they be trained to conduct hearing screening (HPCSA, 2002:4). Important state institutions that should be included are also omitted. The Department of Health has a significant role to play in enforcing the

implementation and maintenance of such programmes and specific responsibilities are also required for the primary, secondary and tertiary healthcare centres. Another state department that needs to be specified as an important role player is the Department of Education. The educational changes toward an inclusive educational system requires that children with hearing loss be included in the mainstream school system. The ultimate goal of EHDI programmes is therefore to ensure successful inclusion of children with hearing loss (Van Dijk, 2003:14).

The specific roles and responsibilities in addition to the benchmarks and standards specified by the HSPS are a helpful guide but their contextual relevance to the South African situation requires further investigation with more comprehensive recommendations.

4.2.3. Contextually relevant benchmarks and standards

The Professional Board for Speech, Language and Hearing Professions' year 2002 HSPS provides valuable direction regarding the development and implementation of EHDI programmes in accordance with its mission of guiding the professions and protecting the public in South Africa (HPCSA, 2002:1). Although there are many aspects that still require in-depth consideration, the position statement has provided a general direction for infant hearing screening (IHS) in South Africa (Swanepoel et al., 2004:634). Charting a course at a national, provincial and district level, it provides a set of standards and benchmarks where none previously existed.

The implementation and evaluation of these standards, however, require that the principles and benchmarks *be evaluated against the unique characteristics of South Africa*. The fact that the South African year 2002 HSPS is based on the JCIH year 2000 position statement, which was developed in and intended primarily for the USA, makes it necessary for these benchmarks to be assessed within the South African context. This is essential because of the vast difference between the needs of developed (e.g. USA) and developing countries (e.g.

South Africa), and even between the needs of different developing nations (Madriz, 2001:91). The unique features of the South African context in terms of demographics, policies and services must therefore be investigated alongside with the current status of audiological services to infants and toddlers in the country. This will ensure evidence-based planning and implementation of appropriate early intervention services for infants with hearing loss in South Africa.

The following section, therefore, provides a critical evaluation of the challenges posed by the South African context to the implementation of widespread hearing screening. After this section a more specific assessment will be made of the current status of audiological EHDI services to infants and toddlers in South Africa.

4.3. EVALUATION OF THE SOUTH AFRICAN CONTEXT

Sub-Saharan Africa has an estimated population of 518 million people, which constitute almost 10% of the world's population (McPherson & Swart, 1997:18). The health and related socio-economic indicators put the continent of Africa among the least developed regions of the world (Dennill et al., 1999:29). Examples of these indicators in the continent of Africa are an infant mortality rate of 111 per 1 000 compared to 9 per 1 000 in developed countries; a life expectancy at birth of 51 years compared to 76 years; an adult literacy rate of 51% compared to 95%; a safe water supply of 43% compared to nearly 100%; and a gross national product of $505 compared to $18 884 (Dennill et al., 1999:29).

Although two-thirds of the world's least developed nations are in sub-Saharan Africa, the country of South Africa, which occupies the southern tip of the African continent, has a comparatively well-developed infrastructure (McPherson & Swart, 1997:18; Children in 2001, 2001:26; Woolard & Baberton, 1998:15). The South African population is heterogeneous with mixed sections of developed and

developing contexts (Fair & Louw, 1999) that are classified collectively as a developing nation. The country of South Africa has been described as a "world in one country" – not only because it has four or five relatively different climates and a vastly contrasting geography, but also because it has a diverse collection of peoples and cultures (Tuomi, 1994:6). These facts contribute a variety of challenges to the widespread implementation of IHS in South Africa and will be considered in the following sections (Swanepoel, 2004:11).

4.3.1. General characteristics of the population

It is essential that healthcare professionals such as audiologists should familiarise themselves with the general characteristics of a population since they have a significant impact on the service-delivery approach and strategy to follow (Louw & Avenant, 2002:145). The estimated South African population in 2002 was 45,1 million compared to 40,6 million for the 1996 census (Statistics South Africa, 2003:9; Census Key Elements, 2003:10). Almost half (44%) of the current population is younger than 20 years of age, with 10% of the total population between 0 and 4 years old (Census Key Elements, 2003:10). According to the Government report on *Children in 2001* (2001:28) children of 18 years and younger will dominate the age distribution of the population of South Africa in the short to medium term, at least. Most young children (55%) live in rural areas where poverty is most rife and the infrastructure least developed. More than half (62%) of children residing in rural areas are 10 years or younger (Children in 2001, 2001:29).

The country is grouped into nine provinces, with the largest population found in KwaZulu-Natal (9,4 million people) followed by Gauteng (8,8 million people). The population is comprised of a mixture of races. Figure 4.2 illustrates the distribution of South Africans according to race as identified by Census 2001 (Population Census Key Results, 2003:6)

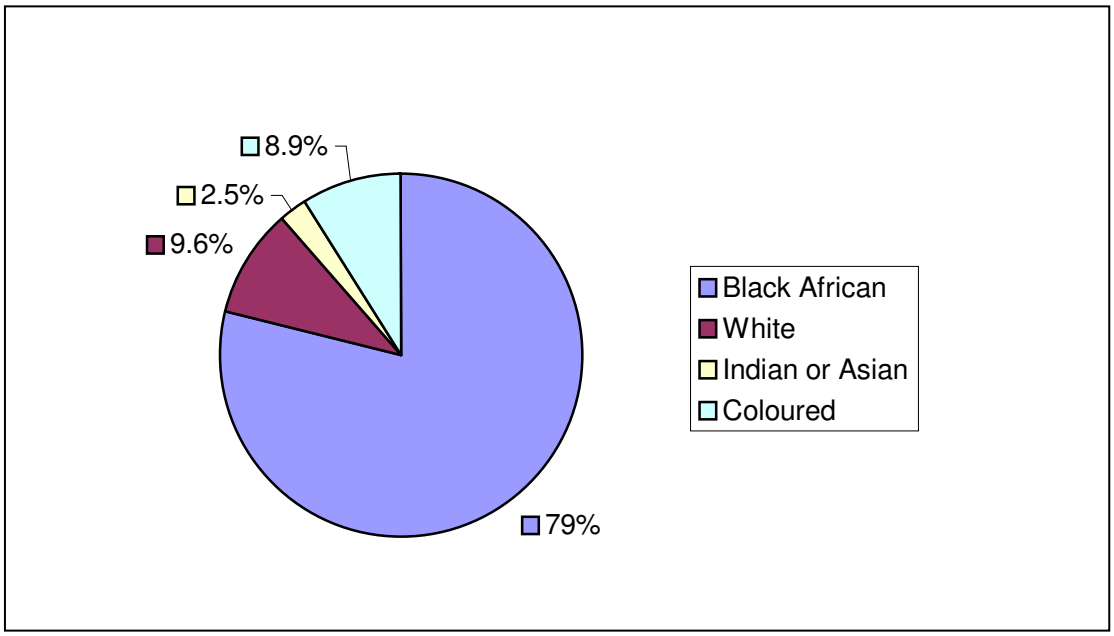


FIGURE 4.2 Distribution of South African population according to race (Population Census Key Results, 2003:6)

This race diversity is even further diversified by different cultures within these race groups, each with their own language or dialect. South Africa, often referred to as the "rainbow nation", has eleven official languages of which Zulu is spoken most commonly (24%) with Afrikaans third (13%) and English fifth (8%) (Population Census Key Results, 2003:8). Although half of the South African population lives in rural areas, the distribution of people in urban and non-urban areas varies according to race. Almost two-thirds (63%) of Africans live in non-urban areas, as against a far smaller proportion of coloureds (16%), Indians (5%) and whites (9%) (Central Statistics, 1998:9). The diverse characteristic of race and language poses a significant challenge to delivering culturally sensitive early intervention services to infants with hearing loss in their home language. This is compounded by the distribution of race between urban and non-urban areas, which means that services are least accessible to those disadvantaged communities most in need of services.

The distribution by age among Africans resembles the typical age-pyramid of developing countries where a large proportion of people are infants and young children, and among those aged 15 years or more, the proportion of people in different age categories decreases steadily (Central Statistics, 1998:7). Among coloureds and Indians there emerges a transitional profile of age distribution that depicts a situation which lies somewhere between developing and developed countries. The picture of age distribution for whites is typical of developed countries. There are proportionately fewer infants, pre-school children and children of school-going age, compared to the other population groups, while the proportion of older people is increasing. Approximately one in every seven (15%) white females and one in every eight (12%) white males in the country are aged 60 years or more (Central Statistics, 1998:7,8).

These figures demonstrate that national EHDI services will have to be directed primarily toward the African population since this population comprises the largest percentage of the population, have the most children in relation to other races, and are the most disadvantaged. The multiracial and multilingual characteristics of South Africa and the geographical distribution of young children with special needs present as significant challenges to the implementation of effective early intervention services to children with disabilities in South Africa.

4.3.2. Disability in South Africa

Approximately one in every 20 people in South Africa is reported to be disabled, with a similar proportion across race and gender (Central Statistics, 1998:38). The prevalence of disabilities in South Africa as determined by the Census 2001 is represented in Figure 4.3.

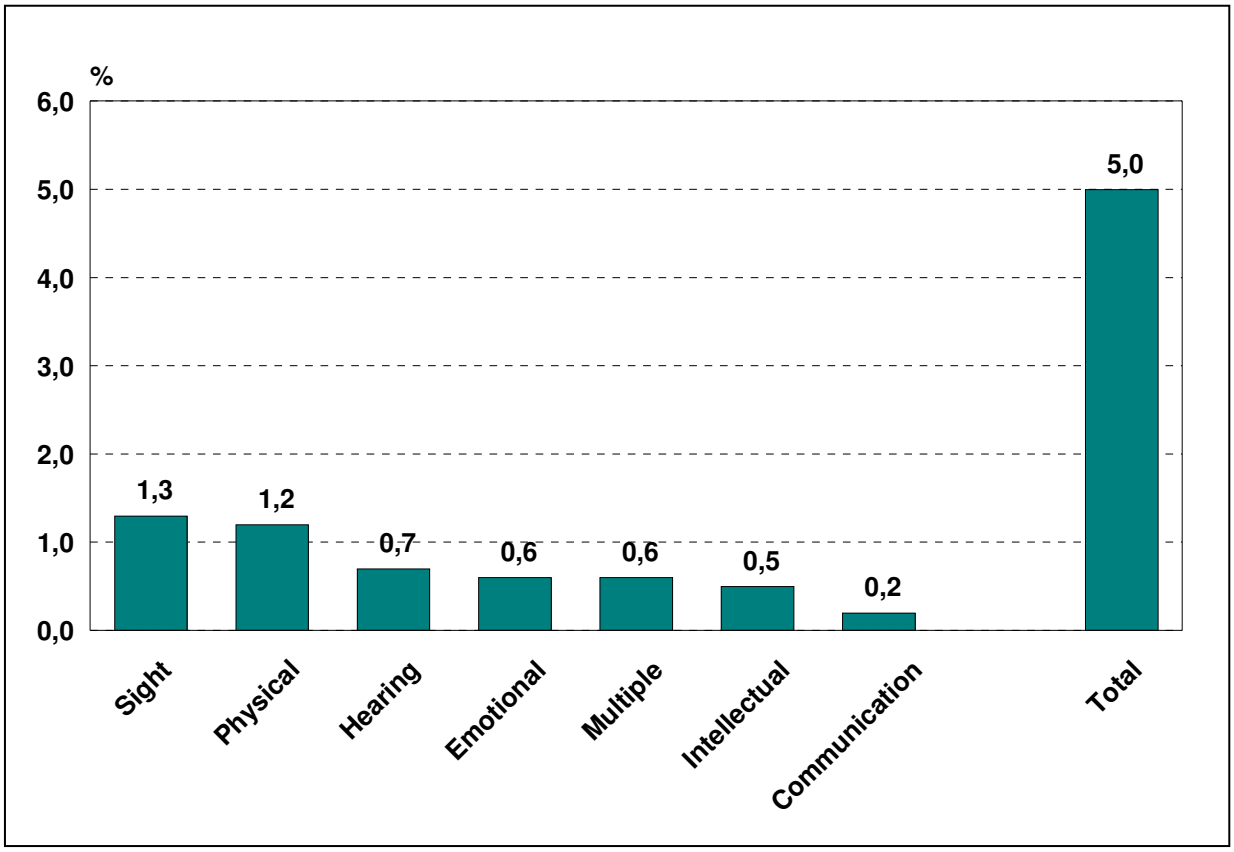


FIGURE 4.3 Prevalence of disabilities in South Africa (Population Census Key Results, 2003:6)

A total of 5% of South Africans suffer from some type of disability, with hearing loss making up 0.7% of the total figure. According to the Central Statistical Services (Central Statistics, 1998:38) this is probably a gross undercount due to the social stigma related to disabilities especially among the African population, as well as due to the fact that the definitions of disability in the census often differ and are not always explicit. Consequently, the accuracy of these prevalence studies have been questioned by some within the disability movement since the figures are considerably lower than the previous estimate of 10% of the population estimated by international agencies (Children in 2001, 2001:116). The international prevalence of disabling hearing loss, as estimated by the WHO, is much higher than the estimated South African figure at 2.2% (Mencher, 2000:180). This percentage does not, however, account for different regions in

the world and a survey done in South Africa indicated an even higher prevalence of 10% sensori-neural hearing loss (Sellars & Beighton, 1997:15).

Of the total population who present with disabilities, children between 1 and 15 years of age comprise approximately 9.4% (Children in 2001, 2001:114). Even though there is some controversy regarding the percentage of disabilities because international agencies estimate it higher at 10% of the total population, it is agreed that there are at least over half a million children with disabilities who are in need of appropriate services (Statistics South Africa, 1999:15). Although figures differ across provinces, rural children between birth and 10 years are twice as likely to have three or more disabilities than their urban counterparts. Hearing loss is reported to comprise approximately 22% of disabilities in South African children and is second only to impairments of sight. An additional 4% have multiple disabilities of which hearing loss probably constitutes an additional number of cases (Statistics South Africa, 1999:15). This figure, however, also seems to be a gross underestimation of congenital hearing loss prevalence since it is the most prevalent major birth defect in the USA (White, 2003:79). There is no doubt that hearing loss comprises a large proportion of disabilities in children. Despite the need for widespread EHDI services as part of the public healthcare system the misrepresented prevalence and impact of hearing loss in South African children, due to limited and poor quality statistical data, have resulted in a lack of legislative support and subsequent service delivery.

According to the report on *Children in 2001* (2001:116), South African child disabilities such as hearing loss were mainly caused by illness, prenatal and perinatal problems such as genetic disorders and birth trauma, injuries, accidents and violence. Children living in poverty are also much more vulnerable to disability as poverty-related factors lead to many preventable impairments which in turn perpetuate poverty. It is also true that the majority of children with disabilities in South Africa live in extreme poverty in inhospitable environments. Harmful, negative and discriminatory attitudes are probably the most significant barrier to development for these disabled children. Many children with disabilities are hidden in backrooms and often given no stimulation as they are deemed

worthless and available money is invested in the education of other siblings (Children in 2001, 2001:116). The perception of disability among African families is often characterised by an attitude of fatalism, which leads to an accepting, passive stance toward hearing loss in infants. This may have a negative effect on caregivers' decision to participate actively in the screening and early intervention process (Louw & Avenant, 2002:146,147).

The prevailing attitudes, ignorance of society and the protectiveness of their parents limit the rights of children with disabilities to participate and typically result in them growing up to be dependent, disempowered adults, unable to take initiative (Olusanya et al., 2004:301; Children in 2001, 2001:116). These attitudes pose a significant challenge in the form of cultural-based and ignorance-based resistance to the implementation and maintenance of successful EHDI programmes (Louw & Avenant, 2002:147). It will require implementation to occur in conjunction with educational awareness programmes to establish positive supportive attitudes in communities.

The following section focuses on epidemiological information that is available to describe the disability of hearing loss in the paediatric population of South Africa.

4.3.2.1. Epidemiology of childhood hearing disability in South Africa

An increasing world population and better survival rates for high-risk newborns will progressively and substantially increase the number of infants and young children with disabling hearing loss if decisive public health action is not taken. The first step in the implementation of such action is a thorough knowledge of the prevalence and aetiology of hearing loss in specific geographical regions for specific populations, in other words, community-based data (Olusanya, 2000:168). Few such studies have been conducted in South Africa, and those that have been completed are limited to small groups that are unrepresentative of the diverse South African population. In developing countries like South Africa, studies on children are typically of screening programmes for young school-aged children. These often reflect conductive losses and therefore are not a true

indicator of the incidence of congenital sensori-neural impairment (Mencher, 2000:179). Notwithstanding, such research is of value and some of the most prominent studies will be reviewed in the following section.

A number of studies have been conducted to ascertain the incidence of middle-ear pathology among young children from various South African communities, including black, white and coloured groups. The incidence varied between 13,4 and 29,4% (Celliers et al., 1988:35; Oosthuizen, 1986:26; Nel, 1988:25; Meyer & Van der Berg, 1985:73; Pretorius, 1984:22; Meyer et al., 1987:43), which indicates that the prevalence of middle-ear dysfunction in South Africa is higher than in First World countries, lower than in other Third World countries outside Africa and very comparable to other countries in Africa. The prevalence rates according to race and geography indicate it to be lower among black groups and higher in urban areas. Bhoola and Hugo (1995:22) evaluated 728 subjects aged between 4 and 5 years (315 black; 413 Indian) with a Middle-Ear Screening Protocol (MESP) and established a prevalence of 13% failures for black subjects and 14,3% for Indian subjects. Excessive cerumen caused 38,4% of the black and 49.9% of the Indian children to fail the outer ear tests.

In 1985 Meyer and Van den Berg (1985:73) found a 15,2% incidence of ear and hearing pathology in a group of children between 1 and 12 years old in an isolated community in Venda, Tshikunda-Malema. Altogether 13,4% presented with middle-ear conditions and 1,8% presented with sensori-neural hearing loss. A similar study, using immittance and pure tone screening procedures, was performed with grade one pupils (201) in the Eersterust community, which represents a developing context with primarily coloured children. All in all 15,7% did not conform to hearing within normal limits, with 2% presenting with sensori-neural hearing losses and 13,6% with middle-ear conditions (Meyer et al., 1987:45). A summary report on otitis media in South Africa concluded that there is a higher prevalence of otitis media in South Africa than in developed countries with difference across gender (less among black citizens) and geography (less in rural areas) (Hugo, Louw & Meyer, 1991:20). The high prevalence of middle-ear

and outer-ear disorders in South African children emphasises the need for effective national hearing healthcare services.

More recently the incidence of hearing loss in very low birth weight infants born at Kalafong hospital was determined for a small sample of 98 subjects. The incidence at discharge was found to be 4,1% and for a follow-up evaluation at 12 months chronological age, 41 of these infants were retested. An incidence of 16,3% hearing loss (6,1% sensori-neural; 10,2% conductive) was indicated (Van der Watt, 2002:14). This increased incidence is probably due to later onset conductive and sensori-neural hearing loss and draws attention to the urgent need for effective EHDI services providing routine follow-up for high-risk infants.

A comprehensive project to establish aetiologies of hearing loss for children at schools for the deaf in South Africa was performed between 1975 and 1983 (Sellars, Napier & Beighton, 1975:1136; Sellars, Groeneveldt & Beighton, 1976:1196; Sellars, Beighton, Horan & Beighton, 1977:311; Sellars & Beighton, 1978:812; Sellars & Beighton, 1983:888; Beighton, Sellars, Goldblatt & Beighton, 1987:210). Acquired hearing loss was identified in 25% of cases, with one third of acquired losses caused by meningitis and 19% by maternal rubella. In South Africa meningitis is responsible for 1.1% of deaths for children under five years of age (Solarsh & Goga, 2004:112). A genetic cause was identified in 18% of the study population with the most common aetiologies being Waardenburg, Treacher-Collins, Pendred, Usher and Brancial Arch syndromes. These results indicate a variety of causes for childhood hearing loss, including a large number of acquired losses due to environmental and disease-based causes and a smaller range of genetically based hearing disorders.

Prevalence studies for children in Southern Africa have consistently shown higher rates of severe to profound bilateral hearing loss when compared to those in the developed world (McPherson & Swart, 1997:7). There is, however, still a great paucity of prevalence and aetiological data for infant hearing loss throughout the South African population. The high prevalence of HIV/AIDS in South Africa emphasises the importance of investigating hearing loss in infants,

which may be related to HIV/AIDS infection or exposure (UNAIDS, 2003:1,2). Intra racial differences exist for outer-ear, middle-ear and inner-ear pathology, making it necessary to ascertain the prevalence of various types of hearing loss for the different ethnic groups according to age, geographical region and socio-economic status.

The current lack of true prevalence data for all regions in South Africa makes future hearing health service planning and provision difficult (McPherson & Swart, 1997:7). The underestimated prevalence of childhood hearing loss by inadequate means such as a census also renders political lobbying for legislative support in South Africa mostly ineffective. These factors are further complicated by a resource poor South African socio-economic infrastructure when compared to developed countries.

4.3.3. Socio-economic infrastructure

A small proportion of the population in South Africa represents the developed world, with a much larger proportion representing the developing world (Tuomi, 1994:6). South Africa is an upper-middle-income country with a *per capita* income similar to that of Botswana, Brazil, Malaysia or Mauritius (Woolard & Barberton, 1998:13; Children in 2001, 2001:26). When measured against other sub-Saharan African countries on the basis of socio-economic indicators such as the Human Development Index and Child Risk Measure, South Africa demonstrates low risk, but when compared to other countries with similar resources the measures are high (Woolard & Baberton, 1998:15; Children in 2001, 2001:31). The country is considered to exhibit a medium level of human development despite the fact that there are great disparities in human development levels in different regions and across different races (Woolard & Baberton, 1998:15). Certain provinces such as the Western Cape and Gauteng display high levels of human development whilst the Northern Province exhibits a low human development level. Large racial disparities further point to great inequality, with the black population's human development level on par with the

Congo and the white population on a level with Canada (Woolard & Baberton, 1998:15).

Extreme income inequality is evident in the form of destitution, hunger and overcrowding side by side with affluence. The experience of almost 50% of South Africa's population is that of outright poverty or of continued vulnerability to becoming poor (Children in 2001, 2001:26). The poorest 10% of households amass less than 1% of total household income in South Africa, in contrast with the wealthiest 10% who reap over 40% of household income (Woolard & Barberton, 1998:13). More than half the households living in poverty are found in rural areas where remittances and state social grants are relied on as the primary sources of income (Savage, 1998:67). According to Woolard and Baberton (1998:27) only 1% of African households earned more than R5 000 a month in 1993, compared to 51% of white households. Although poverty is not confined to one racial group in South Africa, it is concentrated among blacks, particularly Africans. A full 66% of Africans are poor compared to less than 2% of white households, whilst 8% of Asian households and 25% of coloured households are poor (Woolard & Barberton, 1998:27). The inequality is not only between racial groups, however, since the gap between rich and poor within the black community is also widening (Children in 2001, 2001:26). Poverty is an ever-present obstacle that will impede the delivery of EHDI services to the majority of South Africans and must therefore be carefully considered for future implementation of services.

Inequality is also evident in the provision of education in South Africa as low levels of income are strongly related to low levels of education (Louw & Avenant, 2002:147). There is a large discrepancy in the level of education across race and gender. One in every five (20%) African women have received no education at all, compared to one in every seven (14%) African males. On the other hand, only one in every 500 (0,2%) white males and females has received no education at all. At the upper end of the educational scale, almost all whites aged 20 years or more (99%) have received at least some secondary school education (Standard 6 or higher), while 30% of white males and 24% of white

females in this age category have obtained post-school qualifications. Among African males and females, however, only 6% have attained post-school qualifications (Central Statistics, 1998:11). Among the economically active, the proportion of unemployed is 34% or higher for those who have attended but have not completed school. However, the unemployment rate drops to 18% among those who have completed at least Grade 12 (Central Statistics, 1998:18).

The large percentage of poorly educated mothers or caregivers, primarily from low-income families, often lacks the knowledge to confirm suspicions of a disorder such as hearing loss and may not be able to access appropriate forums for guidance or concrete referrals early on (Louw & Avenant, 2002:147). Mothers and caregivers are at a disadvantage due to this lack of knowledge, which often causes confusion regarding developmental expectations for their children. This has important implications for the early detection of hearing loss in South Africa (Louw & Avenant, 2002:147) and emphasises the need for comprehensive EHDI programmes with a strong focus on empowerment through education, especially for those communities hardest hit by poverty and low levels of education. Unfortunately, additional socio-economic strains such as widespread unemployment diminish the priority for such services in healthcare systems.

Employment opportunities in South Africa are extremely limited, and many unemployed people have ceased to seek work actively. Transport and other costs entailed in job seeking, often with negative results, have however discouraged people from going out and seeking work (Central Statistics, 1998:17). The unemployment rate varies considerably across provinces, race and gender. On average, African women who are in the age group of economically active people are most likely to be unemployed (47%), followed by African males (29%), and then by coloured women (28%). White females (8%) and males (4%) are least likely to be unemployed. Comparisons of unemployment in urban and non-urban areas in the various provinces of South Africa show that, with some exceptions such as the Western Cape (which in any case is largely urbanised) unemployment tends to be higher in non-urban rather than in urban areas (Central Statistics, 1998:17,18). This is also related to race,

as 63% of Africans live in non-urban areas as against a far smaller proportion of other races (Central Statistics, 1998:9). The strain of finding employment may well cause parents of infants with hearing loss to demonstrate passivity toward EHDI. A negative socio-economic situation causes individuals' priorities to move away from habilitation to the more basic needs of daily provision and stability.

The above-mentioned socio-economic aspects of depravity such as poverty, unemployment and low levels of education have also demonstrated a significant relationship with the prevalence of congenital hearing loss as reported in a recent study (Kubba et al., 2004:123). This means that the more socio-economically depraved sections of South Africa will have an increased prevalence of hearing loss, and that the situation will be aggravated by the compounding factor of limited resources. The limited availability of resources creates barriers to the acquisition of equipment and the provision of appropriate training as well as supporting equipment and personnel for EHDI programmes. *The extensive poverty and inequality evident throughout the general population must spur efforts to provide hearing services to those who can least afford it, who need it most, and who are often furthest from hearing healthcare services.*

4.3.3.1. Socio-economic effects on children

The growth, development, well-being and safety of children depend largely on the ability of their caregivers to provide for them. In South Africa, however, six out of every ten children live in poverty (Children in 2001, 2001:33) and the children in rural areas are more likely to be poor than those in urban centres because seven out of every ten poor people live in rural areas (Central Statistics, 1998:39). The Department of Health estimated in 1995 that about 16% of babies were of a low-birth weight, 16% of children under five years were underweight for their age and the growth of between 20% and 30% was stunted as a result of chronic malnutrition (Savage, 1998:67).

Two measures frequently used to measure the vulnerability of a country's children are the Infant Mortality Rate (IMR) and the Child Risk Measure (CRM).

According to a Demographic Health Survey conducted in 1998, the IMR in South Africa is 45 per 1 000 live births, which means that one in every 22 babies born dies before reaching his or her first birthday (Children in 2001, 2001:31). This rate differs significantly across race with 11 and 47 per 1 000 for whites and Africans respectively. The Under-5 Mortality rate was at 59 per 1 000 and has been showing an upward trend since 1990, which is probably associated with the HIV/AIDS pandemic. Due to AIDS-related deaths it is projected that the child mortality rate for 2010 will be 99.5 per 1 000 (Children in 2001, 2001:31). These figures demonstrate why, in healthcare priorities, there is a move away from disability issues such as hearing loss, toward the more pressing need to address life-threatening conditions.

The socio-economic challenges evident in South Africa are also environmental risk factors that place young children at an increased risk of developmental disabilities and specifically hearing loss (Fair & Louw, 1999:14; Kubba et al., 2004:123). Despite an emphasis on life-threatening conditions, the risk factors emphasise the need for preventive measures that will minimise the use of more expensive rehabilitative measures. This may prevent the burden on society of an economically inactive group, such as individuals with hearing loss who do not receive appropriate early intervention.

The socio-economic pressures on families with infants with hearing loss also result in a priority shift within the family from attending to the rehabilitation of a disability to dealing with the more basic needs of stability and nutrition. This pressure also creates an increased passivity in families and prevents them from becoming active participants in the early intervention process, which ultimately undermines the efficacy of EHDI programmes. It is therefore essential that innovative models of service delivery such as those suggested by Louw and Avenant (2002:149), which “mobilizes caregivers and combats passivity” and “meets the needs of low-income populations” are investigated to ensure that accountable services are provided.

An additional factor affecting the whole of South Africa across all peoples and within all sectors of the economy, social life, healthcare and education is the HIV pandemic so rife in sub-Saharan Africa and also in South Africa.

4.3.4. Effect of HIV/AIDS

Worldwide, the HIV pandemic is showing no signs of abating, with 5 million new infections in 2003 and 3 million deaths due to AIDS-related illnesses. Southern Africa is home to only 2% of the global population but comprises 30% of global HIV cases. South Africa presented with an estimated 5.3 million HIV cases at the end of 2002 – the highest of any country in the world (UNAIDS, 2003:1,2). This rapid progression of HIV/AIDS is already impacting on every aspect of social and economic life in South Africa and is taking a heavy toll on the lives and well-being of all citizens, especially children (Children in 2001, 2001:85). The impact thereof will have a profound effect on family structures and the economy (Children in 2001, 2001:26). At the end of 2002 an estimated HIV prevalence rate of 26.5% was reported among sexually active women aged between 15 and 49 (Mngadi, 2003:1). Surveys by the Department of Health indicate an estimated HIV prevalence rate of 11.4% across the general population (Department of Health, 2002:4), which means that one in every nine South Africans and one in every five adults are living with HIV (UNAIDS, 2003:2).

South Africa is one of the countries with the highest number of children living with HIV/AIDS (UNAIDS, 2003:2). The greatest threat to South African children at birth is contracting HIV from infected mothers. Approximately one-third of children (14-39%) born to HIV-positive mothers are infected and an estimated one in seven will acquire it through breast-feeding (Singh, Georgalas, Patel & Papesch, 2003:240; Children in 2001, 2001:86). Most of these children develop AIDS and die within a few years after birth. This has been the main reason for a steady increase in child mortality, with 40% of deaths for children under five years of age due to the infection (Solarsh & Goga, 2004:112). It is estimated that the child mortality rate in South Africa will double due to HIV/AIDS by 2010 (Children in 2001, 2001:86).

The magnitude of the HIV/AIDS pandemic in South Africa is totally overshadowing disability and quality of life priorities such as hearing loss. It is therefore not surprising that hearing loss is not receiving the attention and support it deserves as a serious disability with devastating effects on individuals and far-reaching societal consequences. Healthcare priorities have furthermore been aligned toward life-threatening conditions in South Africa by the resurgence of tuberculosis, which is now on the rise in developing countries alongside HIV. These two diseases are known for activating and reactivating each other and tuberculosis accelerates the progression of HIV infection to reach the AIDS defining stage (*Department of Health Statistical Notes*, 2000:2).

Infants born of HIV/AIDS-infected mothers are at an increased risk for hearing loss due to significantly lower birth weights and the fact that HIV can affect virtually every organ in the body (Spiegel & Bonwit, 2002:128,129). Infants living with HIV/AIDS are also susceptible to other opportunistic infections and neurological complications that can compromise auditory function such as meningitis and cytomegalovirus (Matkin, Diefendorf & Erenberg, 1998:144; Spiegel & Bonwit, 2002:128). It is therefore no surprise that infants born to HIV positive mothers are at risk for a congenital hearing loss and for developing a hearing loss shortly after birth (Druck & Ross, 2002:4).

According to Matkin et al. (1998:153) approximately 90% of children with AIDS display developmental delays and, more importantly, many of them have a persistent problem with otitis media. Singh et al. (2003:2) report that otitis media was found to be the second most common ear, nose and throat disease in a group of children with HIV, and that 46% of the sample presented with it. Furthermore, HIV/AIDS is related to congenital hearing loss due to ototoxic medications taken prenatally for the treatment of HIV-related diseases. These medications may cross the placenta and damage the foetal ear structure development (Bankaitis, Christensen, Murphy & Morehouse, 1998:178). A recent study in South Africa indicated that for a group of 10 infants with HIV/AIDS between the ages of 6-12 months, 85% of the ears (n=20) indicated abnormal middle-ear functioning (Bam, Kritzinger & Louw, 2003:40). This was in

conjunction with a high prevalence of excessive wax in the external ear canal. It is clear that auditory development may be significantly impacted by the presence of HIV/AIDS.

Projections suggest that by the year 2005 there will be one million and by 2010 two million orphaned children due to HIV/AIDS (UNAIDS/UNDP, 1998:14). These figures suggest far-reaching consequences for children and the possible increase in hearing loss. Family life and the composition of the household are also profoundly affected by HIV/AIDS. It is inevitable that caring for sick family members and participation in ongoing economic activities will fall increasingly to the elderly and the very young (Children in 2001, 2001:88). The lack of dedicated caregivers for the children poses a significant threat to effective caregiver-focused early intervention services for the infants with hearing loss. Furthermore, children orphaned by AIDS face not only trauma of bereavement, but also the likelihood of poverty due to the loss of a breadwinner (Children in 2001, 2001:88). The impact of HIV/AIDS has surpassed an epidemic scale and has reached pandemic proportions in South Africa. This means that it is so widespread that it is starting to (and will continue to) affect all aspects of life in South Africa in a more prominent and observable manner. It is having a significant effect on healthcare system priorities, with the result that non-life-threatening conditions such as hearing loss does not receive adequate support and advocacy.

The fact remains, however, that the increasing number of infants and young children living with HIV/AIDS in South Africa will also increase the prevalence of hearing disorders across the population. This is due to complications of the central nervous system and increased middle-ear and outer-ear disorders caused by HIV/AIDS, which adversely affect hearing ability (Druck & Ross, 2002:4; Bam, Kritzinger & Louw, 2003:40). Paediatric HIV/AIDS in infants who have access to quality healthcare is not viewed as a critical short-term disease anymore but rather as a chronic condition (Davis-McFarland, 2002:10; Chan et al., 2002:73). This means that the paediatric population of infants with HIV/AIDS is an important and growing patient group that will require EHDI services. These

services are important to ensure a better quality of life and to improve the potential for development and education for these infants (Bam, Kritzinger & Louw, 2003:36). Although HIV/AIDS is shifting healthcare priorities primarily toward life-threatening conditions at the cost of disabling conditions such as hearing loss, the need for EHDI services to this very population is clearly indicated. A discussion of healthcare priorities in South Africa is presented in the following section.

4.3.5. Healthcare system for children

South African health services are based on a primary healthcare philosophy that aims to decentralise services with the principal emphasis on community care. The aim of the primary healthcare plan was "to ensure the provision of cost effective primary healthcare to all the inhabitants of South Africa" (Department of National Health and Population Development, 1992:6). The goal of the South African health policy, therefore, is to meet the health needs of the whole population by implementing an intersectoral approach. The emphasis is on healthcare rather than on medical care, with consensus that all South Africans have the same right to that care (Kritzinger, 2000:88).

Within this approach the health of children is recognised as a priority and the Government has legislated free healthcare services for all children under the age of six years (*White Paper on Integrated National Disability Strategy*, 1997:80). The White Paper (1997:84) also states that all children with disabilities who are under six ears old have free access to assistive devices and that the Department of Health is responsible for assistive devices that improve the independent functioning in these children. In spite of the efforts to provide healthcare for these vulnerable sections of society, specific policies for the disabled and at-risk population are lacking in South Africa (Moodley et al., 2000:26).

The new health system in South Africa clearly specifies child health as one of the priority components of the primary healthcare (PHC) package but a basic component like screening services, although in agreement with current

healthcare priorities and legislation, has not yet been realised in practice (Baez, 2003:1). This is despite former president Nelson Mandela pledging his government's commitment to children in June 1994 by stating that they would be put first (Children in 2001, 2001:21). The South African context poses several significant challenges to the implementation of EHDI services and the country's children are still in need of intensive efforts to nurture, develop and protect the future of South Africa. Table 4.3 reflects the status of children in the South African context.

TABLE 4.3 Key indicators for South African children (*Children in 2000*, 2001:27)

- Six out of every 10 children live in poverty, mostly in rural areas.
- The Infant Mortality Rate in 1998 was 45.4 per 1 000 live births. For Africans it was 47, coloureds 18.8 and whites 11.4.
- The Under-Five Mortality Rate was 59.4 per 1 000. For Africans it was 63.6, coloureds 28.2 and whites 15.3
- 63% of children were fully immunised and only 2.2% had received no immunisations.
- Nearly a quarter of children under 5 years old are stunted in their growth, and one in 10 is underweight for his/her age.
- One third of children under 5 years have a Vitamin A deficiency and 1 in 10 is anaemic.
- 21% of children under five die from diarrhoea, and 10% from acute respiratory infections.
- In 1998, 22.8% of women attending antenatal clinics in public health facilities were HIV positive. The rate of increase among teenagers between 15 and 19 years was 65.4% from the previous year. At the end of 2001 an estimated HIV prevalence rate of 24.8% was reported among sexually active women aged from 15 to 49 (Department of Health, 2002). This percentage grew to 26.5% at the end of 2002 (Mngadi, 2003).
- 180 000 children under the age of 15 were estimated to have lost their mother or both parents to AIDS.
- School enrolment is high at primary and secondary levels but an estimated 5% of children between the ages of 10 and 16 are not in school.
- In 2000, there were 226 631 children in state-supported reception year classes for 5-year olds.
- The pass rate for the Grade 12 examinations in 2000 was 57.9%.
- At least half a million children have moderate to severe disabilities and need access to specialist services.
- 42% of children under 7 years of age live only with their mother and 20% do not live with either parent.

It is clear from these key indicators that despite policy and programmatic interventions by the government, prevailing socio-economic conditions do not support the normal, healthy development of many of the country's children (Children in 2001, 2001:26). These factors constitute significant challenges to EHDI services in South Africa and need to be integrated and addressed in prescribed benchmarks and standards of service delivery.

The South African Hearing Screening Position Statement (HPCSA, 2002:1-9) provides benchmarks and guidelines for the implementation of screening services in the healthcare system in order to identify infants with hearing loss. In the previous discussion these benchmarks and recommendations were set against the background of the South African context, but they also need to be viewed within the existing framework of hearing healthcare services for infants and young children in South Africa. The next section therefore reviews the current status of audiological services in South Africa.

4.4. EVALUATION OF EHDI SERVICES IN SOUTH AFRICA

4.4.1. Introduction

Pienaar, the father of Speech-Language Pathology and Audiology in South Africa wrote as early as 1962 that "[a] young country, with a comparatively small percentage of wage earners, keen on expansion in every sphere of life, with no endowments and handicapped by a lack of funds, has had to march forward on faith, hope and charity and its youthful idealism. We are jealous of our standards of training, of research and therapeutics… We realise the vastness of the field still lying fallow; the great task still ahead of us to cater to the needs of the whole population of South Africa and through South Africa to the whole of the awakening Southern Africa" (Pienaar, 1962 in Cilliers, 1980:1). Almost 40 years later with a new government and new healthcare system, the main aim of audiology in South Africa has remained the same: availability of accountable services to all peoples of the country.

During the last decade large-scale changes have occurred in the South African socio-political arena. These developments have not only been political but have also brought about changes in national health, education and welfare policy (Kritzinger, 2000:86). An ongoing paradigm shift in the profession of speech-language therapy and audiology in South Africa has mirrored these political changes in order to improve imbalanced service delivery, redress teaching programmes and focus its research endeavours on the specific needs of the context. According to Kritzinger (2000:85), the shift has not only been reflective of the national changes in South Africa, but it has also been stimulated by international trends and developments in healthcare, education for learners with special needs, and views on people with disability.

The use of traditional institution-based models of service delivery in the field of speech-language therapy and audiology has proved to be ineffective in reaching the majority of vulnerable and disadvantaged communities in South Africa (Moodley et al., 2000:25). A resultant transformation is occurring towards a community-based service delivery model for speech-language pathology and audiological services to meet the unique needs of the broader South African community (Uys & Hugo, 1997:27). This type of model matches the South African government's current policy for a comprehensive, equitable and integrated National Health System. The restructured National Health System mandates the transition in service delivery from institution-based to community-based services to provide for the health needs of the whole South African population (*White Paper on an Integrated National Disability Strategy*, 1997:22,26).

Two recent initiatives from the HPCSA have reaffirmed these objectives, thereby providing a continued impetus for bringing services to the entire population. The first is the publication of a South African year 2002 Hearing Screening Position Statament (HSPS) by the Professional Board for Speech, Language and Hearing Professions of the Health Professions Council of South Africa (HPCSA, 2002). This document acknowledges the Joint Committee for Infant Hearing (USA) Year

2000 Position statement as the definitive document on infant hearing screening and admits that it forms an integral part of the South African position statement (HPCSA, 2002:1). The primary benchmark states that by 2010, 98% of neonates/infants in South Africa should be screened for hearing loss. The intermediate step in the pursuit of universal neonatal/infant screening is a targeted screening approach (HPCSA, 2002:5). These benchmarks reflect the commitment to the delivery of services to all South Africans and, according to the HSPS, "Primary Health Care principles need to be adopted in order to respond to the escalating need for community based and family oriented early intervention programmes" (HPCSA, 2002:7).

The second initiative was the decision to implement a community service year for all speech-language therapy and audiology graduate students. This legislation was implemented in 2002 and the graduate class of students began the first year of community service in January 2003 (Padarath et al., 2004:302). This community service year will not only provide in-service training to the new graduates, but more importantly, it aims to bring services to the communities where they were not previously available. Although there are still many challenges in terms of equipment and disposable supply shortages, this initiative is a step towards more community-based speech-language therapy and audiology service delivery. It also provides an infrastructure of audiologists and therapists to manage and oversee the delivery of new services such as EHDI programmes. To permit realistic planning, the infrastructure of audiological manpower in the public health sector needs to be ascertained alongside with the status of audiological services in this context.

The following section therefore reviews the available audiological manpower and the status of the professional functions of audiologists in South Africa as they relate to EHDI.

4.4.2. Audiological manpower in South Africa

Approximately 2 113 speech-language therapist audiologists are registered at the HPCSA (HPCSA, 2003:1). Traditionally, speech-language therapy and audiology constituted a combined qualification offered by South African universities and therefore, HPCSA registration was done as therapists and audiologists. Recently, university courses have changed, allowing qualification as either a therapist or audiologist or both. Since this change, 35 audiologists have been registered with the HPCSA (HPCSA, 2003:1).

According to projections made in 1993 there would already be a shortage of 10 000 speech-language therapists/audiologists in the year 2000 (Uys, 1993:4). There is also a limited awareness of the services offered and the relevance and need for services are subsequently not recognised (Malherbe, 1999:25). The recent initiative to add a compulsory community service year for audiology graduates may increase the awareness of services offered, due to an increased visibility of the profession. The number of community service positions and of permanent audiology positions in the national healthcare system is presented in Table 4.4.

A total of 128 community work placements were allocated for 2004 (Tau, 2003). However, the majority of these placements are not only for audiologists but are in fact dual posts for speech-language therapists/audiologists. This implies that these professionals are not dedicated solely to providing audiological services. Also, although speech-language therapists may conduct hearing screening as a professional function, they cannot manage an EHDI programme without being qualified as an audiologist too (Hugo, 2004:6). Disparities in distribution also become evident when the placements are related to the population per province. For example, the Free State with a population of 2.7 million received 17 placements, whilst the Eastern Cape with a population of 6.4 million only received 4 placements.

TABLE 4.4 Number of community service* audiologists and permanent audiologists employed by the Department of Health in each province

PROVINCE	POPULATION (Census Key Results, 2003:7)	NUMBER OF COMMUNITY SERVICE PLACEMENTS 2004 (Tau, 2003)	NUMBER OF COMMUNITY AUDIOLOGISTS FOR 2004
Eastern Cape	6.4 million	4	8
Free State	2.7 million	17	18
Gauteng	8.8 million	20	Info unavailable
KwaZulu-Natal	9.4 million	33	Info unavailable
Limpopo	5.3 million	7	28 (Only 2 are trained audiologists)
Mpumalanga	3.1 million	19	Info unavailable
Northern Cape	0.8 million	2	1
North West	3.7 million	16	Info unavailable
Western Cape	4.5 million	5	Info unavailable
SA Military Health Service	-	6	-

* Community service audiologists are audiology graduates busy with their compulsory year of community service.

From a national perspective, disparities also exist between private and public audiological services. The vast majority of audiologists are in private practice and provide services to a small minority of the country – primarily to people from developed contexts who can afford the services. The majority of the population however, with a higher prevalence of congenital hearing loss due to socio-economic depravity (Kubba, 2004:123), cannot afford audiological services in private practice and rely on the national healthcare system. This problem is exacerbated by the fact that many of the national healthcare positions for audiologists and speech-language therapists are filled by community speech and hearing workers who are not adequately qualified to implement and maintain EHDI services (Doctoroff, 1995:340; Centner, 2000:42). Previously audiologists preferred not take up these positions because of a more lucrative market in the private sector. It is the healthcare system's responsibility to reassess these positions as a competitive proposition to qualified audiologists.

According to the data contained in Table 4.4 (number of audiology /speech-language therapy posts) there is an obvious shortage of audiological manpower in the public health sector of South Africa. Based on the international estimated prevalence of congenital hearing loss of 2.2% there must be approximately one million individuals with hearing loss in South Africa (Mencher, 2000:180). If a South African prevalence estimate of 10% is used (Sellars & Beighton, 1997:15), the number of individuals with sensori-neural hearing loss is approximately 4.5 million. According to these prevalence estimates, if only half of the registered audiologists /speech-language therapists in South Africa provide dedicated audiological services, each of these audiologists are required to serve between 903 and 4 103 individuals with hearing loss. However, the vast majority of these audiologists are in private practice. This significantly increases the ratio of individuals with hearing loss per audiologist in the national healthcare system, which serves the largest proportion of the population. These figures indicate an overwhelming number of individuals with hearing loss who require audiological services from a very small number of professionals.

A final manpower challenge lies in the multilingual and multicultural characteristics of a country such as South Africa where the minority of people are mother tongue speakers of English and Afrikaans. So far, only a small percentage of mother tongue speakers of an African language have qualified as audiologists (Uys & Hugo, 1997:24). Delivering linguistic and culturally appropriate EHDI services to the vast majority of the population is a significant challenge to the audiological community in South Africa. The audiological manpower available in South Africa is insufficient, culturally and linguistically misrepresented, and unequally distributed between the private and public sector. The following section will review the status of audiological service provision to infants and young children in the public healthcare system.

4.4.3. Status of audiological services to infants and young children

The infrastructure of audiological services available in the public health sector must be ascertained to allow for reliable planning of widespread EHDI

programmes. Although the number of audiologists in each region provides an indication of human resources, providing services to infants and young children is heavily dependent on available equipment, effective referral mechanisms and teamwork. An inventory of this type of information is essential to the planning, implementation and execution of widespread audiological services such as infant hearing screening. Unfortunately no comprehensive South African study has as yet been conducted to ascertain the status of audiological services in the public healthcare sector. This neglect of audiology in the public healthcare sector is also evident in the national primary healthcare facilities survey of 2003 where no mention is made of audiology positions (Reagon et al., 2004:1-96). This emphasises the need for urgent action to provide a profile of the current status of audiological service in the South African healthcare system.

To provide an interim overview of local audiological services, an evaluation of the status of specific professional functions of audiologists in South Africa is provided in the following section. These professional functions include research, prevention, screening, assessment and intervention selected as those primary functions that are essential for an EHDI programme (Hugo, 2004:7).

4.4.3.1. Audiological research in South Africa

A science is built on the research it generates (Hugo, 1998:4). This is no different in the field of audiology where research is an essential cornerstone that underlies all aspects of the profession. It is a basic and inseparable part of all the other professional functions in audiology. According to Hugo (1998:4) a profession is established, sustained and developed by generating research. Audiological training and services in South Africa have always incorporated and used international research to guide service delivery to infants and children. The necessity for local research to sustain and develop the profession of audiology in South Africa has, however, become more prominent with an increased emphasis on providing relevant and accountable services for the entire population. Future activities must therefore be guided by findings of past research (McPherson & Swart, 1997:3)

Although research has always been an important part of audiological service delivery for infants and young children in South Africa, it has occurred on a small scale with limited application to the whole population. An urgent need exists for comprehensive research endeavours toward the improvement and development of audiological services to infants and young children in South Africa. Despite limited resources for research in developing countries, the research endeavours must mix the ideal formal research protocol with the reality of the nation and then problem solve to make it work (Mencher, 2000:180). Research efforts should be aimed at addressing two main aspects, namely determining the prevalence and aetiology (epidemiology) of hearing loss in infants and young children across the whole South African population, and establishing the status of the audiological service infrastructure of South Africa in terms of personnel, work setting, functions, collaborations and equipment as it relates to infants and children.

Currently there is a paucity of knowledge regarding both of these aspects (McPherson & Swart, 1997:5). Effecting the necessary changes in South African healthcare is dependent on context-specific research initiatives reporting both specific characteristics and needs based on representative research reports (Gopal et al., 2001:100; White, Behren & Strickland, 1995:12). Epidemiological data on childhood hearing loss in South Africa is scarce and those studies available are limited to small regions – mostly reporting on school-aged children – and are often not comparable due to methodological differences. Information regarding the status of audiological services for EHDI programmes throughout the country is even more difficult to come by. This information is, however, essential to the planning of widespread EHDI programmes based on accurate knowledge regarding existing infrastructures and service provision. The following section provides a summary of audiological services rendered to infants and young children.

4.4.3.2. Audiological prevention and screening for infants in South Africa

Prevention of hearing loss is an important professional function of the audiologist and a role that is supported by the South African Department of Health. The lack

of awareness among healthcare professionals and the lay public regarding audiology services is a continued obstacle toward prevention of hearing loss in South Africa. This includes a lack of awareness about the profession of audiology, risk factors for hearing loss, the effect of hearing loss and the importance of early intervention (Centner, 2000:40; Kathrada, 2000:54; Kopp, 2000:37; Malherbe, 1999:24).

The only studies reporting on the status of prevention and screening of infants in South Africa are unpublished undergraduate research projects, which provide fragmented information but are nonetheless useful in light of the lack of available published reports. A study investigating speech-language therapy and audiology services in the Western Cape identified an inadequate awareness of audiological services among nurses, parents and the general public (Centner, 2000:40). Studies indicate that nurses possess relatively limited knowledge about the role of the audiologist for providing services to infants (Kopp, 2000:37) and it seems that community rehabilitation workers also have a restricted, and in some cases misguided, perception of the profession (Malherbe, 1999:24). This lack of awareness among important team members leads to poor knowledge of the services audiologists can offer. The majority of health professionals (health administrators, neonatal nurses and paediatricians) surveyed in the Durban metropolitan area in KwaZulu-Natal had not heard of neonatal hearing screening programmes before (Kathrada, 2000:54). These reports, although regional, imply a general lack of knowledge regarding audiological services and remain a stumbling block to exercising the professional function of prevention.

The lack of preventive audiology in the public health sector is despite the fact that child health is a priority component of the primary healthcare package in the new South African health system. The latter includes comprehensive curative and preventive services for children younger than 6 years of age. Currently, however, preventive care seems limited to immunisation against diseases and growth monitoring, when it should also include developmental screening, which incorporates hearing screening (Baez, 2003:1). Since the introduction of free health services for children under the age of 6, which led to a dramatic increase

in demand for services, the focus of nursing staff training has shifted to curative rather than preventive care. It is unfortunate, therefore, that the implementation of any programme or policy for developmental screening, including hearing screening, has thus far been overlooked (Baez, 2000:1). Late identification of hearing loss in South Africa is therefore not surprising, and children are identified as late as four and eight years of age (Centner, 2000:43). This leads to irreversible delays in language development, speech and cognition, with far-reaching social and economical ramifications (Yoshinaga-Itano, 1998:1161; JCIH, 2000:10; Mohr et al., 2000:2).

The relationship between early recurrent otitis media and poor language and central auditory processing has already been established by research and clinical findings (Campbell et al., 1995:73). The Department of Health has made an attempt at preventing hearing loss caused by otitis media in the form of a guiding document constituting part of the Primary Healthcare Package for South Africa (Department of Health, 2000:1). The document provides norms and standards for health clinics and specifically includes the prevention of hearing loss due to otitis media. A guideline that specifies the procedure and protocol for the prevention of hearing loss due to otitis media was also published at clinic level (Department of Health, 2001:4). Apart from this document, however, there is no other legislation regarding the prevention of hearing loss in South Africa. A broader approach to prevention has been suggested considering that other preventive strategies to reduce the prevalence of meningitis, measles, rubella, ototoxic drugs, congenital syphilis and some familial aetiologies may also reduce the number of cases of acquired childhood hearing loss (McPherson & Swart, 1997:18).

Limited studies have been conducted that document infant hearing screening services in South Africa. A study investigating neonatal hearing screening practice in two private and three public hospitals in the Durban metropolitan area indicated that no neonatal hearings screening programmes existed (Kathrada, 2000:54). Another survey by Höll (1997:51) regarding neonatal hearing screening practice in 13 well-baby nurseries and 7 NICUs in six state-subsidised

hospitals provides some indication of audiological neonatal screening services. The results indicate that at least 15% of the hospitals in the study did not perform any neonatal hearing screening. Of those hospitals that implemented hearing screening, 85-86% used behavioural observation screening techniques. The study concluded that neonatal hearing screening was unsatisfactory due to the following reasons: a lack of standardised procedures for conducting neonatal hearing screening; trained personnel and nurses not being used to conduct screening; shortage of training programmes for nurses; no efforts to make screening more reliable; no definite control over follow-up of screening results; and limited collaboration between audiologists and nurses. If the private hospitals that offer more advanced and structured screening programmes are excluded, the reported results should provide a fair reflection of neonatal hearing screening in the national healthcare system.

These types of surveys need to be conducted on a larger scale to ascertain the standard and scope of audiological screening on a national basis in South Africa. Currently the ability to perform neonatal hearing screening is limited to audiologists as they are the only professionals trained to perform IHS screening (Kathrada, 2000:54). Although it is recommended that nurses do IHS (HPCSA, 2002:4), this practice has not realised thus far. In addition, electrophysiological hearing screening is primarily confined to private hospitals with only a small number of audiologists in tertiary state-subsidised hospitals having access to such equipment. In general, however, the state neonatal screening programmes in South Africa are fragmented and lack standardised criteria for testing, referral and follow-up (Höll, 1997:27-29). It is clear that significant improvements in audiological prevention and hearing screening for infants in the public healthcare sector are necessary. Once an infant at high risk for having a hearing loss is identified by means of prevention or screening programmes, a thorough audiological assessment is essential.

4.4.3.3. Audiological assessment in South Africa

As mentioned earlier, audiological services are distributed unequally in South Africa with services mostly confined to metropolitan areas whilst other areas experience a dire need of services (Uys & Hugo, 1997:24; Centner, 2000:41). Although assessment protocols and procedures for infants and young children are well developed, they are not freely available in the South African context. A further concern regarding audiological service provision is that in certain cases unqualified persons were employed in the past due to a lack of qualified personnel. This has obviously resulted in poor and fragmented service delivery (Doctoroff, 1995:340; Centner, 2000:42).

A study by Centner (2000:39) investigating speech-language therapy and audiology services in the Western Cape indicates that audiological services have not been integrated into the primary healthcare structure. The study reveals that rehabilitative audiological care was not accessible in its complete form to the population and many children were unable to receive the required intervention due to inaccessibility and financial constraints (Centner, 2000:42). There were no audiological services at primary healthcare level or at secondary healthcare level. All identified cases were subsequently referred to tertiary healthcare levels (Centner, 2000:49). This poor referral system – with no audiological services at secondary level – causes excessive numbers of cases to report at tertiary hospitals (Centner, 2000:42). The over-referral to the limited number of personnel at these hospitals causes long waiting lists, which make service provision inefficient especially in light of the importance of immediate action for infants with hearing loss.

Accessible audiological services require a strong, effective and well-coordinated referral system that ensures easy and logical movement between primary, secondary and tertiary services (Kopp, 2000:3; Centner, 2000:42). The limited number of referrals unfortunately reflects the fact that only a few audiologists are present at primary and secondary healthcare centres and that nurses demonstrate a relatively limited knowledge of audiology (Kopp, 2000:37). Some

clinic nurses feel that it is senseless for them to conduct infant hearing screening since diagnostic facilities are not locally available (Centner, 2000:44). It must be noted, however, that the implementation of a community service year in 2003 for audiology graduate students may begin to address this persistent problem, provided that appropriate equipment is also made available.

Diagnostic audiology centres for infants and young children in the South African healthcare system are primarily based at tertiary hospitals and university clinics, making them less accessible to the majority of the population in rural areas (Kopp, 2000:3; Centner, 2000:42). Surveys are necessary to ascertain the audiological infrastructure throughout the healthcare system. This information will allow for future planning, development and implementation of audiological services. Once an infant is diagnosed with a hearing loss, the intervention process must commence as soon as possible to ensure optimal outcomes.

4.4.3.4. Audiological intervention in South Africa

A limited number of studies have documented the current status of early intervention service delivery to infants and young children with special needs such as hearing loss in South Africa (Fair & Louw, 1999:14). It is, however, generally accepted that infants and young children in the developing contexts of South Africa are not receiving adequate intervention services (Fair & Louw, 1999:14). Speech therapy and audiology service delivery to the developing rural population groups has specifically been shown to be inadequate (Seef & Bortz, 1994:73). This is detrimental to the eventual outcomes of those infants, since the first intervention step in treating hearing loss in infants involves the efficient and timely fitting of appropriate amplification devices (Diefendorf, 2002:473).

No state subsidy is allocated for cochlear implants although three private implantation centres are established throughout South Africa. The South African healthcare system does, however, provide hearing aids to individuals with hearing loss at minimal costs although the availability thereof is questionable (Wansbury, 2002:26). A recent study by Wansbury (2002:20) investigating the

availability of these hearing aids in six state-subsidised hospitals revealed an unequal distribution of available amplification devices. In 50% of the hospitals the demand for hearing aids exceeded the supply and waiting lists of between 2 and 9 months for up to 48 patients were reported. In the other half of hospitals hearing aid demand was adequately met and supply even exceeded demand in one hospital. These results indicate poor coordination and distribution of resources and emphasise the need for large-scale surveys addressing all aspects of audiological service delivery, inventory of equipment and availability of supplies (Wansbury, 2002:24,25). It is essential to optimise the intervention process, beginning with amplification as the first step, since early identification benefits are lost when there are long waiting lists. Neonatal or infant hearing screening without prompt intervention is also considered unethical (HPCSA, 2002:6).

Due to a shortage of qualified personnel, audiologists' use of traditional institution-based models of service delivery has proven to be ineffective in reaching the majority of the vulnerable and disadvantaged communities of South Africa (Moodley et al., 2000:26). The restructured National Health System mandates a transition in service delivery from institution-based services to community-based services (*White Paper on Integrated National Disability Strategy*, 1997:86). Implementation of community-based services has not been without persisting problems. Poor coordination of early interventions is a continuing problem especially in South Africa in the light of the country's history of limited resources, fragmentation and lack of coordination in health service systems (Moodley et al., 2000:26).

Educational intervention for infants and young children with hearing loss in South Africa has not been conducive to the inclusion of individuals into society. Children with hearing loss have primarily been placed in special schools for the deaf of which there are 35 nationwide (Van Dijk, 2003:17). These schools are not enough for the conservative estimate of approximately 169 550 school-aged children with hearing loss (Van Dijk, 2003:21). It is only more recently that the government policy started to stress more inclusive practices to allow

accommodation of children with hearing loss into mainstream schools (Department of Education, 2001:4). Although this approach is aimed at the better integration of hearing disabled persons into society, it faces many challenges in the current South African context, such as overcrowding of classrooms and large teacher/child ratios (van Dijk, 2003:21). A change of focus in South African education toward more inclusive practices is a positive change for children with hearing loss since the outcomes of an effective EHDI programme should be inclusive school placement. Challenges to the comprehensive implementation of this inclusive educational system are therefore also possible barriers to the desired outcomes for infants with hearing loss enrolled in EHDI programmes.

The discussion of audiological manpower and the current status of audiological services in the above paragraphs has highlighted a significant number of barriers and persisting challenges to the delivery of effective and widespread EHDI services to all South Africans. These challenges are summarised in the following section.

4.5. SUMMARY OF THE CHALLENGES TO EHDI IN SOUTH AFRICA

A review of the South African context and EHDI services in South Africa has revealed that there are many challenges to the implementation of the recommendations made in the South African HSPS (HPCSA, 2002:1-8). The challenges that require consideration for implementing widespread EHDI programmes in South Africa (as discussed in paragraphs 4.3 and 4.4) are summarised in Table 4.5.

TABLE 4.5 Summary of challenges to EHDI in South Africa

CHALLENGES OF THE SA CONTEXT	CHALLENGES OF SA AUDIOLOGY SERVICES
- Multicultural, multilingual, and multiracial nature of SA population - Geographical distribution of infants and young children with special needs - Large third world sections and small first world section coexist - Large racial disparities in human development - Extensive poverty and inequality - Large discrepancies in levels of education across race and ender - Prevailing socio-economic conditions do not support the normal healthy development of many of the country's children - Most young children (55%) reside in rural areas where poverty is rife and the infrastructure least developed - Majority of children with disabilities live in extreme poverty in inhospitable environments - Prevailing attitudes and ignorance hinder prevention of and early intervention for hearing loss - South African socio-economic challenges are environmental risk factors which place infants at and increased risk of developmental disabilities - HIV pandemic: High prevalence of infected infants and orphaned infants and children - HIV infected infants are prone to ear disease and disease and deterioration of the auditory system - There is a crowding out of non-HIV related illnesses - Demands on health sector are increasing while the capacity is undermined through losses of staff owing to HIV/Aids - Lacking in policies and legislation for disabled and at-risk infants	- Paucity of neonatal / infant hearing screening programs - Importance of hearing screening largely overlooked - Only audiologists are currently trained to perform neonatal / infant hearing screening - Limited collaboration between audiologists and nurses in terms of screening - Limited hearing screening with OAE and AABR screening technologies - Unequal distribution of audiology services – mostly confined to metropolitan areas making accessibility difficult for large portions of the population - Unqualified persons are delivering audiological services in certain cases - Audiological services have not been adequately integrated into the primary health care structure yet - Diagnostic audiological centres are primarily based at tertiary hospitals and are often far and inaccessible to large portions of the population - Shortage of audiologists in the public health sector - Shortage of audiologists who are fluent in African languages and familiar with African culture - Unequal distribution of audiologists across provinces as measured against their population size - Limited audiological equipment and supplies - Small scale research endeavours with limited application to larger sections of the population - Limited information regarding the audiological infrastructure and standard of care for infants and young children in the health care system - No large-scale prevalence and aetiology studies for infant hearing loss in South Africa - Lack of awareness amongst health care professionals and the lay public regarding the audiology profession, risk factors for hearing loss, the effect of hearing loss and the importance of early intervention - Few preventative strategies to reduce no. of acquired childhood hearing loss (e.g. for meningitis, measles, rubella, ototoxic drugs, congenital syphilis, and some familial aetiologies) - Poor coordination of early intervention services - Absence of structured early identification programs and well-organized referral systems causes fragmented early intervention services - Unequal distribution of funds for hearing aids: longs waiting lists are common

Although the challenges summarised in Table 4.5 have been extrapolated from the South African context and EHDI service delivery status, these challenges are not uncommon throughout the developing world. Early identification of and intervention for infants with hearing loss in developing countries are hampered by similar barriers in all developing countries – including lack of trained personnel and equipment, supply shortages, and the overburdening of understaffed health units (Newton et al., 2001:230; Gell et al., 1992:645). The challenges have not, however, discouraged efforts globally to implement EHDI programmes in developing contexts. Despite these difficulties, reports of UNHS programmes are continuing to emerge from developing countries as the desire to implement UNHS is spreading from developed countries to other regions (Chapchap & Segre, 2001:33; Psarommatis et al., 2001:25; Lin et al., 2002:209; Mencher & DeVoe, 2001:19; Rouev et al., 2004:805). The growth in UNHS programmes in countries outside the developed world emphasises the need for the development of feasible and effective EHDI service delivery models suited to the unique challenges of developing countries.

This aspiration to implement widespread EHDI services in South Africa is evident in the year 2002 HSPS, which provides direction in the development of UNHS programmes (HPCSA, 2002:1-8). The document specifies First World screening goals for the South African context in an attempt to provide first-class clinical services in a developing country. The South African healthcare system is relatively well developed compared to other developing countries (Children in 2001, 2001:116,117), which allows the possibility to provide quality audiological services despite the prevailing challenges. This has proved to be possible in other developing regions but also in the development of neonatal hearing screening programmes in the late 1960s in Colorado, USA, when very limited resources were available (Silverman & Moulton, 1997:5-7; Downs, 2002). Such services require a thorough knowledge of the prevailing challenges so that a contextually relevant EHDI system may be developed in the future.

4.6. FUTURE OF EHDI SERVICES IN SOUTH AFRICA

EHDI programmes are consistent with South African primary healthcare priorities (Fair & Louw, 1999:17) and should constitute an essential part of services to infants and young children if these priorities are to be met. The guidelines specified by the year 2002 HSPS provide a valuable set of standards to direct the future of EHDI in South Africa (HPCSA, 2002:1-8). These standards should be used for advocacy purposes at national level and with administrators at management level.

The HSPS specifies neonatal hearing screening in well-baby nurseries and NICUs (HPCSA, 2002:5), which are screening contexts similar to those in developed countries such as the USA and UK. A significant pool of information and resources is available to guide and measure service delivery in these contexts (Mencher & DeVoe, 2001:18). A third screening context is also recommended, namely at 6-week immunisation clinics. These clinics are part of the Maternal and Child Health (MCH) clinics and they are not specified as screening contexts in developed countries (JCIH, 2000:13,14). The HSPS has put forward a benchmark of having screening equipment available at all MCH clinics in 2005 to allow hearing screening for all infants attending their first immunisation visit (HPCSA, 2002:5).

The rationale for including this third screening context is the fact that the South African healthcare system is based on a primary healthcare approach which aims to provide an accessible service to the whole population. A unique problem in developing countries like South Africa is that a significant number of births do not take place in hospitals but either at home or in clinics. Reports indicate that the majority (70%) of South African children are born in hospitals, but the actual percentage varies greatly across regions. In the Central Karoo, for example, all births were reported to have occurred in a hospital, compared to the Tambo district where 51% of births were in a hospital, 2% were in clinics, and the other 40% were home births (Statistics South Africa, 2002:65). The use of 6-week

immunisation clinics at MCH clinics therefore provides a means of reaching the entire population with infant hearing screening.

The Maternal and Child Health clinics are specifically suited to the delivery of community-based services by providing extensive coverage of all newborn and maternal health services in South African communities. The 6-week immunisation clinics provide comprehensive coverage since only 2% of South African children aged 12 to 23 months do not receive vaccinations (Children in 2001, 2001:75). This also means that the use of immunisation clinics for hearing screening could provide coverage of 98% of children younger than 23 months of age. There will obviously be a large discrepancy between the recommended 3-month age of identification specified in the HSPS and the potential 23-month age of actual identification (HPCSA, 2002:5). However, a recent report indicated that 79% of all infants in South Africa were fully immunised by one year of age (Solarsh & Goga, 2004:121). If this is true, it would ensure an almost 80% coverage for hearing screening before an infant is six months old. Although the recommended 95% coverage is not achieved in this way yet, it should be remembered that the 6-week immunisation clinic is but one of three screening contexts recommended by the South African year 2002 HSPS (HPCSA, 2002:5).

A concern, however, is the screening age at these MCH 6-week immunisation clinics. The HSPS recommends identification of hearing loss before three months old (HPCSA 2002:5), but a baby's first immunisation may well occur any time during the first year of life even though it is scheduled for six weeks after birth (Children in 2001, 2001:75). The Department of Health has recently put forward a strategic plan to ensure that full immunisations are realised for all infants by one year of age with an intermediate step of 90% national coverage by 2005 (Solarsh & Goga, 2004:113,122; Children in 2001, 2001:75). Even when infants are screened at exactly six weeks of age on their first immunisation visit, however, it allows limited time for follow-up and confirmation of hearing loss before 3 months of age (JCIH, 2000:15). The 3-month benchmark has originated in the United States, where almost all hearing screenings take place within 48 hours after birth. For hearing screening in well-baby nurseries and the NICU this

may be a reasonable benchmark for South Africa, but it might prove very difficult to attain at MCH clinics. A further concern at these clinics is the fact that older infants are more difficult to test than newborns and this may result in less successful infant screens (Palmu et al., 1999:210).

Timely and efficient confirmation of hearing loss for infants screened at 6-week immunisation visits at MCH clinics will require an integrated multi-disciplinary follow-up system. An essential component will be the education of mothers/ caregivers regarding the importance of returning for follow-up appointments, the effect of late-identified hearing loss, and the benefits of early identification and intervention. According to *Children in 2001* (2001:75), mothers who are better educated are more likely to return for the full set of vaccinations and probably also for the follow-up hearing screenings and evaluations. A large-scale initiative of this nature must, however, be carefully considered, evaluated and planned within an appropriate model of EHDI service delivery in MCH clinics (Fair & Louw, 1999:14).

It is also essential that appropriate screening technology be selected and the best screening protocols be developed for the varying screening contexts in South Africa. This will require applied research methodologies implemented at pilot sites to investigate the various possibilities. In addition to investigating the screening technology and protocols for South Africa, the Year 2002 HSPS provides future challenges as priority aspects to be considered. These challenges are summarised in Table 4.6 (HPCSA, 2002:7).

TABLE 4.6 Priority challenges to developing EHDI programmes in South Africa

- Principles of primary healthcare must be fully adopted in order to respond to the escalating need for community-based and family-oriented early intervention programmes.
- Research is needed to differentiate between truly congenital and perinatally acquired hearing loss.
- Strategies for the optimal management of auditory neuropathy need to be identified and implemented.
- Consideration should be given to the way in which technological advances in the measurement of hearing acuity, amplification and cochlear implantation will affect services delivery.
- Genetics of hearing loss and patterns of inheritance should be investigated.
- Benchmarks and quality indicators need to be developed and established to evaluate the effectiveness of neonatal and infant hearing screening programmes.
- Health, social service, and education organisations associated with early intervention must continually monitor progress to ensure that EHDI programmes are timely, effective and beneficial to the whole South African population.

Important aspects to consider for the future implementation of early intervention services in South Africa are also highlighted by Moodley et al. (2000:37,38). These authors remark that adoption of a transdisciplinary team approach is essential to increase the accessibility of hearing screening services; collaboration is important at different levels of the healthcare system to ensure advocacy at and access to different levels; marketing of audiological services are necessary to increase awareness among professionals and the lay public; and the training of audiologists must be directed at the current and projected demand for EHDI services. In addition to this, recruitment efforts must be made to enrol students from culturally and linguistically diverse backgrounds to reflect the composition of the South African population.

The dire need for EHDI services for infants and young children with hearing loss in South Africa necessitates the proactive collaborative efforts of audiologists in conjunction with legislative support and funding from the government. This challenge needs to be met by consistent efforts from audiologists on all levels

including management, research, service delivery and training in order to ensure effective and accountable early intervention service delivery to the maximum benefit of infants and toddlers with hearing loss in the developing communities of South Africa.

4.7. CONCLUSION

The priority of implementing a national system of EHDI is aimed at ensuring good hearing as a basic human right for all infants. The desire to develop and implement EHDI programmes for children in developing countries such as South Africa is therefore just as intent, humane and appropriate as it is for developed countries (Mencher, 2001:19). Unfortunately the lack of standards, equipment, staff, facilities and other resources are persistent obstacles to developing contexts. These challenges of infrastructure and contextual characteristics must be considered and addressed by systematic planning and legislative support.

Despite the many challenges toward the implementation and maintenance of effective EHDI services, there have been a number of positive changes to support the cause of providing quality services to infants with hearing loss in South Africa. These changes include the following:

- Health and education policies are in support of early identification and appropriate timely interventions for disabilities such as hearing loss (*An Integrated National Disability Strategy*, 1997:22; Department of Education, 2001:4).
- The South African Year 2002 HSPS gives valuable direction by providing a set of standards where none previously existed.
- A compulsory community service year for audiology graduates will raise the awareness of audiological services by giving it better visibility, as well as increase the manpower to implement widespread EHDI programmes.
- An existing MCH immunisation clinic infrastructure provides an important platform for thorough screening and follow-up coverage with 98% of

children receiving at least one immunisation before 23 months of age and 79% of infants being fully immunised by one year of age (Solarsh & Goga, 2004:112; Children in 2001, 2001:75)

- Technological developments leading to reduced costs of electrophysiological hearing screening measures (Oto-Acoustic Emission and Auditory Brainstem Response screeners) and minimal false positive rates (~ 100% screening sensitivity and specificity as low as 98%) make this type of screening a feasible option (Mencher & DeVoe, 2001:18; Mehl & Thomson, 1998:2)

The positive changes provide guidelines, support and a platform for EHDI services in South Africa. The assessment of real cost and efficiency on the basis of pilot studies remains essential prior to the widespread implementation of such services. This is especially relevant in South Africa – a resource-poor country with low literacy levels – where a non life-threatening yet debilitating condition such as hearing loss is not receiving the institutional support, research funding and political advocacy which it deserves. The ability to identify hearing loss at birth does not mean we in South Africa are ready to deal with the responsibilities and consequences of UNHS (Mencher & DeVoe, 2001:19). Contextual research regarding epidemiology and prevalence, especially for unique populations such as HIV-infected infants, is crucial alongside surveys assessing hearing healthcare services. This data is necessary to ascertain the nature and impact of hearing loss in infants and the standard and scope of otological and audiological services in South Africa so as to ensure a relevant course of action. A UNHS programme should be incorporated into primary and secondary healthcare services to ensure that it becomes an integral part of a health and education programme.

South Africa needs to access international resources to guide and support innovative, context-specific research endeavours for the planning of screening programmes that improve hearing healthcare for all infants in a cost-effective and accountable manner.

4.8. SUMMARY

This chapter provided a critical evaluation of EHDI services in South Africa. The benchmarks and standards for EHDI services in South Africa were discussed first as proposed by the year 2002 HSPS. These benchmarks and standards were subsequently evaluated against the current South African context and status of EHDI services in South Africa. The South African context was evaluated in terms of its population characteristics, disability prevalence, socio-economic infrastructure, effect of HIV/AIDS, and the healthcare system for children. The status of EHDI services was also discussed in terms of the available audiological manpower and the status of audiological services for infants and children. The challenges posed by the South African context and the status of EHDI services were summarised together before the focus of the discussion turned to the future direction of EHDI in South Africa. The chapter was drawn to a close by an appropriate conclusion.

CHAPTER 5

RESEARCH DESIGN AND METHOD

Aim: To provide the research design and methodological approach implemented in conducting the empirical component of this study

5.1. INTRODUCTION

Science refers to both a system for producing knowledge and to the knowledge produced by that system (Neuman, 1997:6,7). According to Bless and Higson-Smith (2000:3) the "scientific method of acquiring knowledge, also called scientific research, is a systematic investigation of a question, phenomenon, or problem using certain principles". Different sciences are not united by their subject matter but rather by their common method or way of acquiring knowledge (Bless & Higson-Smith, 2000:3).

Although the South African Department of Health emphasises Essential National Health Research (ENHR) (Department of Health, 1997:21) the literature review reveals an almost complete dearth of contextually relevant research on early detection of hearing loss and subsequent intervention in South Africa. Maternal and Child Health (MCH) clinics, which serve to provide comprehensive primary healthcare services (Dennill, King & Swanepoel, 1999:36-39), have never been investigated as a hearing-screening context. This lack of contextually relevant research, the importance of identifying and intervening early for hearing loss, and finally the recommendation of the South African year 2002 HSPS to implement MCH clinics as a screening context, provide the rationale for the current study. Investigating the utilisation of MCH clinics as hearing-screening context in South

Africa required the selection of an appropriate research design and method to obtain suitable empirical data to address the research problem.

Mouton (2001:55,56) provides an apt analogy to distinguish the research design from the research method. The process is compared to building a house with the research design representing the architectural design or blueprint for the house. The research design focuses on the end product and on what type of study is being planned and what kind of results are aimed at. The departure point is the research problem and it is concerned with the logic of the research and on what kind of evidence is required to address the research question adequately. The research method represents the actual construction process or methods and tools used to complete the house. It focuses on the research process and the kind of tools and procedures to be used (Mouton, 2001:56). The design and method selected for this study had to provide the plan and process instructions to answer the following question: ***Is an early hearing detection programme at MCH clinics in a developing, peri-urban, South African community a feasible option?***

This chapter discusses the selected research design as the general plan for addressing the research question of the study and also sets out the methodological approach to acquiring, recording, and analysing the empirical data.

5.2. AIMS OF THE STUDY

The aims of the research study are as follows:

5.2.1. Main aim and sub-aims

The main aim of this study was to critically describe an early hearing detection programme at MCH clinics in a developing, peri-urban, South African community.

The following sub-aims were formulated in order to realise the main aim of the study:

1. To describe the MCH clinics as a screening context
2. To describe the population of infants and caregivers attending the MCH clinics
3. To describe the results of the High-Risk Register and test procedures
4. To describe the performance and efficiency of the screening protocol
5. To describe the interactional processes involved in the implementation and maintenance of a screening programme in MCH clinics

5.3. CONCEPTUALISATION OF DESIGN AND METHOD

An exploratory descriptive design (Bless & Higson-Smith, 2000:41) implementing combined quantitative and qualitative research methods was selected to address the aims of this study (De Vos, 2002a:365). The quantitative and qualitative methods were jointly implemented using a dominant-less-dominant model of triangulation (Creswell, 1994:177,178). The selected research design and method is represented in Figure 5.1.

The research design is like a route planner providing a set of guidelines and instructions on how to reach the goal that has been set (Mouton, 1996:107) and has two main purposes. Firstly to solve the research problem by developing a strategy for obtaining empirical data that will answer the question or hypothesis posited. The second purpose is to eliminate or minimise the contamination of results by extraneous variables (Ventry & Schiavetti, 1980:65). The research method, however, is defined by Leedy and Ormrod (2001:100) as “merely an operational framework within which the data are placed so that their meaning may be seen more clearly” (Leedy & Ormrod, 2001:100). The design and method utilised in the current study are forthwith discussed.

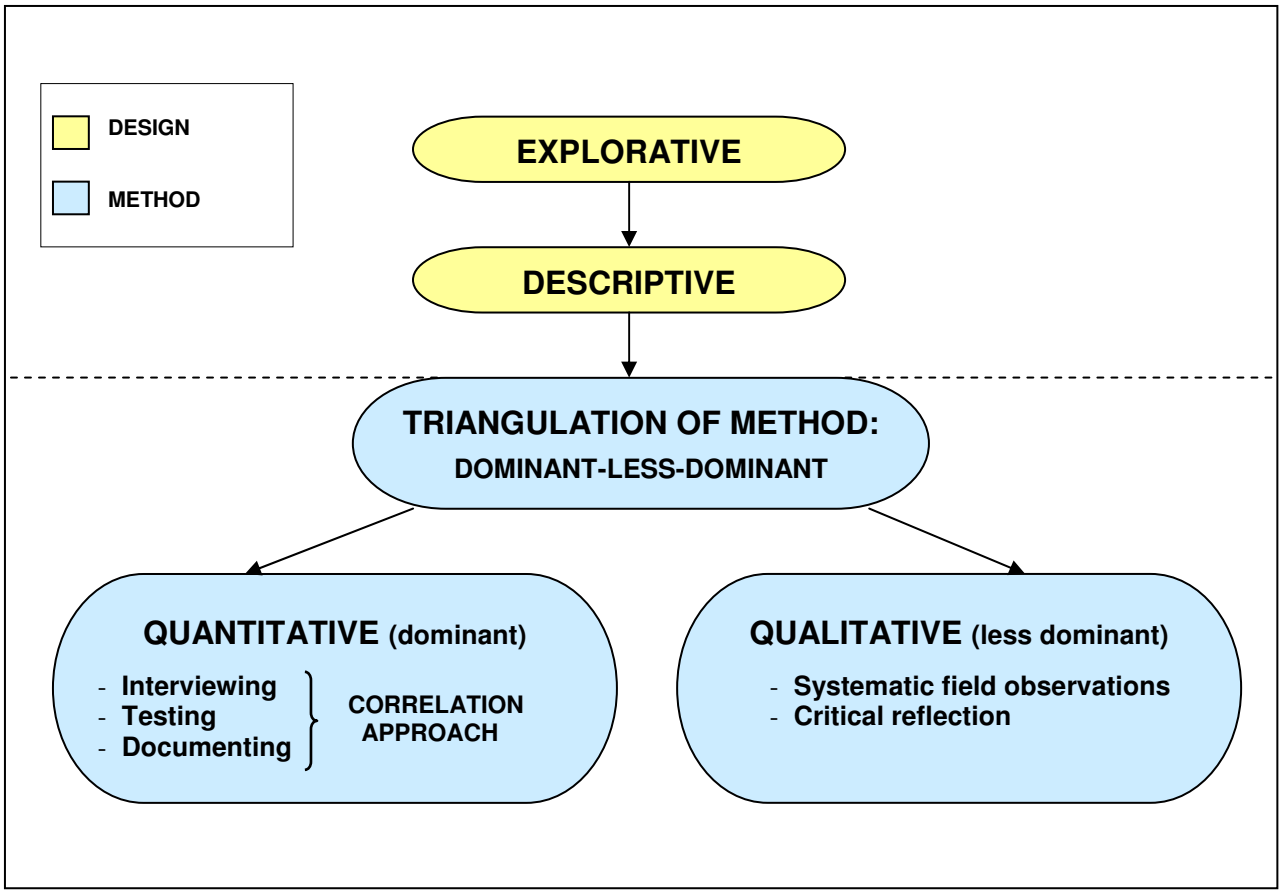


FIGURE 5.1 Research design and method of study

5.3.1. Research design

As illustrated in Figure 5.1 this study utilised an exploratory descriptive design. If an issue of investigation is new and little or nothing has been reported on it, the design is exploratory in nature (Neuman, 1997:19). According to Bless and Higson-Smith (2000:41) the "purpose of exploratory research is to gain a broad understanding of a situation, phenomenon, community or person" and the "need for such a study could arise from a lack of basic information in a new area of interest". The current study investigated a new hearing-screening context in Hammanskraal South Africa, a country and community with a dearth of contextually relevant research on NHS and therefore, is considered to be exploratory. This facet of the research aims to become conversant with basic

facts and to create a general picture of environmental and healthcare conditions (Fouché, 2002a:109). According to Mouton (2001:53) the answer to a *what* question represents the aim of an exploratory study and in this case it relates to "what benefits and challenges MCH clinics present for infant hearing screening in South Africa?"

Neuman (1997:20) argues that exploratory and descriptive research often come together in practice. A descriptive study, however, presents a picture of specific details of a situation, social setting or relationship focusing on *how* and *why* questions (Neuman, 1997:19,20; Mouton, 2001:54). Descriptive research may have a basic or applied research goal and can also be qualitative or quantitative in nature (Fouché, 2002a:109). In every case descriptive research is employed to provide an empirical picture of a situation by examining that situation as it is (Ventry & Schiavetti, 1980:41). The current study followed an applied research goal aiming to describe specific details of MCH clinics in Hammanskraal as screening context, the population attending these clinics, and the screening test and protocol performance. Robson (1993:10) classifies this type of research as "real world enquiry" with an emphasis on the substantive or practical importance of research results, solving problems and developing and testing programmes, interventions, and services.

5.3.2. Research method

Within this exploratory descriptive design a combination of the quantitative and qualitative methods was implemented as illustrated in Figure 5.1. Leedy and Ormrod, (2001:103) note that quantitative and qualitative research is not mutually exclusive and it is not unusual for quantitative researchers to also report on qualitative aspects of a study. Non-experimental quantitative data is not collected in a vacuum but in a specific environment or context with its own network of personal and procedural interactions and relationships. The quantitative measurement of data is nestled in these surroundings of routine activity and it is a description of these surroundings that requires a qualitative approach to observing phenomena (Plante, Kiernan & Betts, 1994:53). A combination

approach is often the only way to adequately encompass human beings in their full complexity. A single approach is limited in investigating phenomena in social science that are often tightly enmeshed (Mouton & Marais, 1990:169,170). By adopting an approach of convergence and complementarity De Vos (2002a:364) believe that greater insight into human nature and social reality may be attained. Posavac and Carey (1989:242) also suggest that mixing the two traditions may often be the best approach in social science providing a fuller or more comprehensive study.

A triangulation of method was used to combine qualitative and quantitative styles of research and data for the current study (De Vos, 2002b:342). A dominant-less-dominant design was selected as triangulation model as illustrated in Figure 5.1 (Creswell, 1994:173-190). This design presents the study within a single dominant paradigm with a smaller component of the overall design drawn from the alternative paradigm (De Vos, 2002a:366). The dominant paradigm for the current study was the quantitative approach and the qualitative approach served as the less-dominant paradigm. The advantage of this type of design is that it pursues a consistent paradigm picture (quantitative) whilst also probing additional information in an alternative paradigm (qualitative) (De Vos, 2002a:366). These two methodological approaches to the current study are discussed forthwith.

5.3.2.1. Quantitative research method

Quantitative research in general terms is implemented to address questions regarding relationships among measured variables with the purpose of explaining, predicting, and controlling phenomena that will generalise to other persons and places (Leedy & Ormrod, 2001:101). The descriptive approach to quantitative research involves either identifying the characteristics of observed phenomena or exploring possible correlations among two or more phenomena (Leedy & Ormrod, 2001:191). This type of research does not attempt to change or modify the situation under investigation and is therefore not intended to detect cause-and-effect relationships (Leedy & Ormrod, 2001:191). The quantitative

paradigm was dominant in the current study. It investigated the population of caregivers and infants attending the MCH clinics and the performance of the screening tests and protocol.

Describing the performance of the screening tests and protocol implemented a correlation research approach (Mouton, 1996:192; Ventry & Schiavetti, 1980:48) within the quantitative method and descriptive design followed in this study. Correlation is concerned with the statistical relationship between two characteristics and does not in itself indicate causation (Leedy & Ormrod, 2001: 191). This correlational approach was implemented to compare the test measurements by considering criterion validity. This is the extent to which results of an assessment instrument correlate with another; presumably related measure (the latter measure is called the criterion) (Leedy & Ormrod, 2001:98).

The collection of the data was performed in four consecutive phases as arranged in the data collection sheet (Appendix B). The quantitative data collection phases were as follows:

- Compilation of biographical information and risk indicators
- High frequency immittance measurements
- Hearing screening with OAE and AABR according to specified protocols
- Diagnostic assessment of infants who referred on the screening protocol

Data collection may be performed using a variety of different methods that will correspond to the data sources (Mouton, 2001:104). The quantitative methods of data collection used for the current study and the type of data obtained is presented in Table 5.1.

TABLE 5.1 Quantitative data collection methods and type of data obtained

QUANTITATIVE DATA COLLECTION	
METHOD	**DATA OBTAINED**
- Structured interview and patient file	- Identifying information for population - Risk indicators for hearing loss
- Test measurements	- Hearing screening result (Pass/Refer) - Measure of middle-ear functioning - Diagnostic testing
- Structured documentation	- Follow-up return rate

The data obtained from these quantitative methods of data collection provided information regarding the population and the test and protocol performance.

5.3.2.2. Qualitative research method

The qualitative approach was the less-dominant paradigm implemented for the current study as indicated in Figure 5.1. Qualitative research focuses on phenomena that occur in natural settings and involve studying phenomena in all their complexity aiming to portray the issue in its multifaceted form (Leedy & Ormrod, 2001:147). The descriptive approach to qualitative research involves revealing the nature of certain situations, settings, processes, relationships, systems, or people (Leedy & Ormrod, 2001:148). This paradigm aimed to describe the MCH as a hearing-screening context and to reveal the interactional processes involved in the implementation and maintenance of such a screening program. According to Neuman (1997:329) the qualitative approach captures and discovers meaning once the researcher becomes immersed in the data. The resulting data is in the form of words from documents, observations and transcripts and analysis proceeds by extracting themes of generalisations from

evidence and organising data to present a coherent, consistent picture (Neuman, 1997:329).

The qualitative methods of collecting data that were used for the current study and the type of data obtained are presented in Table 5.2.

TABLE 5.2 Qualitative data collection method and type of data obtained

QUALITATIVE DATA COLLECTION	
METHOD	**DATA OBTAINED**
- Field notes (Mouton, 2001:107) - Critical reflection by fieldworkers immersed in the data	*Context:* Barriers and assets *Interactional processes*: Attitudes, support, contact, networking, collaboration, neonate/infant state

Field notes were made by the fieldworkers while participating in the fieldwork. After the data collection period the researcher and each research assistant, having been immersed in the data collection context, documented a critical personal reflection regarding the research process according to specified criteria (Appendix C). These two methods of data collection provided rich qualitative information regarding the research context and the interactional processes involved.

5.4. RESEARCH CONTEXT

Two MCH clinics, called *Refentse* and *Eersterus,* in the Hammanskraal district, were selected as research context for collecting research data for the current study. The Hammanskraal district was selected as a community representative of large sections of the South African population. Hammanskraal comprises one of

nine districts constituting the city of Tshwane (Tshwane 2020 Plan, 2002:2). The city of Tshwane municipality is the local governing body of the District Health Services under the Gauteng provincial authorities (Tshwane 2020 Plan, 2002:73) and comprises a geographical area of the municipality is 2198 square kilometres (Municipal Demarcation Board, 2003). Figure 5.2 shows a map of the city of Tshwane indicating the semi-urban district of Hammanskraal approximately 55 km from the inner city of Pretoria.

The total population of Tshwane is 2.2 million (Tshwane 2020 Plan, 2002:28). The Hammanskraal district within Tshwane is home to, predominantly, black Africans with the majority of the population (52%) being males with a large percentage (37 %) of the population between 0 – 19 years of age (Tshwane 2020 Plan, 2002:28). Figure 5.3 presents the age distribution of the Hammanskraal district.

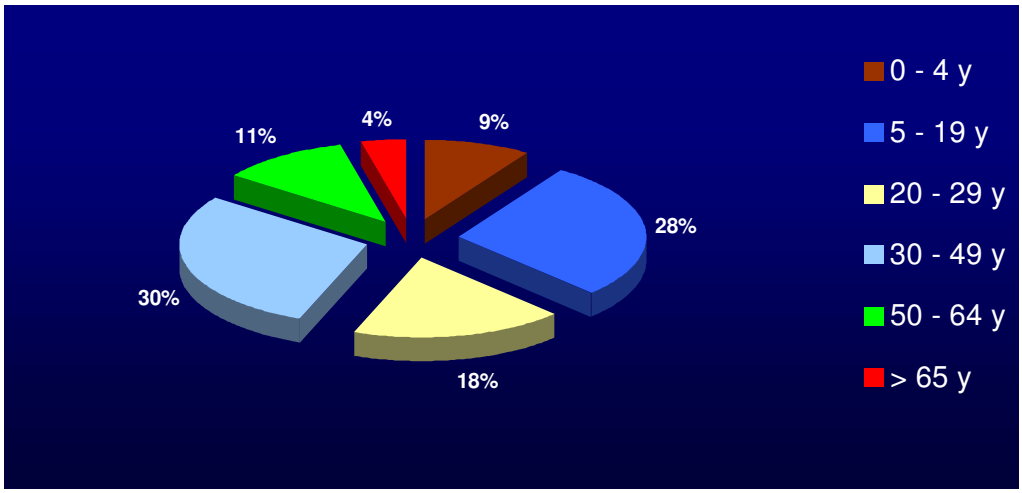


FIGURE 5.3 Age distribution of Hammanskraal population (Tshwane 2020 Plan, 2002:28)

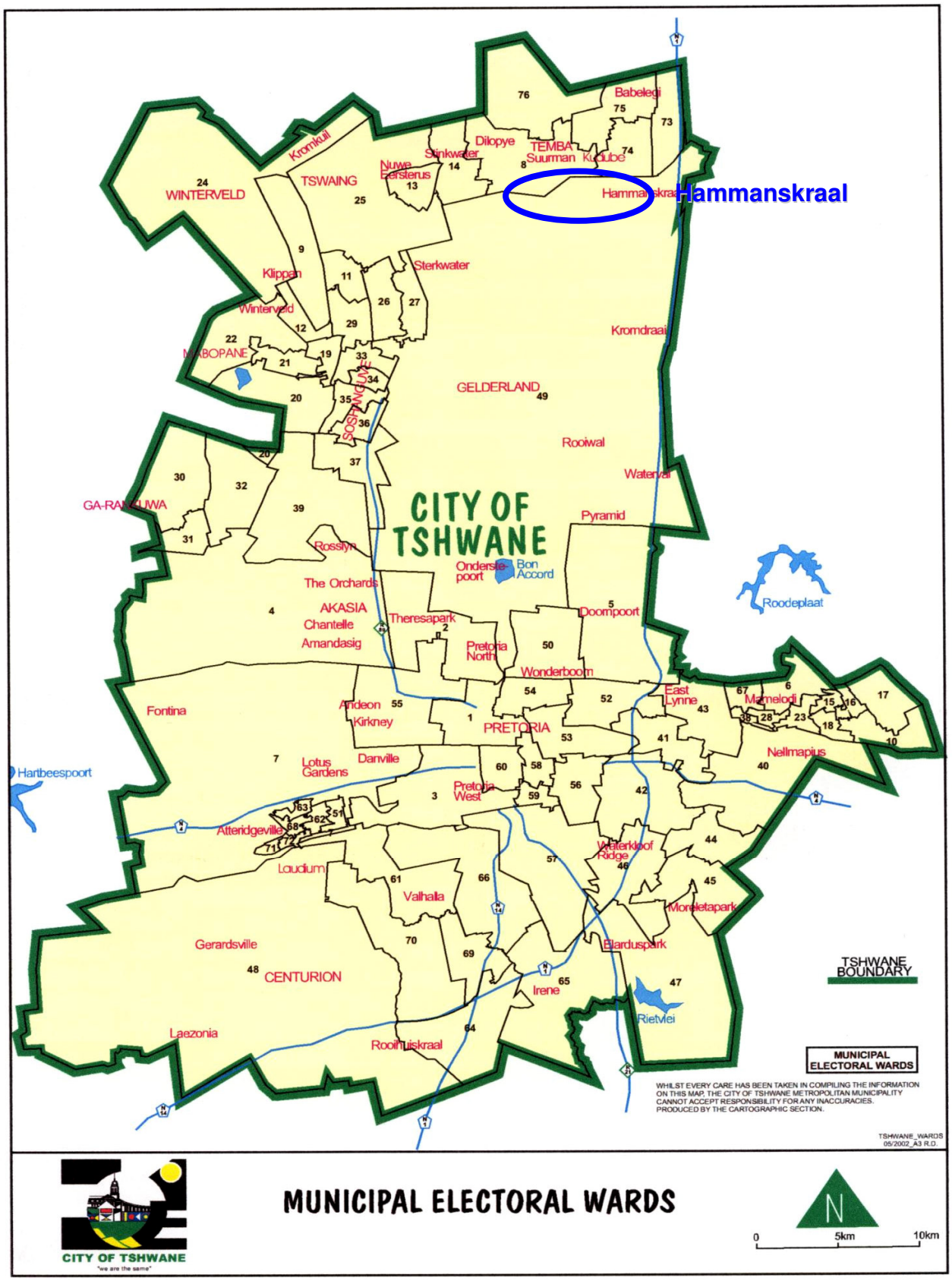


FIGURE 5.2 Hammanskraal on City of Tshwane map (Tshwane 2020 Plan, 2002:1)

Hammanskraal, along with three other districts, have the highest percentage (41%) of households earning less than R12 000 per annum in the city of Tshwane (Tshwane 2020 Plan, 2002:28,29). These same three districts, which include Hammanskraal, are also the poorest supplied of water in the house or on site. Only 50% of households in Hammanskraal have flush toilets and 30% of households are without electricity (Tshwane 2020 Plan, 2002:30). These poor living conditions and lack of income commonly increase malnutrition and lowered immunity (Tshwane 2020 Plan, 2002:28). The risk in these areas is high for Cholera and diarrhoeal diseases and generally children are at higher risk for developmental disabilities and delays such as hearing loss (Tshwane 2020 Plan, 2002:28).

Primary problems with the healthcare system in Hammanskraal can be summarised as: Problems due to a lack of maintenance; healthcare facilities not accessible in all areas; lack of facilities at clinics; all clinics not fully equipped; Primary Healthcare services are provided in a fragmented uncoordinated way; lack of comprehensive package of primary healthcare services at clinics; all staff not adequately trained to deliver comprehensive service; and a lack of required categories of staff to render a comprehensive service (Tshwane 2020 Plan, 2002:336). These challenges evident in Hammanskraal are representative of developing contexts in South Africa.

MCH clinics were selected for investigation as screening context because the Professional Board for Speech, Language and Hearing Professions' year 2002 HSPS (HPCSA, 2002:5) recommends it as one of three main hearing screening contexts to be utilised in South Africa. Currently, however, no research data is available on the positive and negative aspects associated with MCH clinics as such a context. The Refentse and Eersterus clinics were approximately 3 km travelling distance from each other which confines the demographic distribution of subjects to within close proximity; as most subjects travel by foot to the nearest clinic.

MCH clinics are an initiative of the Department of Health to ensure the provision of maternal and child health services to all, including immunisation, communicable and endemic disease prevention, screening of children, child healthcare and counselling (Dennill, King & Swanepoel, 1999:37). According to the Department of Health the restructuring of South Africa's health services from a largely curative-based and fragmented system to a more community-oriented one, based on primary healthcare principles, must emphasise the improvement of preventative, promotive and curative services for children and women (Department of Health, 1997:63). The Department of Health has committed itself to delivering free healthcare for pregnant women and children under the age of 6 years. This package of free services includes immunisation, health surveillance and screening, identification of children with special needs, and basic elements of care and treatment for children with chronic illnesses (Children in 2001, 2000:42).

MCH clinics are part of primary healthcare facilities that serve as birthing, immunisation, and general healthcare centres and are primarily managed by nursing staff (Reagon et al., 2004:9-15). The 6-week immunisation clinics are therefore one of the service-delivery infrastructures within the MCH clinic. Infants and young children accompanied by their caregivers attend these clinics daily during the week for maternal and child health services delivered by means of antenatal visits. Table 5.3 provides an example of the statistics for antenatal visits at the Refentse MCH clinic over a two-month period in 2002. Similar recordings were made at the Eersterus clinic.

TABLE 5.3 Maternal and Child health statistics for Refentse MCH clinic during March and April 2002 (Source: Head of Refentse clinic)

MATERNAL HEALTH (2002)	MARCH (cases)	APRIL (cases)
- First antenatal visits	92	118
- Follow-up antenatal visits	213	262
- Maternal death	0	0
- Live births	2	0
- Delivery to women < 18 yrs	0	0
- Live Births under 2500g	1	0
- Still births	0	0
- Referrals during labour	0	0
GROWTH MONITORING AND CHILD HEALTH (2002)		
- Entry in malnutrition reg. this month	2	1
- Severe malnutrition < 5 yrs – new	1	0
- Not gaining weight < yrs – new	2	4
- Diarrhoea < 5 yrs – new	32	31
- Lower respiratory infection < 5 yrs - new	240	320

5.5. ETHICAL ISSUES

Ethics define what are or what are not legitimate, or moral, research procedures (Neuman, 1997:443) and whenever the focus of investigations is human beings ethical implications of what is proposed must be carefully considered (Leedy & Ormrod, 2001: 107). Any individual involved in research needs to be knowledgeable about the general agreements of what is proper and improper in scientific research (Babbie, 2001:470). According to Strydom (2002b:63) ethics "is a set of moral principles that are suggested by an individual or group, are subsequently widely accepted, and offer rules and behavioural expectations about the most correct conduct toward experimental subjects and respondents,

employers, sponsors, other researchers, assistants and students". Ethical guidelines therefore serve as important standards from which a researcher must evaluate his/her own conduct to protect the participants and subjects involved in a research study.

Ethical issues pertaining to the current study was considered according to the classification provided by Strydom (2002b:64) and are discussed as follows.

- **Harm to experimental subjects and/or respondents**

  The researcher has an ethical obligation to protect subjects against any form of physical and/or emotional harm (Leedy & Ormrod, 2001:107). The collection procedures for the current study were non-invasive and to minimise any other possible emotional harm respondents were thoroughly informed verbally and in written format beforehand about the potential impact of the investigation. This information gave the research subjects the choice and opportunity to withdraw from the investigation if they wanted to (Strydom, 2002b:64).

- **Informed consent**

  Informed consent has become a necessity instead of a luxury or impediment (Hakim, 2000:143). Research subjects must be informed about the nature of the study to be conducted, be given a choice of either participating or not participating and they must know that they have the right to withdraw from the study at any time (Leedy & Ormrod, 2001:107). To address this issue a verbal explanation of the nature of the research project and the required involvement of subjects were provided to all possible subjects. Two fieldworkers were fluent in more than three national languages and were able to convey all information in a language native to the subjects. This was to ensure that subjects comprehended the investigation and were consequently able to make a voluntary, well reasoned decision about their participation (Strydom, 2002b:65). A letter of informed consent, which was explained and provided to all subjects, supplemented this verbal explanation. After ensuring that subjects were

thoroughly informed they could indicate whether they wanted to participate and if so they were required to sign the informed consent form. In addition adequate opportunities were allowed for subjects to ask questions before the data collection commenced, during the collection of data and after the collection procedure was completed (Strydom, 2002b:65).

- **Violation of privacy/anonymity/confidentiality**

  Any empirical research project conducted should respect the participants' right to privacy (Leedy & Ormrod, 2001:108). Confidentiality places a strong obligation on the researcher to guard the information whether it was specifically requested or not (Strydom, 2002b:68). During the current study subjects were informed that all information was confidential and no names would be taken. Caregivers were required to give direct consent for their own participation andthat of their infant in the study (Bless & Higson-Smith, 2000:100). To ensure subsequent confidentiality no subject's data was coupled to any names. Every research subject received a unique number, which was used to refer to his or her data.

- **Actions and competence of researchers**

  An ethical obligation rests on researchers to ensure that they are competent and adequately skilled to undertake the proposed research project (Strydom, 2002b:69). The entire research project must run its course in an ethically correct manner to ensure accountability towards all colleagues in the scientific community (Babbie, 2001:475). To address this issue the researcher and fieldworkers were constantly reminded of his ethical responsibility throughout the composition of the research population, the sampling procedure, the implemented method, processing of the data, up to writing the research report (Strydom, 2002b:69). Competent and accountable data collection was ensured by using fieldworkers with previous experience in the research context and with the research materials and apparatus. In addition data was never collected by a single field worker but always in groups of at least two.

Ethical clearance for conducting the current study was obtained from the Research Proposal and Ethics Committee, Faculty of Humanities, University of Pretoria (Appendix F) and the Ethical Committee of the District Health Department of North West Province (Appendix G). Ethics committees are becoming accepted practice to be enforced by law in 2005 (Strydom, 2002b:75). The involved committees provided ethical clearance based on a review of the research proposal and a completed ethics application form submitted.

5.6. RESEARCH PARTICIPANTS

Five fieldworkers and 510 pairs of research subjects, consisting of a caregiver and neonate/infant, acted as research subjects. The researcher and four research assistants served as fieldworkers in the collection of data for the current study whilst neonates/infants between 0 – 12 months and their caregivers who attended two MCH clinics in the Hammanskraal district during the extent of the research project were employed as research participants.

5.6.1. Selection criteria

The following selection criteria were followed in selecting fieldworkers and subjects for this study.

5.6.1.1. Fieldworkers

To ensure a high degree of internal validity between the different fieldworkers a number of criteria had to be met (Leedy & Ormrod, 2001:103). Fieldworkers were selected according to the following criteria:

- **Tertiary qualification**

  Fieldworkers were required to have at least a bachelor's degree in audiology or a diploma in hearing therapy. A qualification in the hearing assessment and intervention sciences generally assures a higher degree of reliability and

commitment in conducting hearing screening tests (Northern & Downs, 2002:273).

- **Screening experience**

  Fieldworkers were required to have previous experience in screening neonates and infants for hearing loss consisting of at least one week's exposure. Screening experience can increase coverage rates and decrease false-positive results (Messner et al., 2001:128).

- **Exposure to the Hammanskraal district**

  Fieldworkers were required to have had previous clinical experience in the Hammanskraal district. Experience of the cultural and linguistic diversity and the socio-economic circumstances of the community, improves adaptation to and functioning in the selected context.

- **Experience in cross cultural interviewing**

  Fieldworkers were required to have had previous experience in conducting interviews with individuals from different cultures with different home languages. This ensures better collaboration with caregivers and nurses. One fieldworker was included for his experience in community work and his fluency in most of the national South African languages.

- **Training in screening tests and screening protocol**

  The fieldworkers were required to attend a two-hour training session in the use of the specific screening equipment used in this study. In addition, several demonstrations of the data collection procedure was performed in the field to ensure that each fieldworker was familiar with the equipment and test-protocol. Each fieldworker demonstrated a high level of competency, as observed by the researcher, before data collection commenced.

5.6.1.2. Subjects

Neonates/infants and their caregivers served as paired research subjects. Selection criteria were only specified for the neonate/infant, as all caregivers of infants adhering to the selection criteria were included. Caregivers were considered to be the person responsible for bringing the neonate/infant to the MCH clinic. The following criteria for neonates/infants were followed to select participants:

- **Age**

  Neonates and infants of 0 - 12 months were included. This age range was selected because the study aimed to describe the feasibility of an early hearing detection programme at MCH clinics and this range is in line with the challenge of identifying hearing loss by 12 months specified by Healthy People 2000 (Health People 2000, 1990:18).

- **Registered patient of maternal child health clinic**

  Participants had to be registered patients of the Refentse and Eersterus MCH clinic in the Hammanskraal district and a file had to be available for each participant. This ensured that the medical history is on file and other important information which the mother or caregiver may not be able to supply. These two clinics were selected because of their proximity to each other and to Pretoria and both centres provide services to significant numbers of infants representing typical developing contexts in South Africa.

5.6.2. Selection procedure

The selection procedures for the inclusion of fieldworkers and research subjects are discussed in the following paragraphs.

5.6.2.1. Fieldworkers

Three fieldworkers, apart from the researcher, were selected from post-graduate Communication Pathology students at the University of Pretoria who were available to act as research assistants. The fourth fieldworker had previously obtained a tertiary diploma in hearing therapy and was a final year undergraduate Communication Pathology student at the University of Pretoria at the time of data collection. This student participated in the research project as part of his fourth year research report.

5.6.2.2. Subjects

Non-probability convenience sampling was used because the researcher had no means of forecasting or guaranteeing that each element of the population will be represented in the sample by taking subjects that are readily available (Leedy & Ormrod, 2001:218). All subjects were selected from the subjects (infants/neonates and their caregivers) awaiting other services at the MCH clinic according to the selection criteria, and during the times the researchers spent at the clinics. A letter describing the research project and stipulating confidentiality was made available to all caregivers and was carefully explained to the mothers by the fieldworker fluent in the African languages (Appendix D). After the mother or caregiver were informed regarding the research project they were required to provide informed consent before being included as a research subject (Appendix D). As far as possible neonates/infants who were restful or sleeping were selected because the screening procedures cannot be performed reliably on infants who are active or crying.

5.6.3. Description of participants

The fieldworkers and research subjects are described forthwith.

5.6.3.1. Fieldworkers

The researcher and four assistants served as fieldworkers in the collection of data for the current study. All fieldworkers were competent in more than one language and two of the fieldworkers were competent in more than two languages, one of the fieldworkers being fluent in 8 native languages. A description of the field workers are summarised in Table 5.4

TABLE 5.4 Description of fieldworkers

NUMBER OF FIELD WORKERS	GENDER	AGE	QUALIFICATION
1 field worker	Male	25	Graduated M. Communication Pathology and registered for a D.Phil. Communication Pathology degree
3 field workers	Female	23 - 25	Graduated B. Communication Pathology and registered for a M. Communication Pathology degree
1 field worker	Male	33	Hearing Therapy Diploma Final year B. Communication Pathology student

5.6.3.2. Subjects

An interview schedule was conducted with the caregivers to acquire identifying information (Appendix B, section A). 510 infants and their caregivers where included in the study. Infant age ranged from 0 – 12 months and gender was equally distributed with 262 (51%) female and 248 (49%) male infants. The age of the mothers ranged between 15 – 43 years. A detailed description of the research subjects is provided in Chapter 6 as the biographical and descriptive data for the research subjects were collated to achieve sub-aim #2.

5.7. DATA COLLECTION MATERIAL AND APPARATUS

The collection of data for the current study included material and apparatus for the collection of quantitative and qualitative data. These materials and apparatus are summarised in Table 5.5. A recording sheet was compiled on which all the variables of these material and apparatus were documented and an additional space was provided to document any observed difficulties (Appendix B). The material and apparatus are discussed as follows.

5.7.1. Interview schedule

The aim of the interview schedule was to compile a profile of biographical characteristics and risk indicators for hearing loss from the sample of subjects. The schedule constituted two sections which formed part of the recording sheet (Appendix B, section A & B) and was completed by interviewing the caregiver supplemented by information from the MCH clinic file. The first section consisted of biographical type questions and the second section was a risk indicator checklist for hearing loss. Two of the fieldworkers were fluent in African languages and interviewed the caregivers in their home language if they were not able to understand English or Afrikaans. In order to ensure cooperation and a positive attitude as well as to improve the reliability and validity of the results, the following aspects were taken into consideration during the compilation of the interview schedule (Leedy & Ormrod, 2001:202-204):

- Politeness, respect and cultural sensitivity was maintained in the wording of instructions and questions
- Questions were constructed to follow logically on each other
- Questions that are time saving were utilised throughout the questionnaire
- Questions referred to a single aspect for clarity

Each section of the questionnaire is discussed in the following paragraphs.

TABLE 5.5 Data collection material and apparatus

METHOD OF DATA COLLECTION		MATERIAL & APPARATUS	OBJECTIVE	JUSTIFICATION
QUANTITATIVE	Structured interview & extracting info from patient file	***Interview schedule***: 1. Biographical info 2. Risk indicator list *(Appendix B)*	1. To describe the research subject pairs 2. To identify any possible risk-factors for hearing loss	Direct face-to-face interviews and consultations were mainly used because it has the highest response rate (Neuman, 1997:167).
	Test measurement	***Middle-ear analyser***	To measure and record the variables of middle-ear functioning	A high 1000Hz probe tone was used because it provides more reliable results for infants <7months (Margolis et al. 2003:383)
		Combined ***OAE & AABR screening device***	To screen for hearing loss. OAE is the first step screen and AABR is the second step	These two electrophysiological techniques are the only recommended techniques currently (JCIH, 2000:14)
		Diagnostic ABR	To assess the hearing status of neonates/infants who fail the 1st and 2nd screening visits	The ABR is recommended as the gold standard for evaluating hearing thresholds in infants >6months (JCIH, 2000:15)
	Structured documentation	***Recording sheet*** *(Appendix B)*	To record if subjects return for a follow-up screen	This information was documented on a recording sheet to provide an accurate picture of the follow-up process (Mouton, 2001:104)
QUALITATIVE	Observation	***Field notes***	To record all observations regarding context (e.g. facilities, interruptions) and interactional processes (e.g. attitudes, support)	Ideal for presenting a comprehensive account of respondents and their contexts, events taking place, actual interactions, attitudes, perceptions and feelings (Strydom, 2002a:286).
	Critical reflection of fieldworkers	***Reflection sheet*** *(Appendix C)*	To reflect and document the personal experiences of screening in MCH clinics in Hammanskraal in terms of the context and interactional processes	This type of report writing is important for researchers to note their own feelings speculations and perceptions by relying on memory (Strydom, 2002a:287)

5.7.1.1. Biographical information

Sub-aim #2 required a description of the research population and therefore biographical information regarding the caregiver and infant pairs were collected by the questions in this section of the interview schedule (Appendix B, section A). These questions were aimed at obtaining a general description of the research subjects in terms of age, gender, race, home language, family structure, housing, and income. This information also aided in the classification and statistical analysis of results. The format of this section of the interview was twelve closed questions aiming to obtain a general description of the research subjects in terms of age, gender, race, home language, family structure, housing, and income. Except for the two questions concerning the ages of the mother and infant all other questions had a number of options, ranging from two to seven, to choose from. Factual closed-ended questions, like these, were appropriate because attitudes and opinions were not being measured but rather objective information about the subjects, such as social background and related personal data (Bless & Higson-Smith, 2000:116). The use of closed-ended questions also do not require complicated recording and makes comparisons and quantification of results possible (Bless & Higson-Smith, 2001:119).

5.7.1.2. Risk indicator list

The second section of the questionnaire was a checklist for recording hearing loss risk indicators (Appendix B, section B). The list of risk indicators was compiled from the JCIH 1994 and 2000 position statements (JCIH, 2000). Table 5.6 presents the JCIH risk indicators and the risk indicator list compiled for use in the current study.

TABLE 5.6 List of risk indicators for infants 0-1 year as compiled from JCIH 1994 & 2000 lists

RISK INDICATORS: BIRTH – 28 DAYS (JCIH, 1994)	RISK INDICATORS: BIRTH – 28 DAYS (JCIH, 2000)	RISK INDICATORS: 29 DAYS – 2 YEARS (JCIH, 2000)	CURRENT STUDY: RISK INDICATOR LIST (Compiled from JCIH 1994 & 2000 lists)
a) Family history of childhood hearing loss b) Hyperbilirubinemia requiring exchange c) Congenital infections (TORCH) d) Craniofacial anomalies e) Birth weight < 1500 grams f) Bacterial meningitis g) Asphyxia (Apgar score of 0-4 at 1 minute or 0-6 at 5 minutes) h) Ototoxic medications, including but not limited to aminoglycosides, used in multiple courses or in combination with loop diuretics i) Mechanical ventilation lasting 5 days or longer j) Stigmata of other findings associated with a syndrome known to include a sensorineural and/or conductive hearing loss	a) An illness or condition requiring admission of 48 hours or greater to a NICU b) Stigmata or other findings associated with a syndrome known to include sensorineural hearing loss and or conductive hearing loss c) Family history of permanent childhood hearing loss d) Craniofacial anomalies, including those with morphological abnormalities of the pinna and ear canal e) In-utero infections such as cytomegalovirus, herpes, toxoplasmosis, or rubella	a) Parental or caregiver concern regarding hearing, speech, language, and or developmental delay b) Family history of permanent childhood hearing loss c) Stigmata or other findings associated with a syndrome known to include sensorineural or conductive hearing loss or Eustachian tube dysfunction d) Postnatal infections associated with sensorineural hearing loss including bacterial meningitis e) In-utero infections such as cytomegalovirus, herpes, rubella, syphilis and toxoplasmosis f) Neonatal indicators – specifically hyperbilirubinemia at a serum level requiring exchange transfusion, persistent pulmonary hypertension of the newborn associated with mechanical ventilation and conditions requiring the use of extracorpreal membrane oxygenation (ECMO) g) Syndromes associated with progressive hearing loss such as neurofibromatosis, osteopetrosis, and Usher's syndrome h) Neurodegenerative disorders, such as Hunter syndrome, or sensory motor neuropathies, such as Friedrish's ataxia and Charcot-Marie-Tooth syndrome i) Head trauma j) Recurrent or persistent otitis media with effusion for at least 3 months	*a) Family history of childhood hearing loss* *b) Hyperbilirubinemia levels requiring blood transfusion* *c) Congenital infections (in-utero) - Malaria and HIV was included as risks for SA population* *d) Craniofacial defects* *e) Birth weight < 1500g* *f) Bacterial meningitis* *g) Asphyxia (Apgar 0-4 at 1min and/or 0-6 at 5min)* *h) Ototoxic medications ? 5 days* *i) Persistent pulmonary hypertension / persistent fetal circulation. Prolonged mechanical ventilation ? 5 days* *j) Syndrome present* k) *NICU admittance and for how long*

The JCIH 2000 position statement recommend two lists of risk indicators for hearing loss (JCIH, 2000). The first list is for use in neonates from birth through 28 days where universal screening is not yet available. The second list of indicators is for use with neonates or infants who are 29 days through 2 years old and these indicators place an infant at risk for progressive or delayed onset sensori-neural hearing loss and/or conductive hearing loss (JCIH, 2000). Both of these lists have been updated, in accordance with new research evidence, from previous lists recommended by the JCIH, the last of which was put forward in 1994. Risk indicators for the current study were selected from risk indicators specified for neonates from birth through 28 days and for infants who are 29 days through 2 years old since neonates/infants used in the current study varied in age between 0 – 12 months.

In the JCIH 2000 position statement the list of indicators for neonates from birth through 28 days has included admittance to the NICU for 48 hours or longer as a risk indicator which was not previously included in the 1994 position statement. This inclusion has encompassed many of the previously specified risk indicators from the 1994 position statement into a single category. The previous risk indicators included by this new category are birth weight less than 1500 grams, asphyxia (Apgar score ≤ 3 at 5 minutes), mechanical ventilation for 5 days or longer, and most ototoxic medications used in multiple courses or in combination with loop diuretics (JCIH, 1994:7,8). Lutman, Davis, Fortnum and Wood (1997:266) also include this general category as an encompassing criteria in their shortened risk indicator list consisting of attendance in the NICU, family history of congenital hearing loss and presence of craniofacial abnormalities. This study included the 48-hour NICU risk indicator but also incorporated the previously specified risk indicators to compile a comprehensive profile of risk indicators for this sample.

Widespread in-utero infections that characteristic of South Africa were also added to the list and included HIV and malaria (Department of Health, 2000:3; Department of Health, 2001:2,3). HIV has become a pandemic in South Africa with 1 in every 9 South Africans being infected (Department of Health 2002:4;

UNAIDS, 2003:2). The children born of HIV/AIDS infected mothers are at increased risk for hearing loss due to significantly lower birth weights, increased vulnerability for acquiring infections such as meningitis and cytomegalovirus (Spiegel & Bonwit, 2002:128). HIV infected infants are also at a much greater risk of developing middle-ear infections, which leads to a conductive hearing loss and may even result in a sensori-neural hearing loss (Bam, Kritzinger & Louw, 2003:40; Matkin et al., 1998:153; Singh et al., 2003:2; Parving, 2002:255). Malaria is responsible for close to three million deaths each year with one child in the world dying thereof every 30 seconds (Department of Health, 2003:5). Malaria is particularly dangerous for pregnant women and the medications for treatment are ototoxic. (Department of Health, 2003:5; Claesen et al., 1998:482,483) Many regions of South Africa are malaria prone (Department of Health, 2003:4) and therefore this condition was included as a risk factor unique to the South African context.

The second list of risk indicators, specified by the JCIH (2000) for infants 29 days up to two years of age, was recommended for use with infants who passed the birth screen but nonetheless should receive audiological monitoring for the possibility of progressive or delayed-onset hearing loss. Cone Wesson et al., (2000) indicated that 1 of 56 infants identified with permanent hearing loss revealed clear evidence of late onset hearing loss by one year of age. The risk indicators for this infant included low birth weight, respiratory distress syndrome, bronchio-pulmonary dysplasia, and 36 days of mechanical ventilation. The value of this data however must be validated by additional studies using large samples of infants before risk factors for progressive or delayed onset hearing loss can clearly be defined (JCIH, 2000). One additional risk indicator, postnatal meningitis infections, from the second list proposed by the JCIH (2000) was added to the list of risk indicators used for the current study as meningitis is still a leading cause of sensori-neural hearing loss in infants and young children in developing countries (Northern & Downs, 2002:283).

The risk indicator questions were in the format of a checklist with 11 closed questions requiring a *yes*, *no*, or *information unavailable* choice. Four of these

questions had an additional question if a *yes* choice was made. The first question required yes and no responses to the different types of congenital infections whilst the following three questions related to descriptions of Apgar scores, type of syndrome present, and number of days spent in the NICU.

5.7.2. Middle-ear analyser

A GSI Tympstar™ (version 2) Middle-Ear Analyzer was used to record immittance measures. The GSI Tympstar™ was calibrated in January 2003 before research commenced and again after 300 subjects were evaluated. A second calibration was included to ensure that accurate and consistent measures were obtained throughout the data collection period as the equipment was transported to Hammanskraal with every visit. Disposable probes were used to record tympanograms from every infant. The data acquired with this instrument was recorded for each subject on the compiled recording sheet (Appendix B, section C).

5.7.2.1. Middle-ear analyser: test parameters

The test parameters for performing immittance measures are discussed according to the tympanogram measurements and the acoustic reflex measurements.

- ***Tympanograms***

  A high frequency probe tone of 1000Hz was utilised to measure Y-admittance tympanograms with a positive to negative pressure sweep of 200daPa as recommended for young infants (Holte et al., 1991:23). The maximum point on a recorded tympanogram was marked to obtain the uncompensated peak admittance value with the corresponding pressure value at this point.

- ***Reflexes***

  Ipsi-lateral reflexes at 1000Hz using a 1000Hz probe tone were recorded. Reflexes were determined at the lowest intensity eliciting a reflex response

with a deviation larger than 0.02. This deviation was required to be repeatable and indicative of growth at higher intensities and decrease in amplitude at lower intensities.

5.7.3. OAE/AABR screener

The GSI AUDIOscreener™ was used for Oto-Acoustic Emission (OAE) and Auditory Brainstem Response (ABR) screening measurements. This device is a handheld combination OAE/ABR unit does not require the use of a computer and uses a single probe to conduct OAE and ABR measurements. The system uses *real-ear* calibration to allow calibration within the test ear. Distortion Product (DP) OAE and click evoked ABR measurements are made with this device. Disposable probe tips were used for every neonate/infant.

The test parameters used for the GSI AUDIOscreener™ OAE and AABR are discussed in the following paragraphs.

5.7.3.1. OAE screener: test parameters

According to Rabbit-Park (2003:1) before acquiring OAE screening equipment it is important to ascertain whether the equipment has in ear stimulus calibration and to consider the OAE pass criteria for the manufacturer. At present there are no standardised criteria for pass and refer results and this matter is currently under investigation (Northern & Downs, 2002:287). It is therefore understandable that products with differing pass criteria affect the sensitivity and specificity of a screening programme differently (Rabbit-Park, 2003:1; Northern & Downs, 2002:287). Salata, Jacobson & Strasnick (1998:41) indicated that DPOAE screening specificity dropped from 94% to 68% to 38% in a sample of neonates using response levels of 5, 10, and 15 dB SPL, respectively. It is clear that more stringent pass criteria (higher response levels) will increase the sensitivity but increase the number of false positives whilst less stringent pass criteria will increase the specificity but increase the number of false negatives. The minimum

response level for most screening programs require a 3 dB or more response/noise floor difference to be considered acceptable.

The default screening protocol, setting 'DPOAE 2, was selected on the GSI AUDIOscreener™ for screening neonates/infants in this study. Five frequencies were assessed for each ear and a pass criterion was based on passing at least four of the 5 frequencies evaluated. The stimulus parameters are in agreement with the guidelines by the American Speech-Language-Hearing Association (ASHA, 1997) and are presented in Table 5.7.

TABLE 5.7 OAE stimulus parameters (DPOAE 2)

	2000Hz	3000Hz	4000Hz	5000Hz	6000Hz
L1/L2 ratio	65/55	65/55	65/55	65/55	65/55
F1 (Hz)	1750	2550	3250	4250	4950
F2 (Hz)	2100	3100	3950	4950	6000
Fdp (Hz)	1400	2000	2550	3550	3900
F1/F2	1.2	1.2	1.2	1.2	1.2

The recordings of DPOAE are based on a F2 centre method and the frequencies were measured in a downward order starting with the highest and ending at the lowest using a linear averaging method of analysis. The recording parameters for the different frequencies are presented in Table 5.8.

TABLE 5.8 OAE recording parameters (DPOAE 2)

	2000Hz	3000Hz	4000Hz	5000Hz	6000Hz
Level tolerance (dB)	2	2	2	2	2
Min S/N difference	6	6	6	6	6
Min DP level for pass (dB SPL)	-7	-8	-5	-7	-7
Minimum frames	128	96	64	64	64
Max time (s)	30	30	30	30	30

5.7.3.2. AABR screener: test parameters

The AABR does not require subjective interpretation of the ABR waveform but uses a template response pattern obtained from a large sample population of normal hearing newborns as a criterion against which online responses are compared (Northern & Downs, 2002:285). If the responses of the test infant fall within the normative values the equipment renders a *pass* decision; if the response pattern is significantly different to the template a *refer* decision is given.

The default AABR parameters for the GSI AUDIOscreener™ were used to collect data for this study. Stimulus parameters are presented in Table 5.9.

TABLE 5.9 AABR stimulus parameters

STIMULUS	Click
STIMULUS LEVEL	35 dB nHL
SPL – NHL DB LEVEL	37 dB SPL = 0 dB nHL
PERIODIC STIMULUS RATE	37/sec
POLARITY	Rarefaction
DURATION OF CLICK	0.10 msec
INTENSITY SCALE	dB nHL
OUTPUT	Monotic
INTENSITY	Starting intensity of 60 dB nHL

The default recording parameters for the AABR of the GSI AUDIOscreener™ are presented in Table 5.10.

TABLE 5.10 AABR recording parameters

TEST CONFIGURATION	Quick ABRprobe
ELECTRODE PLACEMENT	Mastoid (L&R) = ref & ground Fpz = Active
MAXIMUM IMPEDANCE	12 kOhms
MAXIMUM IMPEDANCE DIFF.	5 kOhms
LEVEL TOLERANCE	2 dB
LOW CUT OFF FILTER	100Hz
HIGH CUT OFF FILTER	1500Hz
µVolt REJECTION	30
MAX % REJECT	60
ANALYSIS METHOD	Overlap
Fsp THRESHOLD	3.2
MAXIMUM FRAMES	8000
NORMAL LATENCY	7.5 msec
NORMAL OFFSET	0.1 msec

5.7.4. Diagnostic ABR

The Biologic NavPro™ unit connected to a laptop computer was used to acquire ABRs. The equipment was calibrated in September 2002. The click stimuli were calibrated using a Larson Davis 824 connected to an IEC 318 artificial ear simulator by determining an averaged sound pressure for the frequency ranges 2 kHz - 4 kHz. Normal Hearing Level (nHL) for the click stimuli was established by testing a group of 20 normal-hearing adults. EAR 3A insert earphones were used with disposable ear tips.

The test parameters used for the Biologic NavPro™ ABR are discussed in the following paragraphs.

5.7.4.1. Diagnostic ABR: test parameters

A click stimulus was used to obtain a general description of hearing sensitivity specifically in the high frequency regions (Gorga, 1999:32). The stimulus parameters used by the Biologic NavPro™ ABR are presented in Table 5.11.

TABLE 5.11 Diagnostic ABR stimulus parameters

STIMULUS	Click
SPL – nHL DB LEVEL	37 dB SPL = 0 dB nHL
PERIODIC STIMULUS RATE	27/sec
POLARITY	Rarefaction
DURATION OF CLICK	0.10 msec
INTENSITY SCALE	dB nHL
OUTPUT	Monotic
INTENSITY	Starting intensity of 60 dB nHL

The recording parameters for the AABR of the GSI AUDIOscreener™ are presented in Table 5.12.

TABLE 5.12 Diagnostic ABR recording parameters

ELECTRODE PLACEMENT	Mastoid (L&R) = ref & ground Fpz = Active
MAXIMUM IMPEDANCE	6 Ohms
MAXIMUM IMPEDANCE DIFF.	2
LOW CUT OFF FILTER	100Hz
HIGH CUT OFF FILTER	3000Hz
µVolt REJECTION	40
MAXIMUM FRAMES	2000

5.8. PILOT STUDY

According to Bless and Higson-Smith (2000:155) a pilot study is a "small study conducted prior to a larger piece of research to determine whether the method, sampling, instruments and analysis are adequate and appropriate". The pilot study is described in the following paragraphs.

5.8.1. Aim

The aim of the pilot study was to evaluate the hearing screening test context (facilities and personnel relations), data collection apparatus and data collection procedures in terms of feasibility and practicality.

5.8.2. Participants

Two subject groups served as participants to collect preliminary data. The first group consisted of the nursing staff (approximately six nurses for each clinic) at the Refentse and Hammanskraal MCH clinics. The second group of consisted of five pairs of caregivers and infants younger than six months of age.

5.8.3. Material and apparatus

The material and apparatus used consisted of an interview schedule (Appendix B, section A & B) and an OAE screening device. The interview schedule was completed by interviewing the caregivers and by using the MCH clinic infant file. The GSI AUDIOscreener™ was used for OAE screening measurements. The device is a handheld combination OAE/ABR unit which does not require the use of a computer. The system uses *real-ear* calibration to allow calibration within the test ear. Distortion Product (DP) OAE measurements are made with this device.

5.8.4. Procedure

The following data collection procedure was followed in the preliminary study:

- Three initial visits to the clinics were made to establish contact with the nursing staff and to discuss the screening procedure and requirements with the staff.
- The first two visits were made to the Refentse clinic and the third was made to the Hammanskraal clinic.
- Initially discussions were pursued during tea breaks when all the nursing staff was gathered together. The screening project was discussed and explained in terms of the period of testing, the actual test procedures, the importance of hearing screening, and it was made clear that it would not add an extra work load on nursing staff.
- After the project was discussed the facility requirements were discussed.
- A fourth visit was subsequently made to collect preliminary data on five pairs of subjects (caregivers and infants).
- The interview schedule was completed by conducting an interview with the caregiver and consulting the infant's file.
- After the interview was completed immittance measurements and an OAE screening were attempted in both ears.
- The default screening protocol, setting DPOAE 2, was selected on the GSI AUDIOscreener™ for screening neonates/infants in this study.
- Five frequencies were assessed for each ear and a pass criterion was based on passing at least four of the five frequencies evaluated. The stimulus parameters were in agreement with the guidelines by the American Speech-Language-Hearing Association (ASHA, 1997).

5.8.5. Results

The results are provided according to the aim of the pilot study.

- **Context**

  This initial investigation provided insight into the functioning of the MCH clinics and assisted in establishing a suitable procedure for combining the regular MCH services with the hearing screening. Relationships with the nursing staff were established and a cooperative collaboration fostered to

facilitate effective and coordinated service delivery between the nursing staff and the research team. The nursing staff arranged an appropriate test room and the facilities were adapted (e.g. furniture, closed windows etc) to suit the interviewing of caregivers and the testing of infants. Both rooms at the respective clinics had appropriate ventilation, adequate seating and enough workspace to conduct all the relevant procedures.

- **Material and apparatus**

  During the structured interview it was ascertained that some questions in the biographical information section were irrelevant to the aim of the current study and were taking up unnecessary time. The OAE battery life lasted for all testing and power points were available for the GSI Tympstar to be used for middle-ear measurements.

- **Data collection procedure**

  Attempting to acquire immittance results with a 226Hz and 1000Hz probe tone was found to be too time-consuming and subjects became restless during the procedures. In addition, the standard 50-daPa/s pressure rate proved to be too time-consuming and this was changed to a default of pressure rate of 200-daPa/s. Collecting acoustic reflexes at two frequencies (500 & 1000Hz) in each ear proved to be too time consuming with infants becoming restless and agitated. The OAE measurements were successfully performed and the noise levels were appropriately low.

5.8.6. Implications

The pilot study resulted in the arrangement of an appropriate test environment and the refinement of the data collection material and procedures. Experiences from the caregiver interview resulted in the exclusion of certain questions from the biographical information due to time limitations and lack of relevance to the aim of the study. The immittance protocol was also changed from performing a 226Hz and 1000Hz probe tone measurement for all subjects to only using a 1000Hz probe tone due to the time constraints. The rate of pressure change

across the tympanogram was also increased to 200-daPa/s because the default 50-daPa/s was too slow. Acoustic reflex measurements were also reduced from two per ear (500 & 2000Hz) to only one high frequency probe tone reflex at 1000Hz. These changes led to the compilation of a data collection sheet (See appendix B). The final data collection protocol based on the pilot study used the following basic procedural sequence:

- Structured interview supplemented by MCH clinic infant file to gather identifying information and risk indicators for hearing loss
- Hearing screening according to the specified protocol
- Immittance measures were performed

The procedures for each of the data collection methods as performed after the pilot study is discussed in the following paragraphs.

5.9. DATA COLLECTION PROCEDURES

All data was collected in Hammanskraal at the Refentse and Eersterus MCH clinics. The research was conducted over a five-month period from mid January to mid June 2003. The Refentse MCH clinic was visited on Mondays, Tuesdays, and Wednesdays whilst the Eersterus MCH clinic was visited on Thursdays and Fridays. Data collection was not done every day over the five-month period due to practical schedule considerations.

Quantitative and qualitative data collection procedures were implemented to collect the relevant data during this period. The quantitative data was collected from each caregiver-infant pair in four phases. Firstly, a structured interview with the caregiver supplemented by the infant file was used to gather biographical information and to complete a risk indicator list for hearing loss. This was done by the two fieldworkers who could speak various African languages. Secondly, immittance measures for both ears were performed to evaluate middle-ear functioning. Thirdly, a hearing screening protocol using OAE and AABR

technologies were used to screen both ears. The final data collection phase was a diagnostic ABR assessment. Only infants who did not pass the test protocol in phase three, however, were referred for a diagnostic ABR assessment.

Qualitative data was collected throughout the period in which quantitative data was collected at the respective clinics. Figure 5.4 provides an outline of the quantitative phases, alongside the qualitative processes, of data collection in the current study.

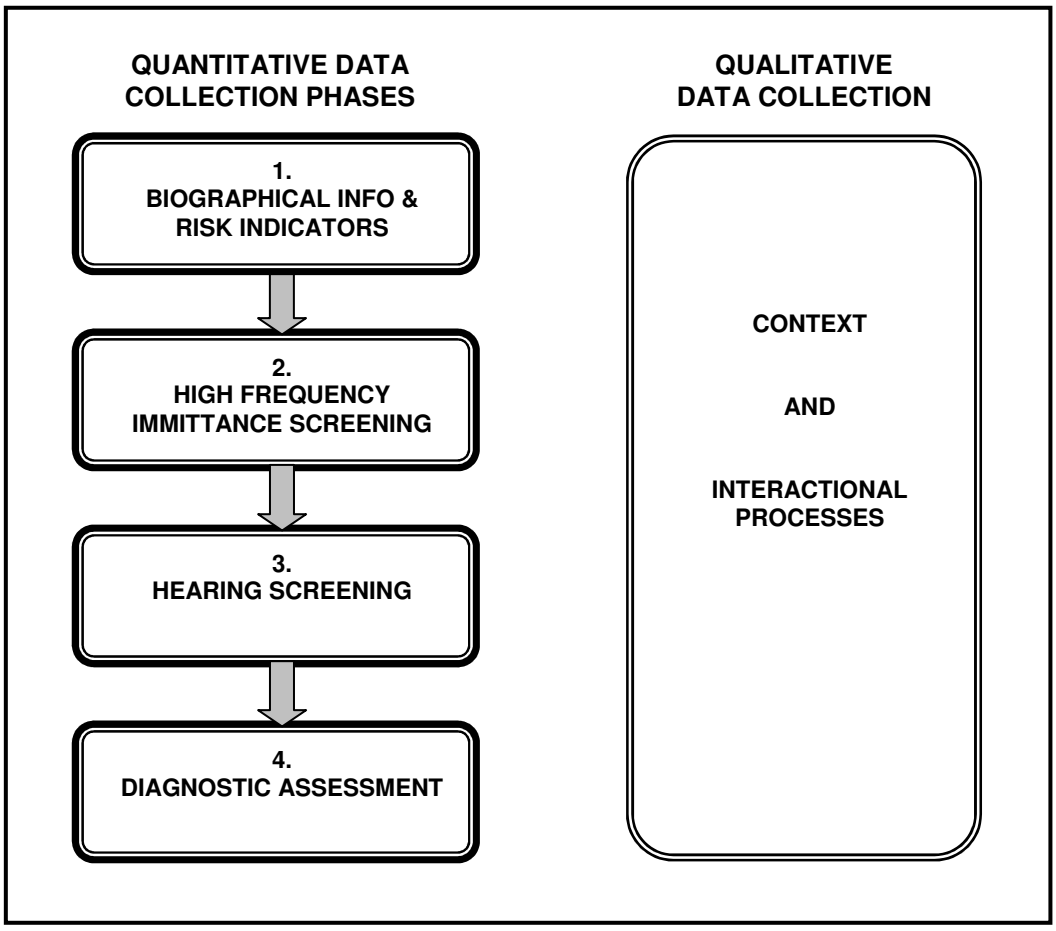


FIGURE 5.4 Quantitative and qualitative data collection procedures

The data collection procedures used to collect the quantitative and qualitative data will be discussed forthwith.

5.9.1. Quantitative data collection procedures

The collection of quantitative data was divided into four phases, as described in the method section, with each phase containing its own set of collection procedures. These phases will be discussed individually in the following paragraphs.

5.9.1.1. Phase 1: Biographical information and risk indicators

The biographical information and risk indicators were obtained using a structured interview supplemented by the file for the infant (Appendix B, section A & B). If the caregiver could not speak English or Afrikaans one of the two fieldworkers able to speak the other African languages completed the structured interview. The following procedure was used to obtain information:

- Caregivers and infants waiting in line for MCH care services were requested to bring their baby and his/her file into the hearing screening room
- The caregivers were instructed to bring their baby preferably if he/she is sleeping or quiet and restful
- Caregivers were informed about the procedure and further testing was only performed if informed consent was obtained (Appendix D)
- After the procedure was explained and informed consent obtained the mother was interviewed
- Biographical information regarding the caregiver and the child was obtained first after which questions were asked about the risk indicators that are present for the specific infant (Appendix B, section A & B)
- Two of the fieldworkers were able to speak one or more African languages and these were used if the caregiver could not understand English or Afrikaans.

5.9.1.2. Phase 2: High frequency immittance measurements

To avoid influence on a participant's performance or cooperation as the screening procedures progressed and to reduce order effects the immittance and hearing screening orders were randomised. Some infants were screened for hearing loss first followed by immittance and others were screened with immittance first followed by the hearing screening protocol. Immittance measures and hearing screening were performed on the neonate/infant after the interview. The immittance measurements were made for both ears in the testing room provided according to the following procedures.

- An appropriate sized probe tip was selected and the probe inserted in the infant's ear
- Once a good seal was attained 1000Hz probe tone tympanograms were recorded
- Two tympanograms were recorded for every ear; first a Y-admittance tympanogram followed by a simultaneous B-susceptance and G-conductance tympanogram
- The peak of every tympanogram was marked with a cursor thus providing the peak pressure (daPa) and peak compliance reading (mmho)
- If no peak was present this was recorded
- The tympanograms were followed by the recording of reflexes with a 1000Hz probe tone at a test frequency of 1000Hz
- Measurements were initiated at 70 dB HL and a reflex threshold seeking procedure of 10 dB up and 5 dB down increments followed. A maximum intensity of 110 dB could be obtained
- All results were printed for each subject

5.9.1.3. Phase 3: Hearing screening

Screening for hearing loss was based on the selection and development of a screening protocol to serve as directive guide for the collection of data. The

screening protocol is subsequently discussed followed by the data collection procedures used.

- **Screening protocol**

The screening protocol for this study was compiled for two populations of infants. The first screening protocol was implemented for all neonates/infants that were not NICU graduates and is presented in Figure 5.5. The second protocol was selected for all neonates/infants who were NICU graduates and is presented in Figure 5.6.

The referral criteria was the same for both protocols, a refer result in one ear determined an overall refer status for the subject. The first protocol was used to screen the majority of neonates/infants and involved a two-stage screening process with OAE as the initial screen and AABR as the second step screening method. This option was selected to limit the cost of disposable supplies that are required for AABR as the first screening procedure (Mehl & Thomson, 2002:6) and to serve as a possible prototype for screening practice in the South African public health sector. Additionally screening with OAE for well babies has a minimal risk of missing a neonate/infant with auditory neuropathy (Mehl & Thomson, 2002:6). The second protocol was used for all NICU graduates because this population has the highest incidence of auditory neuropathy and an AABR is recommended to reduce the risk of missing these infants (Mehl & Thomson, 2002:6). A summary of the Colorado newborn hearing screening project from 1999 – 2001 indicated that all infants identified with auditory neuropathy was from the NICU and that one out of every five NICU babies with hearing loss had auditory neuropathy (Mehl, 2002:1).

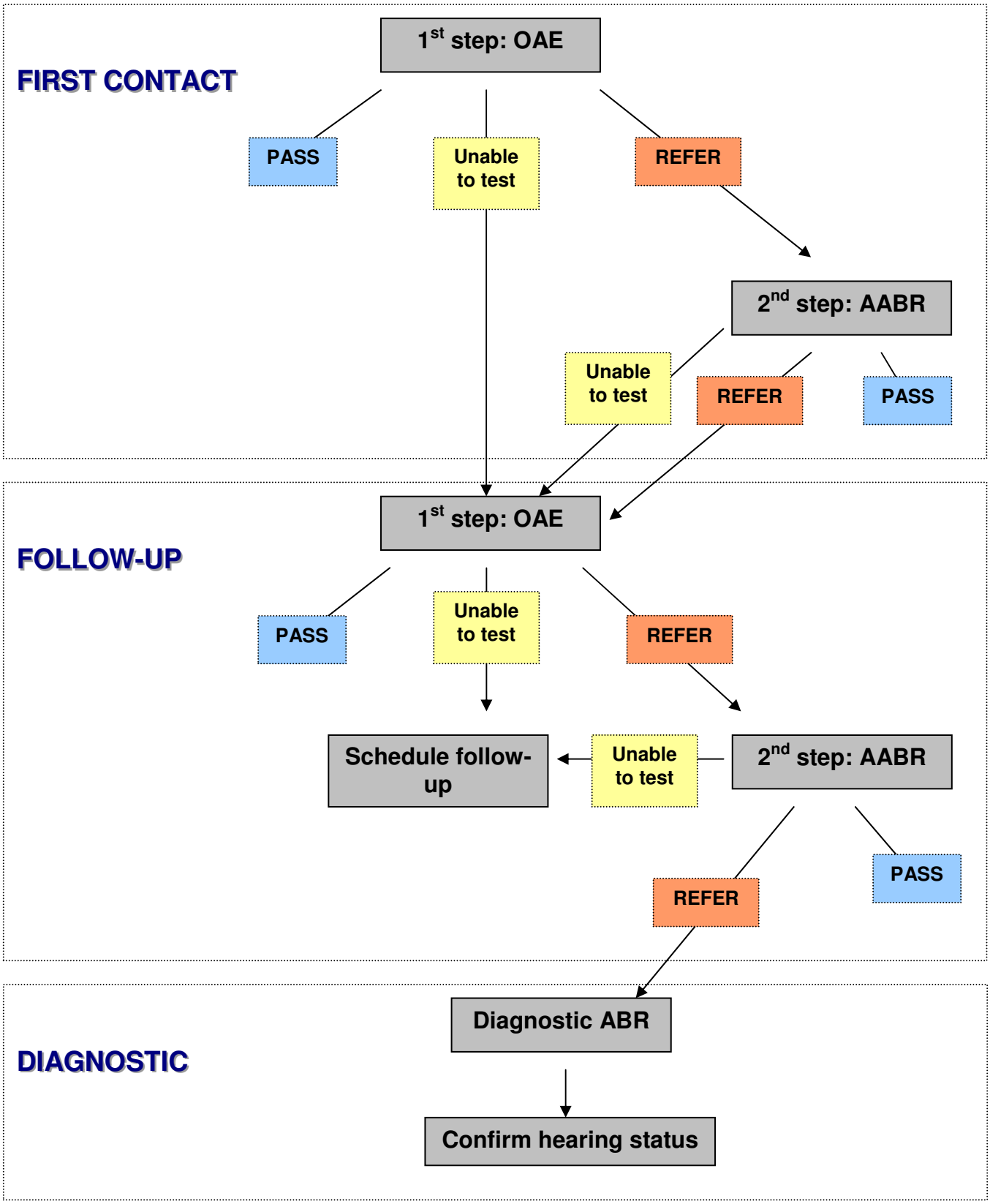


FIGURE 5.5 OAE/AABR screening protocol #1

(For all neonates/infants except NICU graduates)

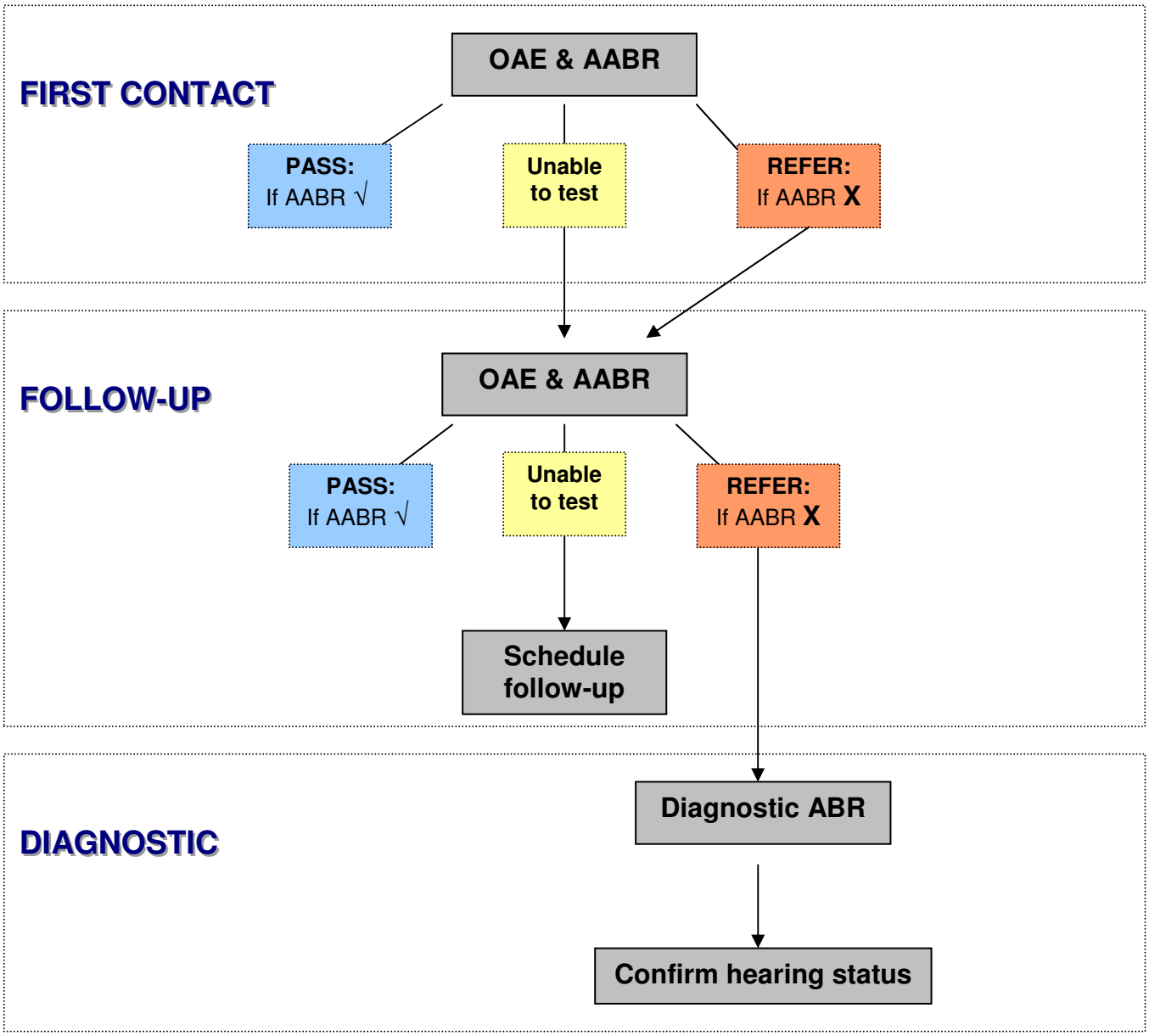


FIGURE 5.6 OAE/AABR screening protocol #2
(For NICU graduates)

Neonates/infants used in this study were between the ages of 0 – 12 months and thus presented with varying degrees of cooperation. If all test procedures could not be performed, or if a subject referred, a follow-up appointment was made and a letter provided with the date and time of the follow-up appointment (See Appendix B, section D).

- **Data collection according to screening protocol**

Hearing screening was performed on the neonate/infant in a randomised order with immittance measures conducted first in certain cases and hearing screening first in other cases. Both these procedures were performed after the initial interview was conducted. The collection procedure used for each protocol specified for the two populations is presented in the following paragraphs:

PROTOCOL #1 (For all neonates/infants except NICU graduates)

- The infant was placed in a comfortable position depending on state of wakefulness (in mother's arms or in a sleeping cot).
- The infant's ear was investigated and an appropriate sized probe tip selected and the probe inserted in the infant's ear.
- The OAE screening module on the AUDIOSCREENER™ was selected and testing commenced for the test ear; this procedure was repeated for the other ear.
- If the infant passed both ears no further testing was done and the results were recorded on the infant's file.
- If the infant did not cooperate a follow-up appointment was scheduled and a letter with the follow-up information provided.
- If a refer result was obtained, two additional recordings were made for that ear, if possible .
- If the second and third OAE result was still a refer, an AABR was attempted using the AUDIOSCREENER™.
- For the AABR three electrodes were attached at Fpz (active) and at A1 and A2 with the reference and ground switched between the two ears depending on the test ear and the probe remained in the infant's ear.
- If an infant passed the AABR for the ear which failed the OAE the overall result for the infant is a pass.
- If the AABR revealed a refer result or if an AABR could not be performed due to poor cooperation a follow-up appointment was scheduled and a letter provided with the follow-up information (Appendix E).

- During follow-up evaluation the procedure was repeated; if after completing the procedure an infant referred a second time a diagnostic evaluation was scheduled.
- If an infant did not cooperate for the follow-up appointment a second follow-up appointment was scheduled.

PROTOCOL #2 (For all NICU graduates only)

- The infant was placed in a comfortable position depending on state of wakefulness (in mother's arms or in a sleeping cot).
- The infant's ear was investigated and an appropriate sized probe tip selected and the probe inserted in the infant's ear.
- The OAE screening module on the AUDIOSCREENER™ was selected and testing commenced for the test ear; this procedure was repeated for the other ear.
- After the OAE procedure a AABR screening was performed for both ears using the AUDIOSCREENER™.
- For the AABR three electrodes were attached at Fpz (active) and at A1 and A2 with the reference and ground switched between the two ears depending on the test ear and the probe remained in the infant's ear.
- If an infant did not cooperate for the AABR screening a follow-up appointment was scheduled and a letter provided with the follow-up information.
- If an infant passed the AABR for both ears even if the OAEs referred the overall result was a pass and no more testing was scheduled.
- If the AABR revealed a refer result or if an AABR could not be performed due to poor cooperation a follow-up appointment was scheduled and a letter provided with the follow-up information (Appendix E).
- During follow-up evaluation the procedure was repeated; if after completing the procedure an infant referred a second time, a diagnostic evaluation was scheduled.
- If an infant did not cooperate during the follow-up appointment, a second follow-up appointment was scheduled.

5.9.1.4. Phase 4: Diagnostic assessment

This phase was only recommended for those neonates/infants who were referred based on the results of the screening protocols used in phase three. The assessment was conducted using a diagnostic ABR instrument and was performed in the testing room provided at each clinic. The following collection procedure was followed during the conduction of this phase.

- ABR recordings were performed in a test room in the MCH clinic.
- Electrode discs of Ag/AgCI were fixed with electrolytic paste to the scalp at Fpz, A1 and A2. Fpz was the active electrode and A1 and A2 were switched between reference and ground depending on the test ear.
- Impedance values were kept below 3 000 Ohms.
- EAR 3A insert earphones used.
- Stimulation was presented monotically at a supra threshold intensity of 60 dB nHL starting with the left ear.
- The bioelectric activity was amplified with a gain of 100 000 and analogue filtered between 100 and 3 000Hz,
- A maximum of 2 000 recordings were averaged for each intensity although less averages were often adequate because of the low levels of ambient noise in the soundproof booth.
- A recording window of 0 – 15 ms was implemented for recordings (Hood, 1998; Bachmann & Hall, 1998),
- A noise level rejection level of 10 was used,
- Threshold was established in descending intensity steps of 10dB until no response was present. The minimum response level for each frequency in each ear was taken as the threshold,
- A latency-intensity function was taken to determine if a conductive component was present.
- This procedure was repeated for each ear.

5.9.2. Qualitative data collection procedures

Qualitative field data was collected throughout the empirical research period. This was collected using field notes and critical reflections of the researchers' experiences. According to Neuman (1997:361) this type of field data consists of what researchers experience and remember recorded in a format that can be subjected to systematic analysis. This data collection aimed to describe the *context* (e.g. facilities, barriers and positive aspects) and *interactional processes* (attitudes, support, contact, networking, collaboration, and neonate/infant state) at the MCH clinics as related to the hearing screening of neonates/infants.

The following procedures were followed in the collection of qualitative data:

- The researchers were sensitised to watch and listen carefully in order to observe factors relating to the screening context and interactional processes.
- This was done throughout the five-month data collection period and within this time the researchers became the instruments absorbing all sources of information (Neuman, 1997:361).
- When an observation was made regarding the context or interactional processes this was documented in field notes.
- These notes were examined and elaborated on once the data collection for a given day was completed by the fieldworkers.
- After the five months of empirical data collection the researcher and each research assistant were required to do a critical reflection of their experiences during the period of collecting data at the respective clinics. This was conducted by considering certain questions to elicit specific responses (Appendix C).

5.10. DATA PREPARATION PROCEDURES

The quantitative data was recorded onto a data collection sheet (Appendix B) which consisted primarily of numerical data whilst the qualitative observations were recorded in the form of descriptions according to field notes and critical descriptions (Appendix C) (Neuman, 1997:295). The quantitative data was in raw format on the data-recording sheet (Appendix B). This data was coded by two research assistants and checked for a second time to ensure that all data was correctly coded. This coding is done to organise the data into a suitable format for data capturing on digital format allowing analysis of the data (Neuman, 1997:295). The coded data on the recording sheets was entered into a computer programme (SAS) to allow for statistical analysis of the data.

The quantitative observations (Field notes and critical reflections) were compiled and grouped into topics or descriptions that were similar. The raw data was organised into conceptual categories to create themes or concepts that were used to analyse the data (Neuman, 1997:421). This type of coding is unlike coding quantitative data because the process is not just a clerical task but forms an integral part of the data analysis (Neuman, 1997:421).

5.11. DATA ANALYSIS PROCEDURES

According to Neuman (1997:422) data analysis means to search for patterns in data. This involves examining, sorting, categorising, evaluating, comparing, synthesising, contemplating and reviewing the data (Neuman, 1997:422). The analysis procedures used in the current study is presented according to each empirical sub-aim in Table 5.13.

TABLE 5.13 Statistical analyses implemented for sub-aims

SUB-AIMS	METHOD	STATISTICAL PROCEDURE
#1 To describe the MCH clinics as a screening context	Qualitative	No statistical procedure Descriptive qualitative analysis
#2 To describe the population of caregivers and infants attending the MCH clinics	Quantitative	Descriptive statistics *(means and frequency variables describing selected characteristics of the subjects)*
#3 To describe the High-Risk Register and test procedures	Quantitative	Descriptive statistics Kruskal-Wallis H-test
#4 To describe the performance and efficiency of the screening protocol	Quantitative	Descriptive statistics Kruskal-Wallis H-test
#5 To describe the interactional processes involved in the implementation and maintenance of a screening programme in MCH clinics	Qualitative	No statistical procedure Descriptive qualitative analysis

Quantitative analysis relied primarily on statistics. After the quantitative data had been prepared for, and captured onto, digital format, statistical analyses were performed on the data set. The coded data represented on spreadsheets was analysed statistically using the SAS statistical package. Both *descriptive statistics,* which describe what the data looks like, and *inferential* statistics, which allow for making inferences about large populations by collecting data on relatively small samples, were used to investigate quantitative data for this study (Leedy & Ormrod, 2001:259).

Qualitative data analysis was performed as an integral part of the data preparation procedures. The preparation and analysis of qualitative data consisted of organising and grouping field note and critical reflection data into *context* (barriers and assets) and *interactional processes* (attitudes, support, contact, networking, collaboration, neonate/infant state) themes (Neuman, 1997:421). The steps conducted in analysing the qualitative data involved the following three steps.

- Units of relevance are identified
  The researcher identified units (e.g. phrases, sentences) relating to the aim of the study (Reid & Gough, 2000:75).

- Classification of themes
  The researcher identified major themes (Context and interactional processes) in the field notes and critical reflections. These sorted themes established a basis for further categorisation of the content (Reid & Gough, 2000:76).

- Categorisation of supporting material
  The units identified in step one were subsequently sorted according to the themes identified in step two. This categorisation formed an interpretive representation of responses (Reid & Gough, 2000:76).

5.12. VALIDITY, RELIABILITY AND TRUSTWORTHINESS ISSUES

This study implemented both quantitative and qualitative research methods which differ in nature and purpose and require application of different quality criteria (e.g. validity, reliability, trustworthiness). The quality criteria applied for each of these methods are as follows.

5.12.1. Quantitative quality criteria

Quantitative methods were implemented for the recording of biographical and risk factors, and the measurement of auditory functioning. Validity and reliability issues were carefully considered to ensure that the study generated accurate and valid findings (Neuman, 1997:145). The steps taken to apply these quality criteria are discussed as follows.

- **Ensuring validity**

Validity refers to whether an instrument measures the concept in question and whether the concept is measured accurately (Delport, 2002:167). External validity simply refers to the "generalizability of the data, that is, the extent to which the results can be generalized from the study sample to the population of the people from which, presumably, the sample was drawn" (Ventry & Schiavetti, 1980:81). According to Leedy and Ormrod (2001:105), when research is conducted that has implications that extend far beyond the specific situation actually studied, more is contributed to humanities knowledge about the world. It is for this reason that this study aimed to increase its external validity according to two main criteria specified by Leedy and Ormrod (2001:105,106) namely, selecting a *real life setting* and allowing a *representative sample*. Both internal and external validity was considered in the current study in the following ways (Bless & Higson-Smith, 2000:126; Neuman, 1997:145).

- The MCH clinics in Hammanskraal are *real life settings* in use by the District of Health in Mpumalanga.
- A *representative* sample was acquired as mothers and their babies who came for routine visits were selected as research subjects.
- A third criteria for improvement of external validity, *replication in a different context*, was met to a lesser extent by selecting two clinics within the district, but replications were not made outside of the Hammanskraal area (Leedy & Ormrod, 2001:106).
- Since the interview schedule did not measure attitudes or perceptions and was supplemented by the MCH clinic file, recording only biographical facts

and risk indicators, a high degree of internal validity can be assumed (Delport, 2002:167).

- The validity of OAE/AABR hearing screening devices as measures of auditory functioning has been firmly established (Hall et al., 2004:415) (See Chapter 2).

▪ **Ensuring reliability**

Reliability is defined as the accuracy of an instrument and the degree of consistency between two independently derived sets of scores (Delport, 2002:168). This means that information provided by the instrument does not vary as a result of the device itself. A high degree of reliability is necessary to ensure the final results can be trusted (Neuman, 1997:145). The following aspects were addressed to ensure reliable results were obtained:

- The reliability of the interview schedule was maintained by providing concise and simple instructions, limiting the length of the questions and by supplementing the interview with information from the MCH clinic files.
- The hearing screening and middle-ear assessment equipment was calibrated twice during the five-month data collection period to ensure reliable measurements (performance reliability) were being made.
- The reliability was further improved by ensuring that the same research group collected data throughout the study and always did so in a team of at least two field workers.
- Reliability was further maintained during the data analysis by having a single person coding the data on the data-recording sheet for consistency (Appendix B). Verifying the data for a second time validated the accuracy of the coding (Leedy & Ormrod, 2001:105).

5.12.2. Qualitative quality criteria

Qualitative data collection constituted the less-dominant method of accruing data for the current study. This method of data collection was used to gain insight into the context and interaction processes of MCH clinics in Hammanskraal as a

hearing-screening platform. The quality criteria used for quantitative research (e.g. validity and reliability) is inappropriate for naturalistic or qualitative inquiry (De Vos, 2002b:351). Four quality criteria are specified to establish the trustworthiness of qualitative data (Lincoln & Guba, 1985:290). Table 5.14 presents these criteria and a working definition for each.

TABLE 5.14 Aspects of trustworthiness (De Vos, 2002b:351,352)

TERM	DEFINITION
CREDIBILITY	The goal of demonstrating that the inquiry was conducted in such a manner as to ensure that the context was accurately identified and described
TRANSFERABILITY	The goal of demonstrating the applicability of one set of findings to another context
DEPENDABILITY	The goal of accounting for changing conditions in the phenomenon chosen for study. Minimisation of idiosyncrasies in interpretation.
CONFIRMABILITY	The goal of demonstrating that the findings of the study could be confirmed by another study

The strategies employed during the current study to ensure these quality criteria are applicable on the qualitative method of this study were as follows.

- **Ensuring credibility**
  - An in-depth and encompassing literature study was performed to ensure the credibility of the theoretical underpinnings of the study (Krefting, 1991:217).
  - The aim and objectives of the research study were carefully constructed so that unambiguous goals were clearly stated (Reid & Gough, 2000:65).

- Combining the field notes and critical reflections including the experiences of four fieldworkers increases the credibility of the data (Reid & Gough, 2000:67).
- Conducting the naturalistic observations in two different MCH clinics increased the credibility of the data (Reid & Gough, 2000:67).
- During the extent of the research project the primary researcher reflect on the possible influence of his own background, perceptions, experience and interest on the interpretation of findings and was cautioned against bias as a result (Krefting, 1991:219).

- **Ensuring transferability**
  - The transferability of the data was discussed for the quantitative data in this study but also applies to the qualitative data. Real life settings (MCH clinics) were implemented from a typical developing South African context and therefore does carry transferability toward other MCH clinics in developing contexts.
  - Conducting the naturalistic observations in two different MCH clinics in the region also increases the transferability of the data because it involves more than just one setting (Reid & Gough, 2000:67).
  - To allow informed transferability judgements to be made to other contexts detailed descriptions of the participants, data collection instruments, procedures and variables were provided (Krefting, 1991:221).

- **Ensuring dependability**
  - A combination of data collection methods, including field notes and critical reflections, and a small number of researchers (n=5), allowing less variability, ensured a higher degree of dependability (Krefting, 1991:220).
  - A careful description of the data collection, recording, analysis, and interpretation methods was provided to ensure accurate and justifiable judgements regarding the dependability can be made (Krefting, 1991:220).

- **Ensuring confirmability**
  - The use of field notes and a structured critical reflection with sub-divisions for different topics provided an improved degree of confirmability (Reid & Gough, 2000:70).
  - The researchers were cognitive of assuring an unbiased approach toward the data collection procedure and the inference of conclusions to satisfy the confirmability criteria (Reid & Gough, 2000:71).

The strategies above ensured a high degree of quality measures in terms of validity, reliability and trustworthiness in the present study.

5.13. CONCLUSION

The need for contextual data has become imperative in light of the recommendations by the year 2002 HSPS produced the Professional Board for Speech Language and Hearing Professions of the HPCSA. This statement recommends MCH 6-week immunisation clinics as a primary context for implementing TNHS toward UNHS in 2010 (HPCSA, 2002:2). The empirical research of the current study was designed to investigate the use of these clinics as screening contexts in a representative South African community. Ensuring that a holistic representation of the clinics as screening facilities was accrued both quantitative and qualitative methods were used. These methods provided the means of investigating the context and interactional processes as well as providing insight into the demographics of the population served, screening test and protocol performance and programme efficiency. This type of information is pivotal to establishing evidence-based infant hearing screening programmes at MCH 6-week immunisation clinics suited to the developing contexts of South Africa.

5.14. SUMMARY

This chapter provided a thorough description of the procedures implemented in the research method to acquire the data according to the sub-aims, in order to address the main aim of the study. Evaluating the feasibility of an early hearing detection programme at MCH clinics in Hammanskraal was the driving force behind this project. The research design was described, followed by the selection criteria and description of subjects used in this study. The apparatus used, the collection of data and analysis thereof was discussed subsequently, followed by the data collection procedures according to the different techniques. The chapter was concluded by an overview of the data preparation and analysis procedures implemented and a discussion of ethical issues involved in the current study.

CHAPTER 6

RESULTS AND DISCUSSION

Aim: To present the results of the empirical research and to elucidate the meaning and significance thereof

6.1. INTRODUCTION

The move toward newborn and infant hearing screening at Maternal and Child Health (MCH) 6-week immunisation clinics, as recommended by the Professional Board for Speech, Language and Hearing Professions year 2002 HSPS (HPCSA, 2002:2), has created new challenges for audiological practice in the national healthcare system of South Africa. It has produced an obligation to conduct Essential National Health Research (ENHR), as recommended by the Department of Health (1997:15), to establish the feasibility of using these clinics as platforms for widespread infant hearing screening. This type of research is essential to the planning and implementation of widespread screening programmes that constitute the first step in establishing a South African Early Hearing Detection and Intervention (EHDI) system.

A theoretical underpinning for the implementation of newborn and infant hearing screening programmes including the justification for, current practice of, challenges in developing contexts and the status of EHDI internationally and in South Africa was provided in Chapters 2 to 4. Chapter 5 presented the methodological approach that supplied the operational framework for extracting the necessary data for addressing the main aim of this study. **The aim of this chapter is to describe an early hearing detection programme at two MCH**

clinics in a developing South African context and to discuss it in terms of relevant and comparable literature. Figure 6.1 provides a presentation of the sub-aims investigated to attain the main goal of the study.

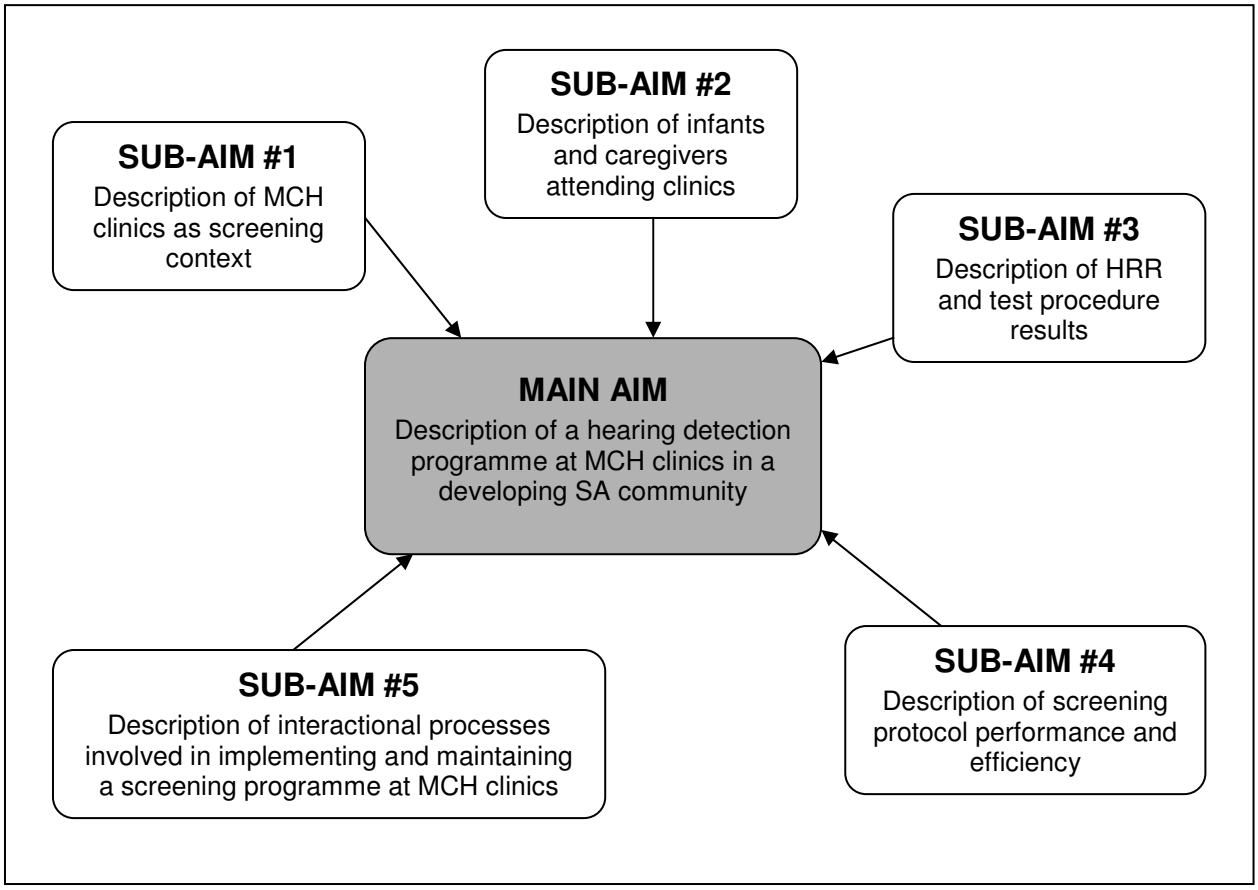


FIGURE 6.1 Sub-aims constituting the main aim of the current study

The descriptive results for all sub-aims will address the research question and attain the goal of the current study. According to Neuman (1997:367), comparison is the key to all research and the meaning and significance of results depend upon appropriate interpretation, relevant conclusions, and generalisations based on the analysed data (Smit, 1983:22). The results of the current study are presented and discussed according to the sub-aims as specified in Figure 6.1.

6.2. RESULTS AND DISCUSSION OF SUB-AIM #1: MCH CLINICS AS HEARING SCREENING CONTEXT

The first sub-aim of the study was to describe the two MCH clinics in the Hammanskraal community in terms of their suitability as a platform for conducting newborn and infant hearing screening. The descriptions were part of the less-dominant research method being qualitative in nature. All descriptions were recorded and analysed from field notes and critical reflections by the fieldworkers involved.

6.2.1. Presentation and discussion of results for sub-aim #1

A summary of the fieldworkers' descriptions classified in terms of assets and barriers posed by the MCH clinics as a context for hearing screening is presented in Table 6.1.

TABLE 6.1 Summary of qualitative results describing the clinics as screening platforms

CLINICS AS HEARING SCREENING CONTEXT
ASSETS:
- A room with enough space was made available at each clinic. At one clinic the testing room was separate from the rest of the clinic, which allowed for a quiet and controlled screening environment. - Chairs and tables were available in each screening room. - Gloves and disinfectant were supplied by clinic personnel. - Electricity and enough power points were available for the equipment. - Bathrooms with toilet facilities were available at each clinic although running water was not always present. - Although facilities were not ideal they were adequate in both cases.
BARRIERS:
- External noise levels were the main problem. Noise was primarily due to mothers talking outside the test room; clinic staff moving through the screening area; nearby construction and a sewage

TABLE 6.1 Continued

truck which came every other day and halted screening for 30 minutes. If mothers outside were instructed to keep quiet during the screening they obeyed for a period of time and would have to be asked again after some time. It was also noted that noise levels were least early in the morning and became gradually more as noon approached.

- Running water was not consistently available.
- Five electricity failures that lasted between one hour and one day were counted during the 6-month screening period.
- A lack of large enough waiting rooms for all the caregivers and infants makes accommodating all persons in poor weather conditions difficult and causes noise levels that are too high to allow hearing screening.
- Distance from Pretoria was noted as a significant barrier for fieldworkers to travel to and fro.
- A poor gravel road had to be travelled on for 1 km before reaching each of the clinics – to the one clinic an especially poor road with many potholes had to be driven.
- Safety was a concern at times. Unfamiliar men including an inebriated man illicitly entered the screening area on isolated occasions, alarming fieldworkers and caregivers.

The prominent findings indicated both clinics had adequate basic (separate furnished room, toilet, electricity points) and support (gloves and disinfectant) facilities available for the implementation of infant hearing screening programmes. The most prominent barriers included high external noise levels due to patients, nursing staff, sewage trucks and construction. Other barriers were the travelling distance and poor roads with intermittent barriers including no running water, electrical power breaks, and safety issues.

Generally the developing contexts of the world are reported to have an absence of proper facilities for newborn and infant hearing screening (Mencher & DeVoe, 2001:19). The quality of primary healthcare clinic facilities is an important determinant of the satisfaction of patients and staff with the health service and South African healthcare facilities indicate much room for improvement (Day et al., 2004:343).

Previous reports indicated that South African clinics and especially rural clinics offer very little in the way of facilities, even though there may be adequate medicine available (Strachan, 1999:1). Although there is substantial variability

between provinces a national survey done in 2003 indicated that only 59% of primary healthcare facilities had adequate consultation rooms, 48% had adequate waiting areas, and only 42% had adequate toilets for patients and staff (Day et al., 2004:343). The current study also reported a lack of adequate waiting areas and although toilets were available for staff, running water was not always available. In addition to this, interruptions in electricity were also reported as a barrier. The survey of primary healthcare facilities indicated that although there has been a substantial improvement in water provision at facilities with 98% having on-site water supply, and electricity supplied to 95% of facilities, interruptions in supply were still far too frequent (Day et al., 2004:343). The fact that new hearing screening equipment is battery-operated means that short interruptions in electricity supply need not affect the screening process although longer breaks will certainly be a barrier.

The reported barrier of high noise levels in the current study is primarily due to inadequate waiting areas close to a room without soundproofing. Although this did not make screening impossible there were times in which the noise-levels were too high to screen in. Strategies to address this problem included regularly informing all caregivers in the waiting area regarding the importance of silence in order to conduct the screening and closing all doors and windows. Provision of adequate waiting areas as recommended by the 2003 survey of primary healthcare facilities (Reagon et al., 2004:29) will provide a solution to the barrier posed by excessive noise to the screening of infant hearing.

The reported safety concern at the clinics investigated in this study is also a significant problem identified by the 2003 survey of primary healthcare facilities (Reagon et al., 2004:34). The provision of adequate security measures is essential to ensure the protection and security of patients and staff. A call has been made for the improvement of security measures at the majority of these facilities especially those where the incidence of crime is highest (Reagon et al., 2004:34).

6.2.2. Summary of results and discussion for sub-aim #1

An investigation of MCH clinics as a screening context revealed the following conclusions as summarised in Table 6.2.

TABLE 6.2 Summary of results and discussion for sub-aim #1

Prominent obstacles to infant hearing screening which were evident in the clinics were: - high noise levels - interruptions in electricity and water supply - safety concerns Despite the obstacles observed at the MCH clinics and the identified areas requiring improvement, the clinics proved to be an adequate platform with sufficient basic assets for conducting an infant hearing screening programme.

6.3. RESULTS AND DISCUSSION OF SUB-AIM #2: INFANTS AND CAREGIVERS ATTENDING THE MCH CLINICS

The second sub-aim of the study was to describe the infants and caregivers attending the two MCH clinics in the Hammanskraal community. The descriptions are part of the dominant quantitative research method and were accrued by conducting a structured interview with caregivers and by consulting patient files. The results are presented and discussed for the infants first followed by the caregivers.

6.3.1 Description of infants attending the MCH clinics

The infants are described in terms of age and race in this section. The risk factors for hearing loss, which is a further description of the infants, is presented and discussed in sub-aim #3.

- **Infant age**

510 infants between the age of 0 – 12 months and with an even gender distribution (51/49%) were enrolled in the study. Figure 6.2 provides a distribution of the infants according to their age.

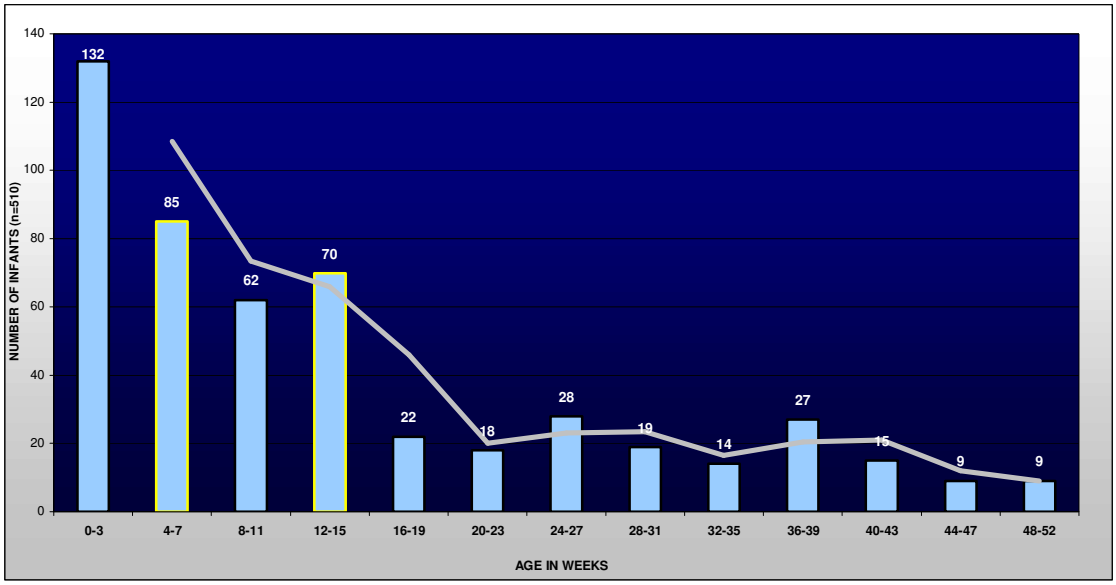


FIGURE 6.2 Age distributions of infants (n=510)

The mean age of the group was 14 weeks with 68% of infants younger than 16 weeks (4 months). The majority of infants were younger than or equal to 10 weeks of age. Figure 6.3 provides a frequency distribution of these infants younger than 10 weeks (n=252).

A large proportion (26%) of infants screened was younger than one month of age with 43% younger than two months and 55% younger than three months. The large number of infants younger than one month of age can be attributed to a significant number of births at the clinics and caregivers attending for an initial evaluation of their newborn infants. At the age ranges for scheduled immunisation visits a visible increase in attendance is evident (Figure 6.2) even though infants of all ages across the first year of life are represented. The scheduled immunisation visits are at 6 weeks of age, 14 weeks of age (3.5 months), and 36 weeks of age (9 months) (Day et al., 2004:404).

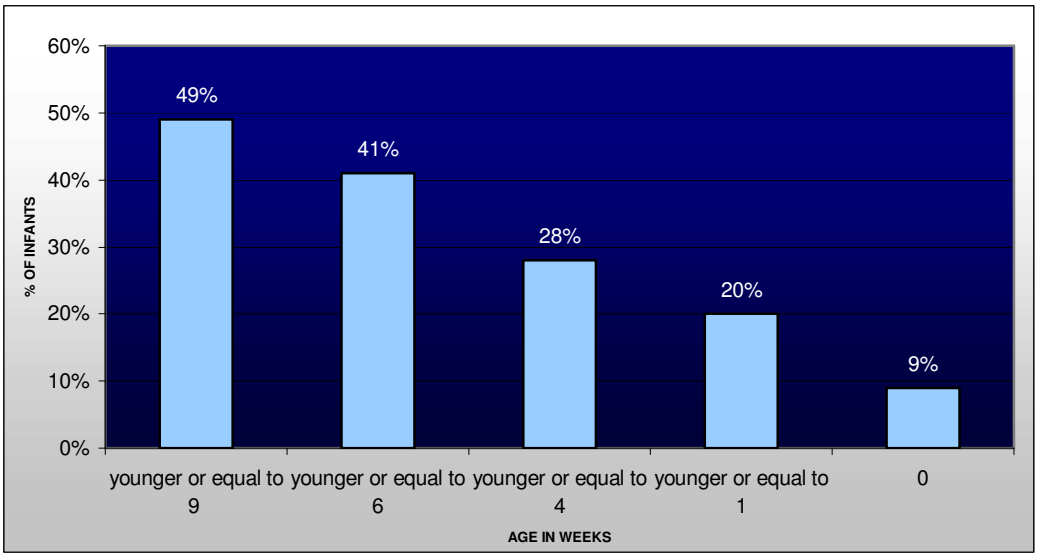


FIGURE 6.3 Frequency distribution of infants younger than 10 weeks (n=252)

- **Infant race**

The subject race was almost exclusively black (n=508) with the exception of two coloured infants. This is in agreement with the demographical indicators specified for this community, which is predominantly representative of black South Africans (Tshwane 2020 Plan, 2002:28). The mere fact that these infants are born as black South Africans places them in the least developed group of South African citizens with 66% of black South Africans living in poverty compared to less than 2% of white households, 8% of Asian households and 25% of coloured households (Woolard & Barberton, 1998:27). In addition to this the fact that the infants are from the Hammanskraal district also places them at an increased risk since it is a developing context characterised by socio-economic strains (Tshwane 2020 Plan, 2002:28,29).

6.3.2 Description of caregivers

The following discussion of results describing the caregivers is presented according to the questions in the interview schedule on the data recording sheet section A (Appendix A).

- **Primary caregiver and marital status of mother**

Figure 6.4 provides the number of different primary caregivers for the infants in this sample.

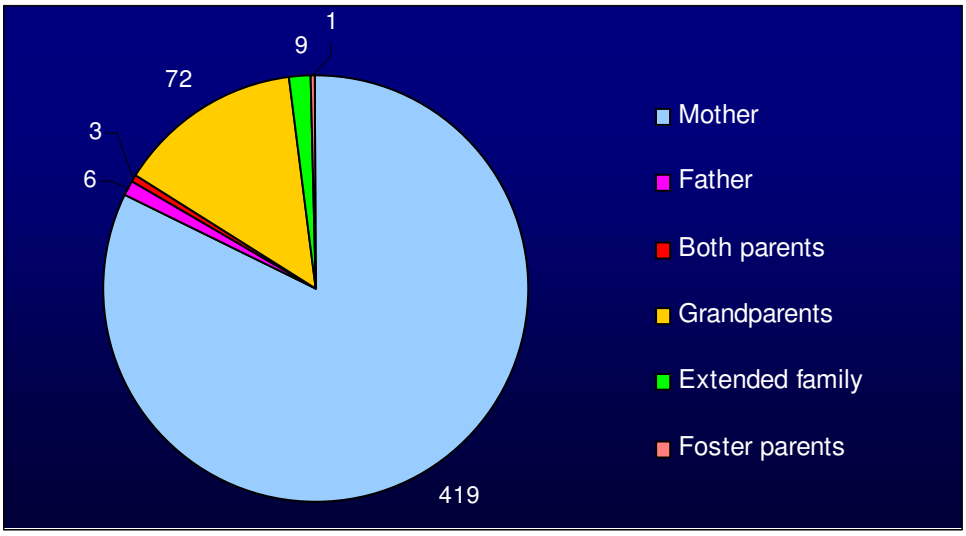


FIGURE 6.4 Primary caregivers of infants (n=510)

Single mothers were the primary caregivers in 82% of cases with both parents involved for only three cases. The second largest numbers of primary caregivers were the grandparents, who comprised 14% of the sample. Figure 6.5 provides a graphical presentation of the marital status of the mothers to the infants included in this study.

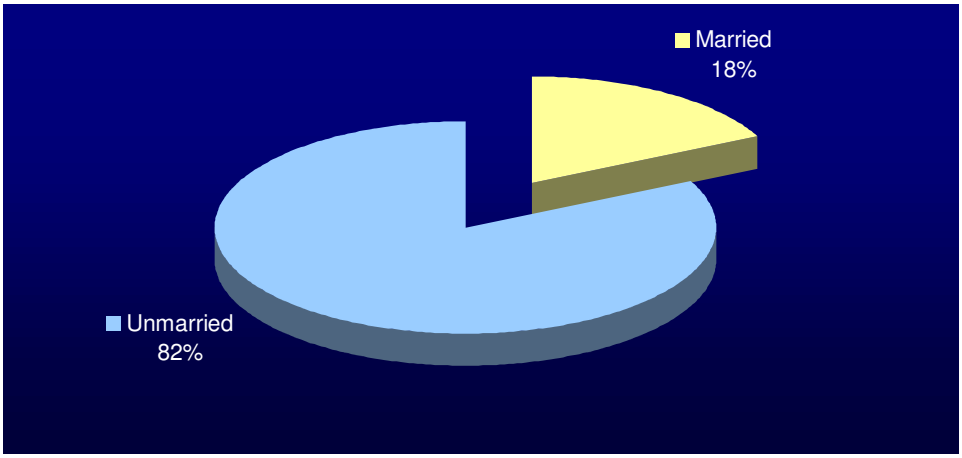


FIGURE 6.5 Marital statuses of mothers (n=504)

South Africa has seen an increase in female-headed households with a staggering 42% of South African children younger than seven years of age reported in 1995 to be living only with their mother (Nyman, 1999:4). The figure is almost twice as high in the current study. Possible reasons for the high percentage of single mothers in the current study left to care for the children are probably due to the following reasons:

- Peri-urban developing community representing the most underprivileged sections of the South African population (Tshwane 2020 Plan, 2002:28).
- High numbers of children are born out of formal partnerships (Children in 2001, 2001:55).
- High number of pregnancies among teenagers in temporary relationships (Children in 2001, 2001:55).
- A number of South African men establish dual households. Typically a man from a rural area will establish a second town household (Children in 2001, 2001:55).

It is not uncommon, with a reported 25%, for grandparents to be the primary caregivers of children in South Africa (Children in 2001, 2001:55). This is often due to the mother and/or father working far away from home or due to death, which is increasingly becoming the case with the spreading HIV/Aids pandemic (Children in 2001, 2001:55). It is therefore not surprising that grandparents are playing an increasing important part in caring for the children of South Africa.

These factors also hold important implications for EHDI programmes since effective early intervention is heavily reliant on parental or caregiver involvement (JCIH, 2000:17). Single mothers and grandparents are under increasing strain due to economic pressure and the breakdown of the family structure and single parenthood places a child at an increased risk for developmental delays (Rossetti, 1996:6; Children in 2001, 2001:55). In addition to this, the breakdown of family structures create stressors, which could seriously impede the nurturing of family-centred intervention programmes for infants identified with hearing loss.

- **Age of mothers and number of children**

The age of mothers of infants in this study varied between 15 to 43 years. Figure 6.6 provides the distribution (in percentage) of mothers for different age categories.

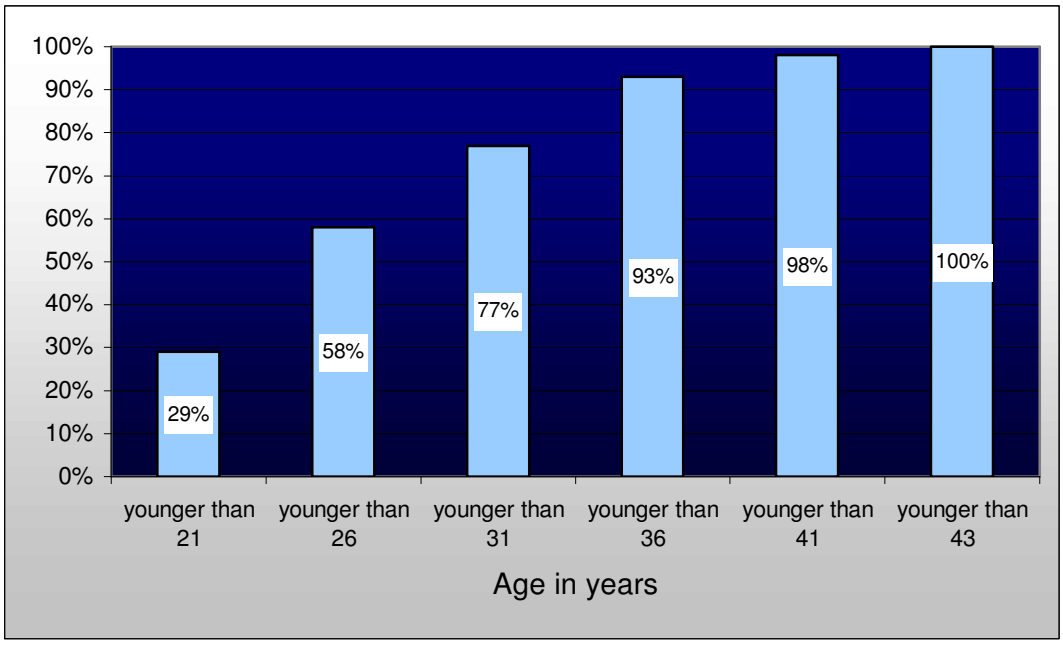


FIGURE 6.6 Frequency distribution of mothers according to age (n=510)

It is clear that majority of mothers are in their late teens and early twenties. 58% of the mothers were 25 years of age and younger with almost two-thirds (29%) of mothers 20 years of age and younger. The numbers of children borne of mothers included in this study are presented in Table 6.3.

TABLE 6.3 Number of children borne of mothers (n=503)

# of children by mother	1	2	3	4	5	6	7	9
# of mothers	*217*	*148*	*71*	*38*	*20*	*6*	*2*	*1*
# of sample	*43 %*	*29 %*	*14 %*	*8 %*	*4 %*	*1 %*	*0.4 %*	*0.2 %*

A majority (72%) of the mothers had 1 or 2 children. This corresponds to the high percentage of young mothers in the sample who had their first or second child. 21% of mothers were 19 years of age and younger meaning that they were still school-going age and 29% were 20 years of age and younger. These percentage are in close approximation of the estimated South African average of 19% of female learners (18 years of age) and 30% of females 19 years of age who have been pregnant at least once (Bhana, 2004:131; Department of Health, 1999:38). The high incidence of teenage pregnancies is not surprising considering a 41% sexually active teenage population in South Africa exacerbated by limited use of contraceptives (Bhana, 2004:132).

It is a common fact in maternal and child health programmes that the youngest mothers are at the highest risk for adverse reproductive and parenting outcomes (Ventura et al., 1998:6). The high rate of teenage pregnancies in this study therefore increases the risk of developmental disabilities in this community. This is even more so due to an increased low-birth weight incidence present in adolescent mothers, which already predisposes the infant to developmental disorders such as hearing loss (Rossetti, 1996:21; Northern & Downs, 2002:284). Another factor that must be considered is the increase in school dropout rates among adolescent mothers, which adds to the economic burden of the household and limits future prospects due to poor education (Children in 2001, 2001:82).

These factors put this community at an increased risk for having a higher incidence of developmental delays and disabilities (Kubba et al., 2004:125; Rossetti, 1996:21-22) and it is these same factors that have been reported to correlate with mothers who do not complete the infant hearing screening/follow-up process (Prince et al., 2003:1204). This population, therefore, is at risk not only for developmental delays and disabilities but also for not completing the screening/follow-up process.

- **Home languages**

The home languages of the families were primarily Tswana (37%) and Shangaan (31%). Figure 6.7 gives the percentages of different languages spoken by the families.

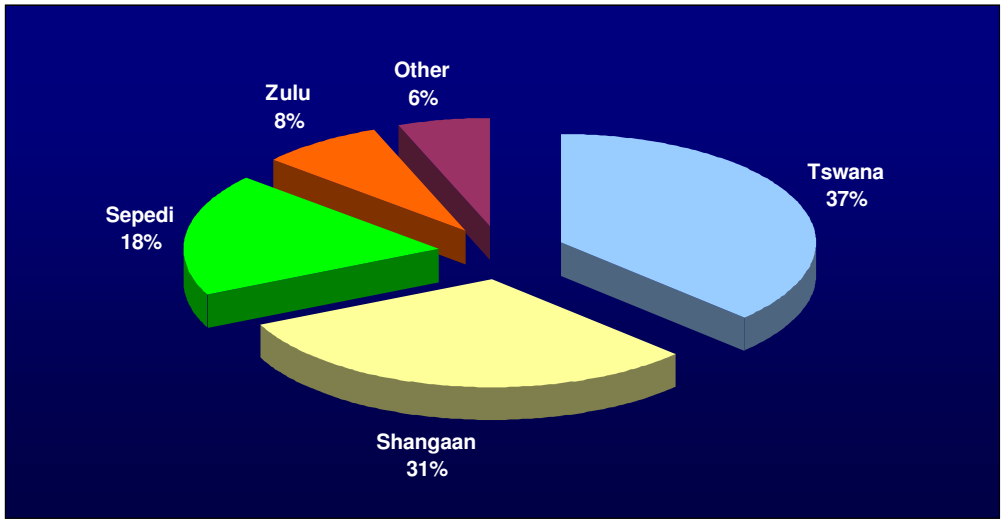


FIGURE 6.7 Home languages of families (n=508)

A variety of home languages were recorded with Tswana being the most prominent in this community. The group speaking other languages included African languages such as Xhosa and Ndebele and one English-speaking and two Afrikaans-speaking families.

The diverse number of languages poses a significant challenge to delivering culturally sensitive early intervention services to infants with hearing loss in their home language. This is especially so since early intervention services should be based on a family-centred approach where professionals empower the family to provide the best stimulation and guidance for their infant (JCIH, 2000:17). Currently, only a very small percentage of African language mother tongue speakers have qualified as audiologists (Uys & Hugo, 1997:24). Thus, delivering linguistic and culturally appropriate EHDI services to this population remains a significant challenge that can only be met by training more audiologists and

speech-language therapists fluent in African languages or by the use of interpreters in an accountable responsible manner.

- **Educational qualifications of parents**

The highest educational qualifications attained by the group of mothers and fathers are presented in Figure 6.8.

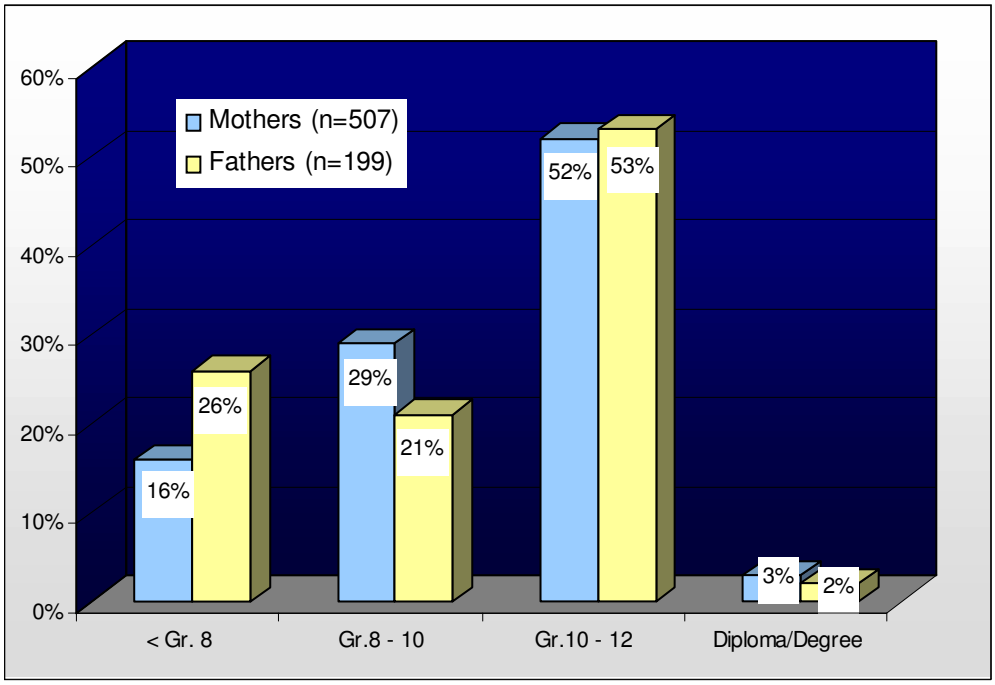


FIGURE 6.8 Educational qualifications of mothers (n=507) and fathers (n=199)

The majority (52%) of mothers had a grade 10 to 12 educational qualification. A significant percentage (26%) of the fathers had obtained less than a grade 8 school qualification and this figure rises to 47% if all fathers with a less than a grade 11 school qualification is considered. In general, the fact that the number of responses for paternal educational qualifications is much less than for the mothers and that caregivers, who were mostly mothers, reported the fathers' qualifications must be considered as possible factors which may affect the results.

Previous reports have indicated that 1 in five African females have had no education at all (Central Statistics, 1998:11). There has, however, been a steady improvement in educational qualifications among South Africans with a reported 28% of Africans between 20 – 24 years of age having obtained at least a grade 12 qualification (Central Statistics, 1998:11). Very few post grade 12 educational qualifications were reported for both fathers and mothers. According to a large study with a cohort or 17,091 infants and caregivers in Hawaii the mothers who had not completed high school were less likely to have their infant complete the hearing screening/follow-up process than were more educated women (Prince et al., 2003:1204). Educational level is therefore significantly correlated to the completion of a screening/follow-up process.

A close correlation also exists between educational qualification and unemployment. Among the economically active in South Africa, the proportion of unemployed is 34% or higher for those who have attended but who have not completed school and drops to 18% among those who have completed at least Grade 12 (Central Statistics, 1998:18). According to these figures the vast majority of mothers and fathers in this study are at risk for unemployment. This is a certain risk factor for child development since secure parental employment is one of the factors most closely related to child well being (Children in 2001, 2001:34).

The poor level of education and subsequent high vulnerability to unemployment are factors that place the population of infants in this study at an increased risk for developmental delays and disabilities as well as for poor involvement of parents in the early hearing loss detection and intervention process (Prince et al., 2003:1204; Rossetti, 1996:5-6).

- **Average household income**

The distribution of average household incomes recorded for this study is presented in Figure 6.9.

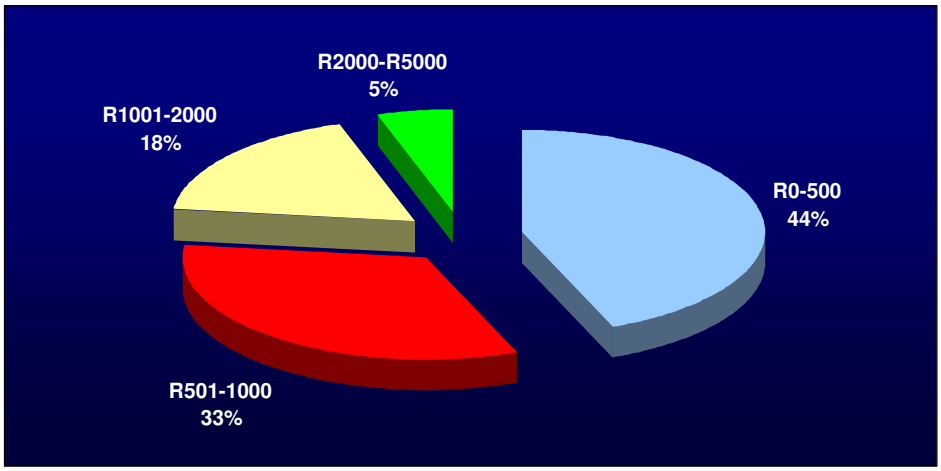


FIGURE 6.9 Average monthly household income (n=184)

A significant majority of respondents (77%) reported an average monthly household income less than R1000. And only a small minority (5%) reported an average monthly household income of more than R2000. According to the 1996 Census, African women earned the least with 47,5% earning less than R500 per month and a further 21,4% earning between R500 and R1000 (Census, 1996:49). This is comparable to the results in of the current study with 44% of households earning less than R500 per month and a further 33% earning between R500 and R1000. The only difference is that this data comes from seven years after the census date. Also, the fact that inflation has taken its toll over these years, exacerbates the picture of poverty in Hammanskraal.

Poverty is unequally distributed between race with 61% of Africans classified as poor compared to 38% of coloureds, 5% of Indians and 1% of whites (Children in 2001, 2001:34). The almost exclusively African sample taken in this study is therefore a large contributing factor to the poverty evident in this sample. Another major reason for the poverty evident in this study, apart from the developing peri-urban region itself, is the fact that the sample is primarily represented by female-headed homes which are more likely to be poor than those headed by a resident male (Children in 2001, 2001:34).

Poor households have less access to essential services such as water and sanitation, communications, roads and energy sources, particularly in rural and peri-urban regions such as Hammanskraal (Children in 2001, 2001:34). These factors create enormous time burdens on poor households and promise to be serious barriers to the implementation of family-centred early intervention services for infants with hearing loss. On the other hand, poverty related stressors also place this population of infants at an increased risk for developmental delays and disabilities such as hearing loss (Kubba et al., 2004:125; Rossetti, 1996:5-6), which emphasises the need for early detection and intervention programmes.

6.3.3 Summary of results and discussion: sub-aim #2

The description of infants and caregivers sampled for this study indicates that this developing Hammanskraal population is a predisposed high-risk group. The factors placing the infants at risk and the most prominent implications are summarised in Table 6.4 (Kubba et al., 2004:125; Rossetti, 1996:21; Prince et al., 2003:1205):

TABLE 6.4 Summary of results and discussion for sub-aim #2

Risk factors

- The sample consisted of predominantly single unmarried (82%) mothers in female-headed family structures, which are more prone to poverty than male-headed families (*Children in 2001*, 2001:55)
- The majority (58%) of mothers are 25 years old and younger with almost two-thirds of the mothers (29%) school-going age. Teenage pregnancies constitute a biological and environmental risk factor because of an increased low birth weight incidence and higher school dropout rates adding to the economic burden of the household (Ventura et al., 1998:6; *Children in 2001*, 2001:82).
- An extremely small number of parents had obtained post-Grade 12 qualifications and the majority had not yet obtained a Grade 12 education. The fact that education level is a significant predictor of mothers completing the hearing screening/follow-up process and of unemployment, is one of the factors that most closely affect child well-being and that put this sample at increased risk (Prince et al., 2003:1205; Central Statistics, 1998:18; *Children in 2001*, 2001:34).
- The average household income evidenced outright poverty, which causes enormous burdens on families and results in poorer education opportunities and increased risk of teenage pregnancy (Census, 1996:49; *Children in 2001*, 2001:34 & 82).

TABLE 6.4 Continued

These factors have a two-fold implication for implementation of EHDI programmes among developing populations such as the sample taken from the Hammanskraal community:

1. These factors are indicators of socio-economic depravity, which has been associated with an increased incidence in congenital hearing loss and which was discussed in Chapter 3 (Kubba et al., 2003:125). Thus this population of infants and caregivers are at an increased risk of having a congenital hearing loss, which emphasises the importance of infant hearing screening programmes.
2. Secondly, the mentioned socio-economic burdens and environmental risk factors cause increasing stressors (*Children in 2001*, 2001:34), which erect barriers toward delivering effective hearing screening and follow-up services, including family-centred early intervention. Thus, the study population is at higher risk for congenital hearing loss, insufficient participation in the hearing screening/follow-up process, and subsequent poor involvement in a family-centred early intervention process for infants identified with hearing loss.

6.4. RESULTS AND DISCUSSION OF SUB-AIM #3: HIGH-RISK REGISTER AND TEST PROCEDURE RESULTS

The third sub-aim of the study aimed to describe the results of the High-Risk Register (HRR) and test procedures conducted for the infants and caregivers attending the two MCH clinics in the Hammanskraal community. The descriptions are part of the dominant quantitative research method and were accrued by conducting a structured interview with caregivers and consulting patient files for identifying risk indicators, and by performing various tests of auditory integrity. The results and discussion will be presented according to the results for each procedure (HRR, High frequency immittance, OAE, AABR) followed by a section concerning these procedures for subjects returning for follow-up appointments.

6.4.1. High-Risk Register results

The following presentation and discussion of results represent data collected by completing the HRR during the caregiver interview supplemented by the clinic file (Appendix A, Section B). The obtained results are summarised in Table 6.5.

TABLE 6.5 Summary of the risk indicators for the sample

RISK INDICATOR	RESULT		DESCRIPTION
a) Family History of childhood hearing loss (n=501)	***YES***	***13 %***	65 subjects reported a family history of childhood hearing loss
	NO	87 %	
	No info	0.4 %	
b) Hyperbilirubinaemia (n=500)	***YES***	***0.2 %***	Only 1 subject had reported high bilirubinaemia levels and only this subject had the levels available
	NO	98.6 %	
	No info	1.2 %	
c) Congenital infections (n=495)	***YES***	***5 %***	Syphilis – 17 Rubella – 1 HIV – 5
	NO	95 %	
d) Craniofacial defects (n=506)	***YES***	***1 %***	7 subjects – atresia and ear tags
	NO	99%	
e) Birth weight less than 1500 grams (n=503)	***YES***	***1 %***	6 subjects weighed less than 1500 grams and info was unavailable for 1
	NO	99 %	
	No info	0.2 %	
f) Bacterial meningitis (n=500)	***YES***	***0 %***	No subjects reported bacterial meningitis
	NO	99.4 %	
	No info	0.6 %	
g) Asphyxia (n=500)	***YES***	***0.8 %***	3 subjects had a 1 min Apgar less than 4 and 1 subject had a 5 min Apgar less than 6
	NO	97.8 %	
	No info	1.4 %	
h) Ototoxic medication (n=504)	***YES***	***1.2 %***	6 subjects were reportedly exposed to ototoxic medication
	NO	97 %	
	No info	1.8 %	
i) Persistent pulmonary hypertension. Prolonged mechanical ventilation ≥ 5 days (n=504)	***YES***	***0.4 %***	2 subjects were reported to have persistent pulmonary hypertension
	NO	98.6 %	
	No info	1 %	
j) Syndrome present (n=504)	***YES***	***0.2 %***	1 subject had a syndrome – Albinism
	NO	99.8 %	
k) Admitted to the NICU for more than 48 hours (n=505)	***YES***	***2.4 %***	12 subjects were admitted to the NICU for between 3 and 30 days
	NO	97.6 %	

Risk indicators were reported for all categories except meningitis. The cases where no information regarding risk factors was available either in the clinic file or from the caregiver varied between 0,3 and 1,8% across the different risk categories. In the majority of these cases a relative brought the infant and the mother was not present to provide all the required information. The high response rate for reporting risk indicators indicates promise for the effective use of a HRR for this population in a MCH clinic.

The distribution of the reported risk indicators for the current study is presented in Figure 6.10.

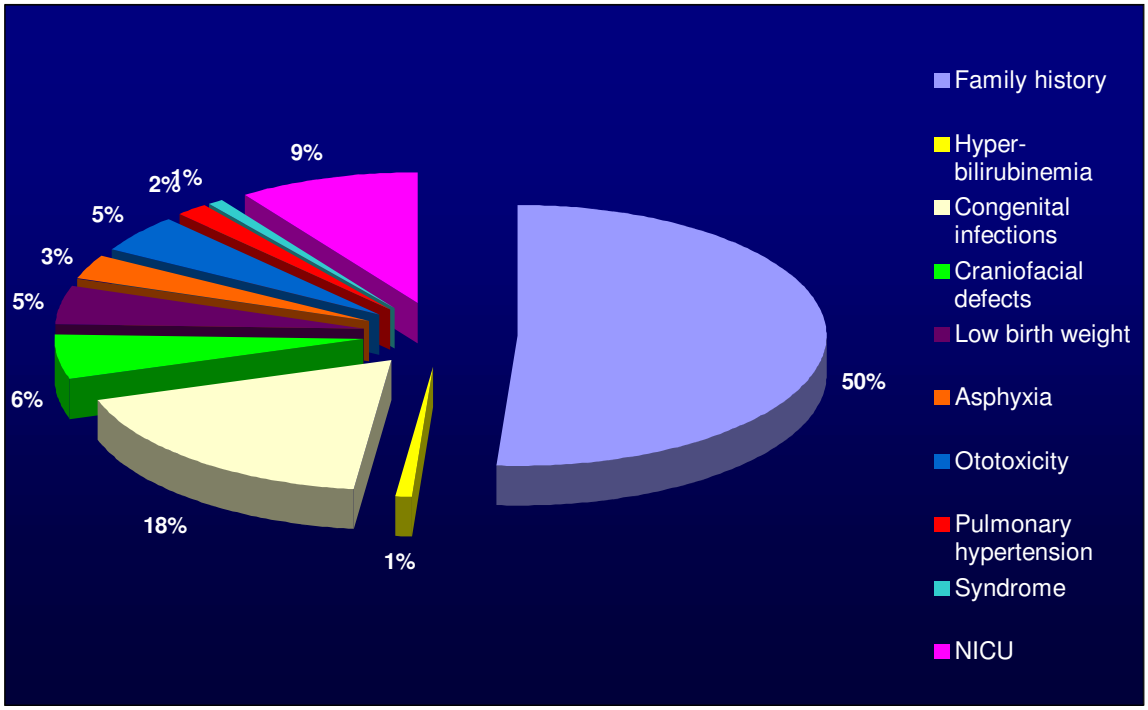


FIGURE 6.10 Distribution of risk indicators identified for the sample (n=127)

The risk factor with the highest incidence was family history of congenital hearing loss (13%) followed by congenital infections (5%), NICU admittance (2,4%), ototoxic medication (1,2%), low birth weight (1%), craniofacial defects (1%), asphyxia (0,8%), persistent pulmonary hypertension (0,4%), presence of a

syndrome (0,2%) and hyperbilirubinaemia (0,2%). The risk factors present in the group of NICU infants (n=12), from most prevalent to least, included low birth weight (n=5), asphyxia (n=4), ototoxic medication (n=4), family history (n=2), and craniofacial defects (n=1).

The incidence of all risk factors in this study, except for family history of congenital hearing loss, is similar to previous reports. Kennedy et al. (1998:1959) in a sample of 21,279 infants reported incidences of 6,6% for family history of hearing loss; 4,2% for congenital infections; 1% for asphyxia; 0,2% for chromosomal abnormalities; and 0,3% for exchange transfusion due to high bilirubinaemia levels. The fact that family history was the most prominent risk factor in this study is similar to previous studies investigating large samples of infants differing only by the incidence margin (Mahoney & Eichwald, 1987:160; Kennedy et al., 1998:1959; Vohr et al., 2000b:380). Previous studies have reported a 6 to 7% incidence of family history of congenital hearing loss compared to the 13% reported in the current study (Mahoney & Eichwald, 1987:160; Kennedy et al., 1998:1959; Vohr et al., 2000b:380).

The high incidence of family history of congenital hearing loss in the current study may be explained by two possible factors. Firstly, depravity is known to correspond with increased incidence rates of congenital hearing loss (Kubba et al., 2004:125) and therefore the existing depravity in this community as evidence in discussion of sub-aim #1 can contribute to this high incidence of family history with congenital hearing loss. The second reason relates to the difficulty in obtaining an accurate history of family hearing loss and the importance of correctly phrasing the question to avoid misunderstandings or erroneous responses (Cone-Wesson et al., 2000:501; Kountakis et al., 2002:136; Northern & Downs, 2002:277). It is possible that caregivers misunderstood or misinterpreted the posed question and gave an incorrect answer, which may have inflated the incidence slightly. This risk factor, however, is very important since it is commonly reported as the most prevalent (22 – 42%) risk factor in at-risk children identified with hearing loss and therefore accurate documentation of its presence is essential (Vohr et al., 1998:355; Mahoney & Eichwald, 1987:160).

This emphasises the importance of parent or caregiver education and counselling about the increased risk for hearing loss when there is a family history.

Another important aspect requiring consideration is the incidence of congenital infections reported by mothers in this study. Due to the HIV/Aids pandemic in South Africa, with an estimated 11,4% of the general population infected, HIV was included as one of the congenital infection risk factors for infants in this study (Department of Health, 2002:4; UNAIDS, 2003:2). Children born of HIV/Aids infected mothers are at increased risk for hearing loss due to significantly lower birth weights, increased vulnerability for acquiring infections such as meningitis and cytomegalovirus (Spiegel & Bonwit, 2002:128). These children are also at a much greater risk of developing otitis media, which results in conductive hearing loss that may lead to sensori-neural hearing loss in certain cases (Bam, Kritzinger & Louw, 2003:40; Matkin et al., 1998:153; Singh et al., 2003:2).

The fact that only five mothers, comprising only 1% of the sample, indicated that they were HIV infected compared to a reported 26,5% of women attending MCH clinics in South Africa being infected, indicates gross underreporting in the current study (Mngadi, 2003:1). According to the estimated average rate of HIV infection in this population of mothers approximately 135 should have reported being infected. This under reporting can be ascribed to a number of reasons including unawareness among mothers regarding their status or reluctance to disclose such information.

A recent initiative implemented by the Department of Health aimed at increasing the HIV testing rate among mothers attending their first antenatal visit promises to improve awareness of HIV status. This will provide representative coverage since 96,9% of mothers in South Africa are reported to attend at least one antenatal visit (Doherty & Colvin, 2004:195; Smit et al., 2004:63). Reluctance among mothers to disclose HIV status may be due to fear of isolation or stereotyping but requires further investigation in the South African context as it

relates to disclosing HIV status as a risk factor for hearing loss. Another aspect that requires investigation is collaboration with nursing staff to assist in the documentation of risk factors and acquisition of HIV status. This may ensure more reliable and comprehensive documentation of risk indicators for hearing loss.

The distribution of the number of risk factors present for subjects identified as at-risk in the sample (n=510) is presented in Figure 6.11.

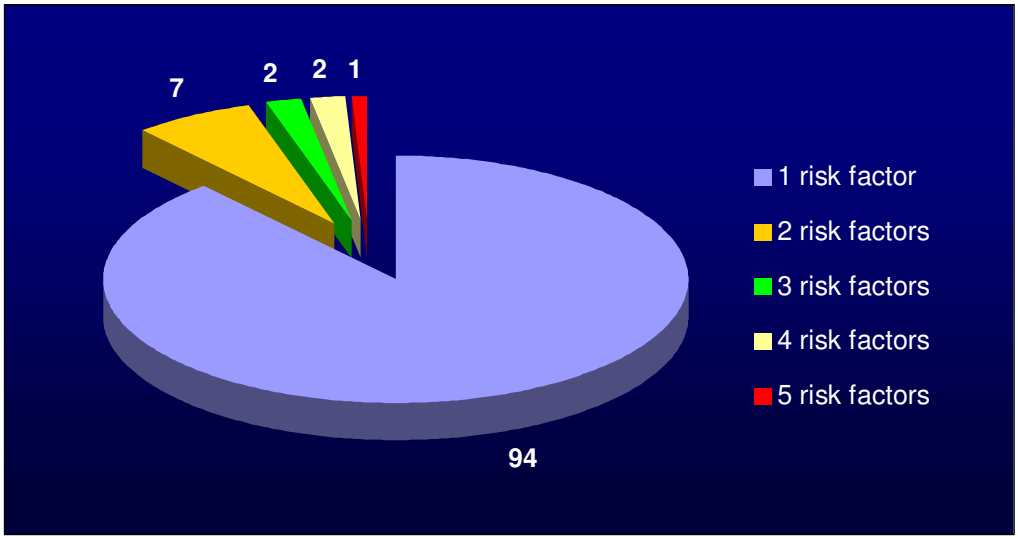


FIGURE 6.11 Number of infants with one or more risk factors (n=106)

In the current study 21% of infants (106/510) presented with at least one risk factor for hearing loss. 11,3% of these at-risk infants had more than one risk factor meaning that 2,4% of infants tested had more than one risk factor for hearing loss. 17% of the documented risk factors, apart from the NICU as risk factor, was forthcoming from the NICU population (n=12), despite only comprising 2,4% of the entire sample (n=510). This means that risk factors in this study were 10 times (1/1,5) more prevalent in the NICU population than in non-NICU exposed infants (1/0,15). Since NICU admittance was considered as a risk factor by itself in the current study the incidence of risk factors for this sample, in actual fact, was 16 times (1/2,5) more prevalent in the NICU population than for

the rest of the sample (1/0,15). Five of the NICU infants (42%) exhibited at least two additional risk factors in addition to NICU admittance. This is compared to only one infant (1%) from the non-NICU exposed at-risk group (n=94), presenting with more than one risk factor. This makes NICU infants in this study 42 times more likely to have more than one risk indicator apart from NICU admittance.

The percentage of high risk factors (21%) present in this study is considerably higher than previous reports. Kennedy et al. (1998:1959) reported that 11,6% of a sample of 21,279 infants in England had risk factors for congenital hearing loss. A larger study (n=283,298) from the USA reported a 9% incidence of risk factors and a more recent report indicated a 13.1% incidence of one or more risk indicators in a sample (n=2701) of infants from well-baby nurseries (Mahoney & Eichwald, 1987:161; Vohr et al., 2000b:380). Reasons for the high incidence of infants with risk factors in the current study were discussed in previous paragraphs and relate to the high incidence of a family history of hearing loss in the study sample. For NICU infants, Vohr et al. (2000b:380) reported that 59% presented with one or more risk indicators compared to 42% reported in the much smaller sample investigated in this study. When compared to the well-baby nursery, risk factors in the NICU population were 18 times more prevalent apart from the established risk of being in the NICU (Vohr et al., 2000b:380). Speculation still exist as to whether the presence of more than one risk factor for hearing loss imparts greater risk and further large scale studies are required to investigate this phenomenon (Vohr et al., 2000b:379).

Risk factors for hearing loss, as reported in this study (21%), suggests a significantly increased number of infants at risk compared to reports from developed countries (9-13%) (Kennedy et al., 1998:1959; Mahoney & Eichwald, 1987:161; Vohr et al., 2000b:380). This number will be even higher if accurately documented HIV status is included as a risk indicator. In general, the small percentage of unavailable information and risk incidence comparable to previous reports, except for family history, suggest that a HRR could be useful in identifying infants at risk for hearing loss at MCH clinics.

6.4.2. High frequency immittance measurements

The following presentation and discussion of results are for high frequency immittance testing. Immittance results represent data collected by conducting high frequency tympanometry and acoustic reflex measurements. These measures will be discussed separately in the following paragraphs.

- **Tympanograms using a 1000Hz probe tone**

The obtained tympanograms were divided into two groups – those presenting with a discernable peak, including double-peaks, and those without a discernable peak. Recent reports indicate that a peaked 1000Hz tympanogram suggest normal middle-ear functioning whilst the absence of a peak suggests the presence of middle-ear effusion (MEE) (Purdy & Williams, 2000:16; Kei et al., 2003:25). Figure 6.12 indicates the incidence of 1000Hz tympanograms with and without discernable peaks obtained in this study.

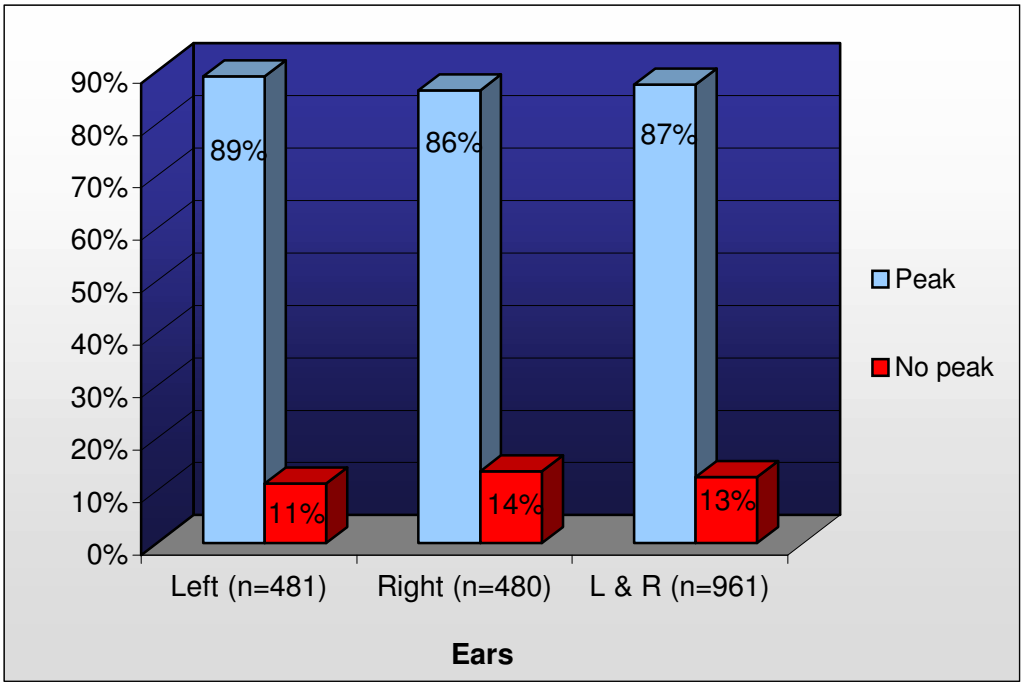


FIGURE 6.12 1000Hz Y-admittance tympanogram peaks (961)

Tympanograms were recorded from 961 ears and no was indicated between the left and right ears. As illustrated in Figure 6.13, 87% of the ears indicated peaked tympanograms indicative of normal middle-ear transmission. If neonatal ears only (0-4 weeks of age) are considered the incidence of peaked tympanograms increase from 87% to 92% (23/280). This is in contrast with a peaked tympanogram incidence of 86% (91/654) for infants between 5-52 weeks of age. Although no right and left ear effect was recorded for infant ears (5-52 years of age) a significant difference of 5% was obtained between the tympanometric data for the right and left neonatal ears of neonates, with the latter having the higher incidence of peaked tympanograms (94 compared to 89%). Double peaked tympanograms were recorded in 43 ears (4.5%) of 961 ears evaluated with 1000Hz Y-admittance tympanometry which is 5% of the tympanograms with discernable peaks. The majority (64%) of the double peaked tympanograms were from male infants and 88% of the ears with double peak tympanograms had OAE pass results.

Although no large-scale 1000Hz probe tone tympanometry studies for infants from birth to one year of age has been reported the incidence of peaked tympanograms for neonatal ears in this study is similar to that of a recent report for a group of 170 babies between 1 – 6 days of age (Kei et al., 2003:23). Using 1000Hz probe tone tympanometry, a peaked tympanogram incidence of 93,4% was reported in 228 ears. Kei et al (2003:24) also reported double peaked tympanograms in 1,2% of the peaked tympanogram ears which corresponded with OAE pass results indicative of normal middle-ear transmission. These results also correspond to previous reports suggesting that double peak tympanograms are not uncommon and are suggestive of normal middle-ear transmission for 1000Hz probe tone measurements (Thornton et al., 1993:320). The 1000Hz tympanometric peak results for neonates in the current study and those reported by Kei et al. (2003:24) are also similar to a 678Hz probe tone study conducted on a group of 200 special care baby unit babies indicating a 91% incidence of discernable peak tympanograms (Sutton et al., 1996:11). These studies only considered neonatal ears and there is a dearth of comparative reports in the literature for 1000Hz tympanometry in infant ears

older than 4 weeks. The fact that a significantly lower incidence (86%) of peaked tympanograms were measured for infants between 5-52 weeks of age may be suggestive of a higher incidence of MEE and will be investigated further in section 6.5.

Table 6.6 summarises results for subjects in which 1000Hz probe tone tympanograms were recorded for both the right and left ears of subjects.

TABLE 6.6 Results of 1000Hz Y-admittance tympanograms recorded for both ears in each subject (n=472)

CATEGORY	NUMBER OF SUBJECTS *	PERCENTAGE OF SAMPLE
Peak both ears	387	82 %
No-peak both ears	32	7 %
No-peak left ear	20	4 %
No-peak right ear	33	7 %

***Subjects with Y-admittance results for both ears**

Bilateral tympanograms were obtained for 93% of the sample (472/510). At least one ear's tympanogram had no peak in 18% of subjects whilst at least one ear had a peak in 93% of subjects as indicated in Table 6.6. Only 7% of the sample had flat tympanograms bilaterally. No tympanometric measurements were made in 4% (n=21) of subjects whilst only one ear could be evaluated in 3% (n=17) of the subjects (13 peak and 4 no-peak results).

- **Acoustic reflexes using a 1000Hz probe tone**

Acoustic reflexes using a 1000Hz probe tone were evaluated at 1000Hz in 915 ears. Thresholds were obtained in 786 (86%) of the ears evaluated for acoustic reflex thresholds. Figure 6.13 indicates the incidence of present and absent acoustic reflex thresholds obtained in this study.

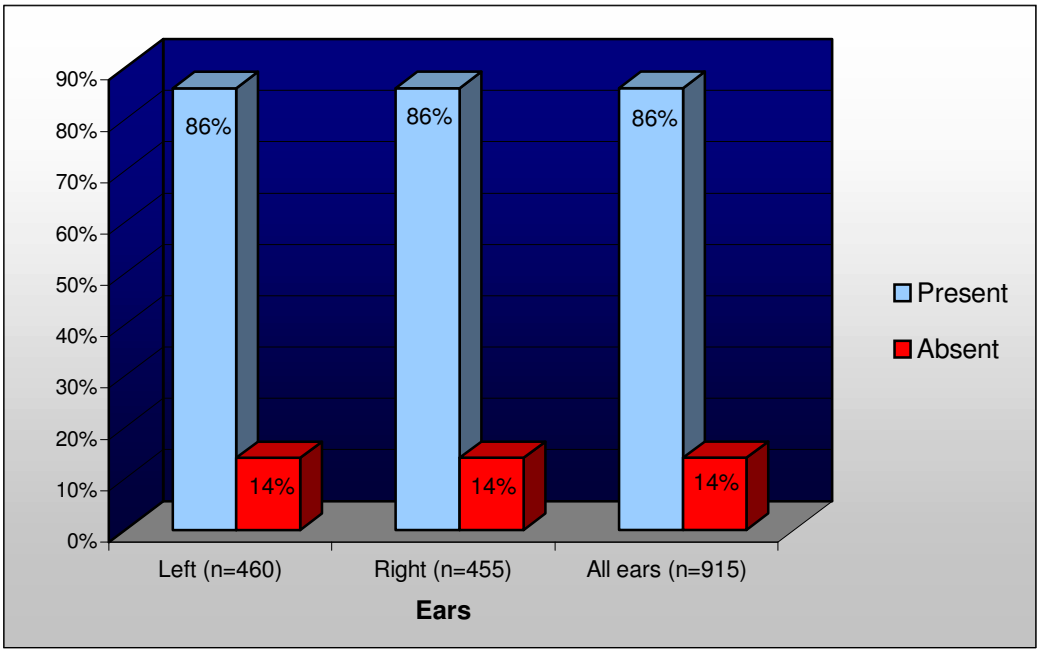


FIGURE 6.13 1000Hz acoustic reflex thresholds using a 1000Hz probe tone (n=915)

Of the ears evaluated in the sample (n=915) no significant difference was observed between left and right ears. An analysis of the acoustic reflex data for neonatal ears (0-4 weeks of age) compared to the rest of the sample ears (5-52 weeks of age) reveals a small difference in the incidence of acoustic reflexes. Neonatal ears indicate present acoustic reflexes in 88% of cases compared to 85% of ears for the rest of the sample. This suggests a similar trend to tympanometry, indicating a lower incidence of peaked tympanograms for older infants (5-52 weeks of age) suggestive of a higher incidence of MEE compared to neonates.

Table 6.7 indicates the mean, standard deviation, range and percentile values for the thresholds obtained for the sample.

TABLE 6.7 Mean, standard deviation, range and 5th and 95th percentile of acoustic reflex thresholds

# AR thresholds	Mean threshold (dB)	Standard deviation (dB)	Min (dB)	Max (dB)	5th percentile (dB)	95th percentile (dB)
785	93	± 9	60	110	80	105

Acoustic reflex thresholds were obtained for 785 ears and did not demonstrate any significant difference between left and right, male and female, and neonatal and infant ears. The percentiles calculated for this study indicate that 90% of all acoustic reflex thresholds in the current study were obtained between 80 – 105 dB with a mean score of 93 ± 9 dB.

Table 6.8 summarises results for subjects in which acoustic reflexes using a 1000Hz probe tone were recorded at 1000Hz both the right and left ears of subjects.

TABLE 6.8 Presence of 1000Hz probe tone acoustic reflexes recorded at 1000Hz for both ears in each subject (n=440)

CATEGORY	NUMBER OF SUBJECTS *	PERCENTAGE OF SAMPLE
Present both ears	348	79 %
Absent both ears	27	6 %
Absent left ear	31	7 %
Absent right ear	34	8 %

***Subjects with acoustic reflex results for both ears**

Bilateral reflex measurements were obtained from 68% of subjects in this sample due primarily to the fact that acoustic reflex measurement proceeded after

tympanometry which caused some infants to be restless and irritable during reflex testing. Of those subjects for whom bilateral reflex measurements were performed at least one ear had an absent reflex in 21% of subjects whilst at least one ear had a present reflex in 94% of subjects as indicated in Table 6.8. No reflex measurements were attempted in 10% of ears whilst only one ear could be assessed in 7% of subjects.

The high percentage of present reflexes recorded (86%) in the current study compared to the poor reliability of recording present reflexes using low frequency probe tones in infants can be attributed to the following facts: 1) A 1000Hz probe tone was used, 2) an ipsilateral stimulus was used, and 3) a mid-frequency (1000Hz) stimulus was used to activate the reflex (Weatherby & Bennett, 1980:107; Rhodes et al., 1999:805; Purdy & Williams, 2000:14). Although using a much smaller sample (n=35) Weatherby and Bennett (1980:106) reported present acoustic reflexes for all subjects. These results may suggest that using a broadband stimulus elicits more acoustic reflexes. Another study by Sutton et al. (1996:12) using a high frequency probe tone (678Hz) to elicit reflexes in high-risk special care neonates, reported the presence of acoustic reflexes in only 42% of ears (71/168). This reduced incidence compared to the high incidence rate in the current study can be attributed to the risk status and young age of the neonates as well as to the use of a 678Hz probe tone instead of a 1000Hz probe tone. The incidence of reflexes for infants in the current study is similar to an 89% incidence of 660Hz probe tone reflexes for neonates reported by McCandless and Allred (1978:63).

The mean reflex thresholds in the current study correlated well with adult norms even though mean reflex thresholds for neonates using a 1000Hz probe tone and a broadband stimuli have been reported to be 14dB lower than in adults (Weatherby & Bennett, 1980:106). The fact that mean threshold in the current study did not appear lower than for adults and may be attributed to the fact that the age of the sample exceeded the neonatal period up until one year of age.

The immittance results in the current study demonstrated that a high incidence of tympanometric and acoustic reflex results (86-87%) suggestive of normal middle-ear transmission in infants could be obtained using a 1000Hz probe tone.

6.4.3. OAE and AABR hearing screening measurements

The following presentation and discussion of results are for hearing screening measures including OAE and AABR. These measures were utilised according to the protocols specified in Chapter 5. The results of each measure will be discussed separately in the following paragraphs.

- **OAE screening results**

The initial OAE screening procedure was performed on 964 ears, which constitute 95% of the ears in the sample of subjects. Some subjects could not be tested due to irritability and restlessness. No significant differences were obtained between the screening results for the left and right ears and therefore all ears were considered as a single group. The OAE pass and refer percentages for this sample of ears is presented in Figure 6.14.

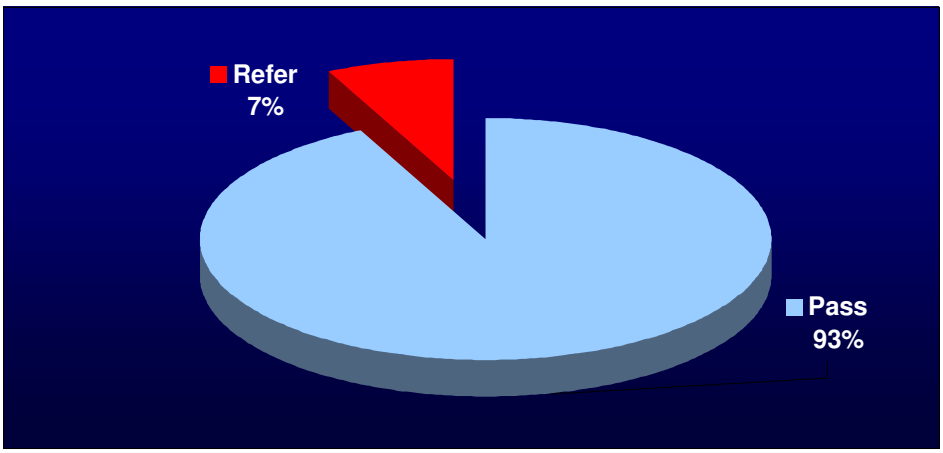


FIGURE 6.14 Percentage of ears with pass and refer results (n=964)

The 93% OAE pass rate represents infants between 1 day and 1 year of age. An analysis of neonatal ears only (n=278) reveals a 95% pass rate compared to older (5-52 weeks of age) infant ears (n=654) presenting with a 92% pass rate. This lower pass rate for older infants is similar to results reported for tympanometry and acoustic reflexes and may be indicative of a higher incidence of MEE in the older infant population. The 7% general referral rate and 5% neonatal referral rate fall well within the range of referral rates for sample ears reported for DPOAE by the NIDCD multi-centre investigation, which varied between 3 and 10% depending on the stimuli specifications and group composition (Norton et al., 2000c:532).

Although the screening protocol specified a bilateral OAE screening for all subjects no measurements could be performed in 4% (n=21) of subjects whilst only one ear could be screened with OAE in 3% (n=14) of the sample. Table 6.9 summarises results for subjects in which an OAE screening result was recorded for both the right and left ear of a subject.

TABLE 6.9 OAE screening results for subjects in which a result was reported for both the left and right ear (n=475)

CATEGORY	NUMBER OF SUBJECTS *	PERCENTAGE OF SAMPLE
Pass both ears	421	89 %
Refer both ears	15	3 %
Refer left ear	20	4 %
Refer right ear	19	4 %

***Subjects with OAE screening results for both ears**

The subjects for whom a bilateral screen could be performed (93% of the sample) presented with at least a unilateral OAE pass result in 97% of subjects as indicated in Table 6.9. The initial OAE bilateral pass result of 89% in the current study is similar to previously reported results. According to Watkin (2003:169) bilateral initial TEOAE pass results are on average between 89 -

92%. This is similar to the range of initial bilateral DPOAE pass results of 82 – 91% reported for different DPOAE screening protocols by Norton et al. (2000c:532). Generally the OAE pass rates for the current study were therefore within the range of reported values for an initial screening procedure (Norton et al., 2000c:532; Vohr et al., 1998:355; Watkin, 2003:169).

- **AABR screening results**

According to the screening protocols specified in Chapter 5 a total of 90 ears (69 referred ears and 24 NICU exposed ears of which 3 referred) should have received an AABR screening. The AABR screening, however, was successfully performed for only 3% (n=17) of the entire sample of subjects which is a mere 27% (17/63) of the total number of subjects requiring an AABR screen according to the screening protocols specified in Chapter 5. The results of the AABR screening procedure are indicated in Table 6.10.

TABLE 6.10 AABR screening results for evaluated subjects (n=17)

CATEGORY	NUMBER OF SUBJECTS
Pass both ears	4
Refer both ears	1
One ear pass – other ear not tested	3
One ear refer – other ear not tested	9

Table 6.10 shows that in 12 cases only one ear was evaluated whilst both ears were evaluated in 5 subjects. This means that 76% (22/90) of ears requiring an AABR screening, according to the protocols in Chapter 5, did not receive it. Reasons for this low percentage of successful AABR evaluations on infants attending the MCH clinics can be attributed to the following factors. Firstly, infants requiring AABR screenings varied in age from birth to 52 weeks with a mean age of 18 weeks ± 14 weeks standard deviation. Since most of the subjects were older than 1 month it was difficult to prepare and test an infant without the infant becoming irritable and restless which made further screening

impossible. Secondly, the AABR screening was performed after OAE and immittance measures were already conducted which contributed to infants already being restless and irritable. Lastly, those infants on whom AABR evaluations could not successfully be performed were referred to return within a week or two to complete the screening. Unfortunately very few mothers returned with their infants. These facts demonstrate the inefficiency of utilising an AABR technique to screen infant hearing at MCH clinics.

6.4.4. Comparison of test procedure results

The high frequency tympanometry and acoustic reflex measurements, and OAE screening results are compared in the following paragraphs. The AABR results are not included in this comparison since it was only performed on 17 subjects. Figure 6.15 compares results of the three test procedures indicative of normal functioning, which are a pass on the OAE, a peak for the tympanogram and a present acoustic reflex threshold. These are compared for all ears in sample and for all subjects for whom both ears were evaluated.

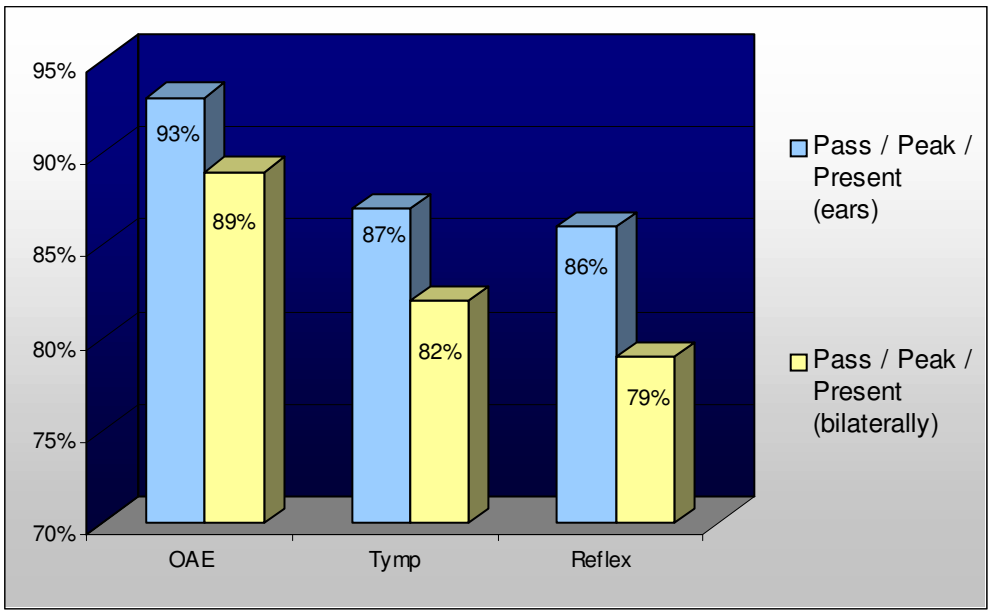


FIGURE 6.15 Comparison of OAE pass, tympanogram peak, and acoustic reflex present results

As evident from Figure 6.15 OAE indicated the highest percentage of positive results suggestive of normal or near normal middle-ear functioning and cochlear integrity (Thornton et al., 1993:323; Taylor and Brooks, 2000:53). This was followed by 1000Hz probe tone tympanometry with the second highest percentage of positive results suggestive of normal middle-ear functioning. Acoustic reflexes presented with only slightly less (1%) positive results indicative of normal middle-ear functioning. It is clear that the positive results (pass, peak, present) for these procedures decrease once a bilateral positive criterion is used. Results decrease by 4, 5 and 7% for OAE, tympanometry and acoustic reflexes, respectively. This points toward better bilateral results when using OAE than when using the other two procedures. The results, as indicated by Figure 6.16, may suggest a higher specificity for normal auditory functioning using OAE compared to a higher sensitivity for auditory dysfunction using acoustic reflexes. This relationship will be investigated further in section 6.5.

Figure 6.16 compares the positive results (pass, peak, present) for OAE, tympanometry and acoustic reflexes for neonatal ears (0-4 weeks of age) and infant ears (5-52 weeks of age).

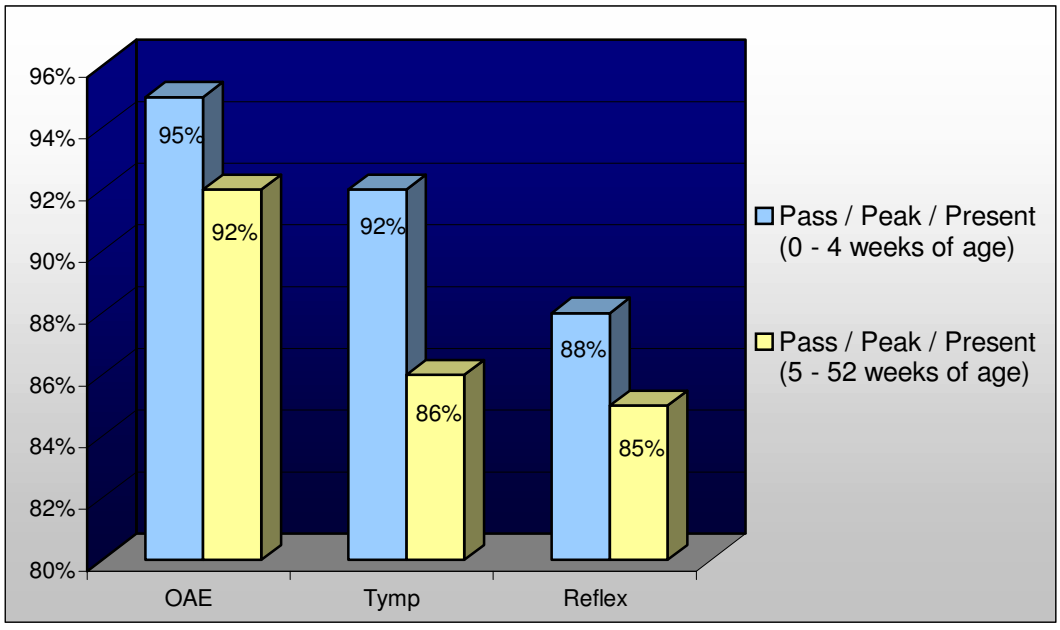


FIGURE 6.16 Comparison of OAE pass, tympanogram peak, and acoustic reflex present results for neonatal and infant ears

Figure 6.16 demonstrates a similar pattern of positive (pass/peak/present) result incidence for the two age groups with OAE presenting with the highest incidence of positive results followed by tympanometry and acoustic reflexes. This pattern is similar to that of the entire sample of ears and for bilateral positive (pass, peak, present) results for subjects as illustrated in Figure 6.15. The difference between the neonatal ears and older infant ears in this study is the decrease in positive result (pass, peak, present) incidence for older infants (5-52 weeks of age). The most significant drop in incidence is for discernable tympanometric peaks where a 6% drop is recorded for infant ears compared to neonatal ears. The decrease of OAE pass, peaked tympanogram, and present reflex results for older infants may be suggestive of an increased incidence of MEE, and even late-onset or progressive types of sensori-neural hearing loss, for these ears compared to neonatal ears.

Generally, the results for these three test procedures evaluating the structures of the middle and inner ear are within 7% of each other indicating a close relationship between their measuring specificity. The strong relationship between these three test procedures has been reported previously and will be discussed and compared in section 6.5 (Purdy & Williams, 2000:12; Sutton et al., 1996:11; Thornton et al., 1993:321).

6.4.5. Summary of results and discussion: sub-aim #3

A description of the HRR and test results obtained in this study reveals the following conclusions, summarised in Table 6.11, regarding each procedure for the sample of subjects investigated.

TABLE 6.11 Summary of results and discussion for sub-aim #3

High-Risk Register

- A significantly increased incidence (21%) of risk indicators for hearing loss were documented for the study population compared to reports from developed countries (9-13%) (Kennedy et al., 1998:1959; Mahoney & Eichwald, 1987:161; Vohr et al., 2000b:380).
- The higher incidence of risks was primarily due to an increase in reported family history of congenital hearing loss reported by caregivers.
- Reasons for the higher incidence of family history for congenital hearing loss as a risk indicator was attributed to increased depravity among this population, as evidenced in sub-aim #2, which leads to a higher prevalence of hearing loss (Kubba et al., 2004:125) and to the difficulty in accurately ascertaining family history in subjects (Kountakis et al., 2002:136; Northern & Downs, 2002:277).
- The incidence of risk factors may also increase significantly if mothers' HIV status is included as a risk indicator that can be accurately documented.
- In general, the small percentage of unavailable information and a risk incidence comparable to previous reports, except for family history, suggest that a HRR could be useful in identifying infants at risk for hearing loss at MCH clinics.

High frequency immittance

- The immittance results in the current study demonstrated that a high incidence of tympanometric and acoustic reflex results suggestive of normal middle-ear transmission in infants (86-87%) could be obtained using a 1000Hz probe tone.
- Double peaked tympanograms were obtained in 4,5% of the sample ears and comprised 5% of the group with discernable peaks. 64% were male ears.
- The high percentage of acoustic reflexes obtained in the current study compared to previous studies in infants was attributed to the fact that a 1000Hz probe tone and an ipsilateral mid-frequency (1000Hz) stimulus was used to activate reflexes (Weatherby & Bennett, 1980:107; Rhodes et al., 1999:805; Purdy & Williams, 2000:14).
- Immittance result indicated a higher incidence of peaked tympanograms and present reflexes for neonatal ears than for infant ears (5-52 weeks of age) and may suggest a higher incidence of MEE in older infants.

OAE and AABR hearing screening

- OAE pass rates were 93% for all sample ears whilst neonatal ears indicated a higher pass rate of 95% compared to 92% for infant ears (5-52 weeks of age). These results are in agreement with the pattern for peaked tympanogram and present reflex results.
- AABR evaluations could only be performed on 26% of the ears requiring it. This inefficiency was due to several reasons including infant age, test order effect, and few returning mothers on whom no successful AABR could be performed initially.

Comparison of test procedure results

- All test procedures indicated higher incidences of positive results (pass, peak, present) for neonatal ears than for infant ears (5-52 weeks of age), which may be indicative of higher MEE, and even late-onset, or progressive sensori-neural hearing loss, incidence for older infants.
- Generally, the tympanometry, acoustic reflex and OAE results for this study were within 7% of each other indicating a close relationship between their measuring specificity for middle-ear transmission and inner ear integrity which has also been reported previously (Purdy & Williams, 2000:12; Sutton et al., 1996:11; Thornton et al., 1993:321).

The HRR and test results summarised in Table 6.11 for sub-aim #3 describes the range of results and points toward their possible usage as procedures for hearing screening in this population of subjects. The results and discussion for sub-aim #4 will build on these results to investigate the issue of screening protocol performance and efficiency in this population.

6.5. RESULTS AND DISCUSSION OF SUB-AIM #4: PROTOCOL PERFORMANCE AND EFFICIENCY

The fourth sub-aim of the study aimed to describe the performance and efficiency of the screening protocol implemented for infants and caregivers attending the two MCH clinics in the Hammanskraal community. The descriptions are part of the dominant quantitative research method and were accrued by conducting a structured interview with caregivers; consulting patient files for identifying risk indicators; performing various tests of auditory integrity; and documenting subjects' follow-up rate. This data is analysed and compared between the various test procedures and between initial and follow-up evaluations. The results and discussion will be presented according to an evaluation of screening procedure performance, compilation of normative data for high frequency immittance testing as a result of test procedure comparisons, and protocol efficiency in terms of coverage, referral and follow-up statistics for the current study.

6.5.1. Screening procedure performance

The relationship between the OAE, tympanometry and acoustic reflex results obtained in the current study is presented and discussed in the following section. Positive results indicative of normal middle-ear transmission as measured by each procedure was specified as a pass for an OAE, a peaked tympanogram, and a present reflex. Negative results indicative of possible abnormality in middle-ear transmission, indicative of middle-ear effusion (MEE), was specified as a refer for an OAE, a flat tympanogram, and an absent reflex. The OAE result

was considered to be the gold standard of middle-ear functioning in this sample because no other standardised non-invasive procedure has been reported as a gold standard for normal middle-ear functioning in neonates and young infants. Although reports have indicated that in certain cases OAE pass results may be obtained in a small number of ears with MEE, a normal middle-ear system is presupposed in the vast majority of OAE pass results (Van Cauwenberge et al., 1996:139; Sutton et al., 1996:15; Taylor & Brooks, 2000:52). No standardised normative data for high frequency tympanometry in young infants is currently available to evaluate middle-ear functioning and therefore results are compared to OAE (Margolis et al., 2003:384; Kei et al., 2003:22; Taylor & Brooks, 2000:53). The positive and negative result correspondence between OAE, tympanometry and acoustic reflex results are presented in Figure 6.17.

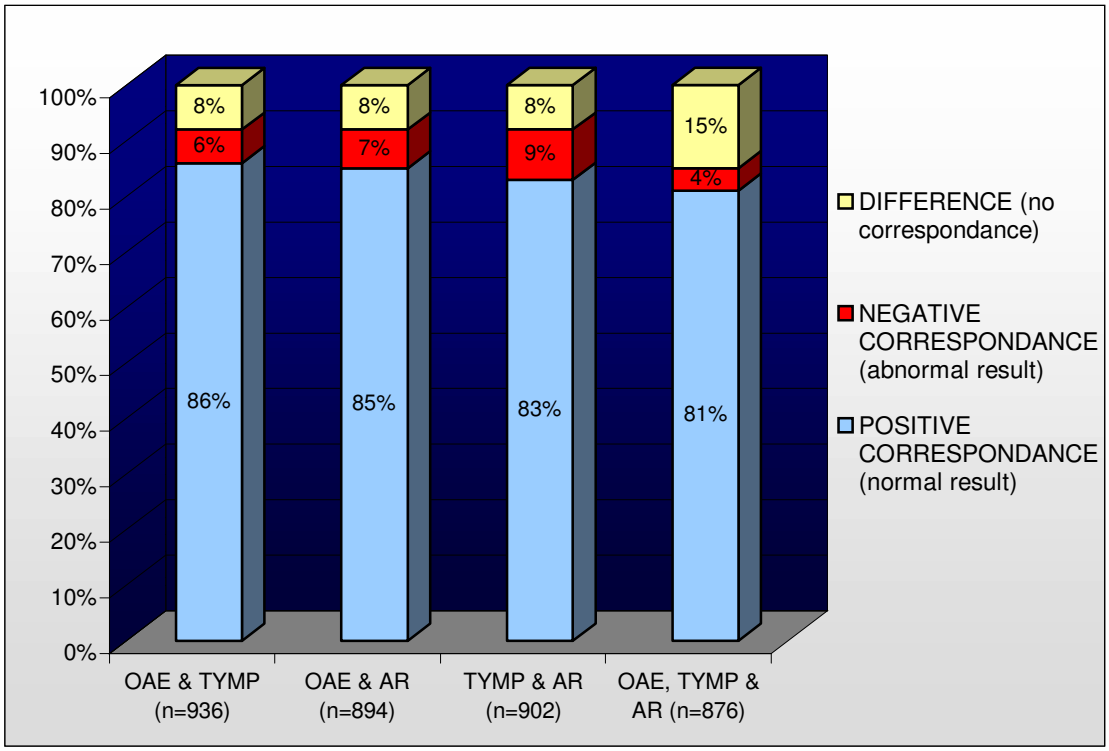


FIGURE 6.17 Positive and negative correlations between OAE, tympanometry (TYMP) and acoustic reflex (AR) results

The percentages presented in Figure 6.17 indicate that results for OAE and tympanogram, OAE and acoustic reflex, and tympanogram and acoustic reflex corresponded in 92% of cases in all instances. Results for all three procedures corresponded in 85% of cases with both the positive and negative correspondences slightly less than for correspondence between only two measures. This can be attributed to the fact that three test measures are required to indicate the same result compared to only two measures in all other instances. It does however indicate a high degree of correspondence between all three-test procedure results. A Chi-square analysis verifies this correspondence by indicating a strong and highly significant association between all combinations of OAE, tympanometry and acoustic reflex result comparisons ($p < 0,0001$). Contingency coefficients confirmed this strong relationship between all test procedure results.

Results reported by Sutton et al. (1996:12) also indicated strong associations between these three variables using TEOAE and a 678Hz probe tone for tympanometry and reflexes for a smaller group of infants (n=84) from special care baby units. In another study by Taylor and Brooks (2000:53) the relationship between TEOAE and 226Hz probe tone tympanometry was investigated in young children, which indicated similarly strong associations between tympanometry and OAE results for the group of infants in the current study.

The strong association between OAE, tympanometry, and acoustic reflex results can be illustrated by specifying predictive values for obtaining a positive (normal) or negative (abnormal) result for one test procedure when compared to the test result of another. These probability percentage values are presented in Table 6.12.

TABLE 6.12 Positive and negative predictive values for OAE, tympanogram, and acoustic reflex results for all ages

PREDICTIVE MEASURE	TYMPANOGRAM		ACOUSTIC REFLEX	
	Peak (n=823)	No-peak (n=113)	Present (n=770)	Absent (n=124)
OAE pass	93%	7%	92%	8%
OAE refer	21%	79%	11%	89%
PREDICTIVE MEASURE	**OTO-ACOUSTIC EMISSIONS**		**ACOUSTIC REFLEX**	
	Pass (n=869)	Refer (n=67)	Present (n=775)	Absent (n=127)
Tymp peak	98%	2%	94%	6%
Tymp no-peak	53%	47%	27%	73%
PREDICTIVE MEASURE	**OTO-ACOUSTIC EMISSIONS**		**TYMPANOGRAM**	
	Pass (n=829)	Refer (n=65)	Peak (n=790)	No-peak (n=112)
AR present	99%	1%	96%	4%
AR absent	53%	47%	35%	65%

The results in Table 6.12 indicate the probability of obtaining a positive or negative result for each test procedure based on the results of the predictive measure. Using the result of the predictive measure, a sensitivity and specificity count can be obtained for the other two procedures (Taylor & Brooks, 2000:52). Measured against the OAE result the sensitivity and specificity of tympanometry compared with OAE screening was 79% and 93%, respectively. Sensitivity and specificity of acoustic reflex compared with OAE screening were 89% and 92%, respectively. Since OAE was considered as the gold standard for establishing normal middle-ear transmission in this study these comparisons can be considered reliable (Kei et al., 2003:22; Taylor & Brooks, 2000:53). Immittance results also proved reliable measures of middle-ear transmission especially for establishing normal functioning as measured by OAE. This is evident in the fact that both peaked tympanogram (98%) and present acoustic reflex (99%) results predicted an OAE pass result with a probability of approximately 100%.

Using tympanometry and acoustic reflexes as predictive measures can be useful but since OAE was considered the gold standard procedure and no standardised norms for high frequency tympanometry is yet available these procedures cannot truly serve as a standard normal middle-ear functioning against which the OAE can be compared. The results do indicate that if a peaked tympanogram is obtained an OAE pass is predicted in 98% of cases and if a flat tympanogram is obtained no emissions were obtained in 47% of cases. For an acoustic reflex being present an OAE pass is predicted in 99% of cases with an absent reflex predictive of an OAE fail in 47% of cases. The sensitivity and specificity of acoustic reflexes compared with tympanometry were 73% and 94%, respectively. This is similar to the sensitivity and specificity of tympanometry compared with acoustic reflex screening which was 65% and 96%, respectively.

An analysis of the predictive values for OAE, tympanogram, and acoustic reflex results in neonates and older infants are presented in Table 6.13.

According to the comparison of abnormal and normal results with the various test procedures in Table 6.13 a significant difference emerges between neonatal (0-4 weeks of age) and infant (5-52 weeks of age) ears. Measured against the OAE result the sensitivity and specificity of tympanometry compared with OAE screening was 57% and 95%, respectively, for neonatal ears compared to 85% and 92% for infant ears. Similar differences were obtained for acoustic reflex results. This suggests significantly higher immittance sensitivity for infant ears compared to neonatal ears. It must be mentioned however, that the smaller number of neonatal OAE referred ears and a higher OAE failure rate (8% compared to 5%) for older infants, may account for this difference.

TABLE 6.13 Positive and negative predictive values for OAE, tympanogram, and acoustic reflex results for infants 0-4 and 5-52 weeks of age

PREDICTIVE MEASURE	TYMPS 0-4 WEEKS OF AGE		TYMPS 5-52 WEEKS OF AGE		AR 0-4 WEEKS OF AGE		AR 5-52 WEEKS OF AGE	
	Peak (n=256)	No-peak (n=22)	Peak (n=563)	No-peak (n=91)	Present (n=236)	Absent (n=33)	Present (n=530)	Absent (n=91)
OAE pass	95%	5%	92%	8%	90%	10%	93%	7%
OAE refer	43%	57%	15%	85%	43%	57%	2%	98%
PREDICTIVE MEASURE	**OAE 0-4 WEEKS OF AGE**		**OAE 5-52 WEEKS OF AGE**		**AR 0-4 WEEKS OF AGE**		**AR 5-52 WEEKS OF AGE**	
	Pass (n=264)	Refer (n=14)	Pass (n=601)	Refer (n=53)	Present (n=234)	Absent (n=33)	Present (n=537)	Absent (n=94)
Tymp peak	98%	2%	99%	1%	93%	7%	95%	5%
Tymp no-peak	64%	36%	51%	49%	32%	68%	26%	74%
PREDICTIVE MEASURE	**OAE 0-4 WEEKS OF AGE**		**OAE 5-52 WEEKS OF AGE**		**TYMPS 0-4 WEEKS OF AGE**		**TYMPS 5-52 WEEKS OF AGE**	
	Pass (n=264)	Refer (n=14)	Pass (n=570)	Refer (n=51)	Peak (n=245)	No-peak (n=22)	Peak (n=541)	No-peak (n=90)
AR present	98%	3%	100%	0%	97%	3%	96%	4%
AR absent	76%	24%	45%	55%	55%	45%	29%	71%

The results suggest that acoustic reflex results for infant ears compared to the gold standard of the OAE result showed the highest sensitivity of 98% compared to a significantly reduced sensitivity of 57% for neonatal ears. The specificity of OAE results compared to acoustic reflex outcome was 100% for infant ears compared to 98% for neonatal ears. These figures indicate that in general OAE results present with the highest specificity for both groups whilst acoustic reflexes present with the highest sensitivity for auditory dysfunction in both groups. Although the number of neonatal ears is significantly smaller than the infant ears, which could affect the reliability of comparisons, results indicate increased tympanometry and decreased reflex specificity for neonatal ears compared with infant ears. Sensitivity of tympanometry and acoustic reflexes increases

significantly for infant ears compared to neonatal ears. These results demonstrate better correspondence of test results for infants older than 4 weeks of age. This suggests that 1000Hz probe tone immittance is more reliable in correctly identifying MEE in infants over 4 weeks of age compared to neonates.

A combination of a tympanometry and acoustic reflex results predictive of OAE outcome for the whole sample is presented in Table 6.14.

TABLE 6.14 Predictive values of combined tympanometry and acoustic reflex results for OAE outcome

TYMP / AR	OTO-ACOUSTIC EMISSIONS		
	Pass (n=814)	Refer (n=62)	% of sample (n=876)
Peak / Present (n=720)	98%	2%	82%
Peak / Absent (n=38)	79%	21%	4%
No-peak / Present (n=38)	84%	16%	4%
No-peak / Absent (n=80)	55%	45%	9%

The results in Table 6.14 indicate that if a peaked tympanogram and present reflex are obtained, an OAE pass is predicted in 98% of cases. Also, if no tympanometric peak and an absent reflex are obtained, an OAE refer result can be expected in 45% of cases. These results, using a combined tympanogram and acoustic reflex threshold to predict OAE outcome, are very similar to results when only a tympanogram or acoustic reflex was used.

An important group of the entire sample to consider are those ears (n=8) that had a peaked tympanogram, absent reflexes and an OAE refer result. This combination of results suggests a high probability of sensori-neural hearing loss since both the OAE and acoustic reflex results, reliant on cochlear integrity, were referred in contrast to normal tympanometry, which is only reliant on normal

middle-ear transmission (Margolis et al., 2003:389; Purdy & Williams, 2000:20). Only 0,9% of the entire sample of ears (n=876) for whom all procedures were conducted presented with this set of results. If those infants for whom present reflexes were measured and peaked tympanograms obtained and OAE refer results were recorded (n=12) are included the sample percentage increases to 2,3%.

Another important group to consider are those ears (n=36 ears) with no tympanogram peaks, absent reflexes, and referred OAEs. All these results together provide a strong indication of a middle-ear transmission problem such as MEE and these numbers of cases suggest an incidence of 4% in the ears of this sample (Purdy & Williams, 2000:20). The small group of ears (n=6) with flat tympanograms, present reflexes, and absent OAE may also be indicative of a milder condition of MEE which obliterates the OAE and gives a flat tympanogram but is not sufficient to obliterate the reflex at higher intensities (Gelfand, 2002:213). If these results are considered together with the group with flat tympanograms, absent reflexes and OAE refer results, an incidence of 5% for MEE (42/876) in ears tested in this population is evident. Although the published estimates of MEE in healthy newborns are varied and consensus is currently lacking there is general agreement that it is more common in NICU infants (Hall et al., 2004:423; Balkany et al., 1978:398). Sutton et al. (1996:15) confirmed this by reporting a higher incidence of 20% (29% of infants) for abnormal high frequency tympanometric results indicative of MEE for babies in special care units, which is similar to previous reports for NICU neonates of 30% (Berman et al., 1978:198).

The predictive values of the OAE result for combined tympanogram and acoustic reflex results are presented in Table 6.15.

TABLE 6.15 Predictive values of OAE results for combined tympanogram and acoustic reflex results

PREDICTIVE MEASURE	TYMPANOGRAM / ACOUSTIC REFLEX			
	Peak / Present	Peak / Absent	No-peak / Present	No-Peak / Absent
OAE pass (n=814)	87%	4%	4%	5%
OAE refer (n=62)	19%	13%	10%	58%

Results presented in Table 6.15 indicate the probability of obtaining different combinations of tympanogram and acoustic reflex results compared to the OAE result. As OAE is considered the gold standard for determining normal middle-ear transmission properties the sensitivity and specificity of combined tympanometry and acoustic reflex usage can be determined by comparing it with OAE results. The sensitivity and specificity of the combined use of high frequency tympanometry and acoustic reflexes were 58% and 87%, respectively. This means that the combined method is able to identify normal middle-ear functioning in 87% of cases and able to identify abnormal middle-ear functioning in 58% of cases as compared to OAE results. Although the sensitivity and specificity of a combined tympanometry and reflex criteria is reduced compared to sensitivity and specificity of each single procedure, a higher degree of reliability is ensured. Reports suggest that the use of both high frequency tympanometry and acoustic reflexes increases the reliability of determining middle-ear functioning in young infants (Purdy & Williams, 2000:18).

If only neonatal ears (0-4 weeks of age) are considered (n=6) the sensitivity percentage of the combined procedure drops from 58% to 43%. For infants between 5-52 weeks of age (n=62) the probability of obtaining abnormal tympanometric and reflex results rises to 65% whilst the probability of obtaining a peaked tympanogram and present reflex is 0% when an OAE refer result is obtained. This data suggests, although the data for neonatal ears is limited, that a closer relationship exist between OAE refer, and flat tympanogram and absent

reflex results for infants older than 4 weeks compared to neonatal ears. This may be due to a higher OAE refer rate in the older infants which may indicate a higher incidence of MEE in these ears, which abolishes OAE, tympanogram peaks, and acoustic reflex measurements (Thornton et al., 1993:320).

Results in the current study suggest that a protocol using high frequency tympanometry and acoustic reflexes in conjunction with OAE may be useful in classifying ears into risk categories for sensori-neural hearing loss and MEE. If a peaked tympanogram is obtained an acoustic reflex is present, normal middle-ear functioning is strongly indicated. If the tympanometry indicates a flat tympanogram and an absent acoustic reflex threshold it will be strongly indicative of a middle-ear conduction problem such as MEE. A mixed result indicating an OAE refer, tympanogram peak and absent reflex will be a high-risk combination for sensori-neural hearing loss. More difficult to interpret is an absent OAE and a flat tympanogram with a present reflex. This may be due to a mild conductive MEE which could lead to an OAE refer and a flat tympanogram but presents with a present reflex at maximum intensities.

Although recent studies have reported preliminary normative data for 1000Hz tympanometry compared to OAE results, the sample sizes were limited, age distribution was confined to neonates, and acoustic reflexes were not included (Kei et al., 2003:23-25; Margolis et al., 2003:385-388). Data from the current study can therefore be used to establish a normative data basis for 1000Hz tympanometry and acoustic reflexes on a large sample of infants varying in age from one day to one year. The following section will discuss this normative data.

6.5.2. High frequency immittance norms

Fowler and Shanks (2002:202) recommend that further studies be performed to establish guidelines for use in distinguishing normal from pathological ears in neonates and infants. The large sample of infant ears on which OAE and high frequency tympanometry and acoustic reflexes were performed in the current study allows for the compilation of comprehensive normative data for 1000Hz

probe tone immittance measures. This type of normative data is becoming increasingly necessary with the implementation of widespread UNHS programmes and a dearth of reliable tests of middle-ear functioning to distinguish sensori-neural hearing loss from middle-ear pathology for infants younger than 7 months of age (Kei et al., 2003:21; Purdy & Williams, 2000:9; Margolis et al., 2003:384; Northern & Downs, 2002:226).

Since OAE was considered the gold standard for normal middle-ear transmission in this study, the tympanometric data was divided into two groups based on the OAE screen result (Taylor & Brooks, 2000:53; Kei et al., 2003:22). The majority (93%) of tympanograms recorded for ears with an OAE pass result had a discernable tympanogram peak. For the other 7% of tympanograms no discernable peak could be identified but the highest point on the tympanogram was marked to obtain a maximum admittance value (mmho) with a corresponding pressure value (daPa). The distribution of these admittance and tympanic peak pressure (TPP) values for the recorded tympanograms in these two groups are presented in Figures 6.18 and 6.19.

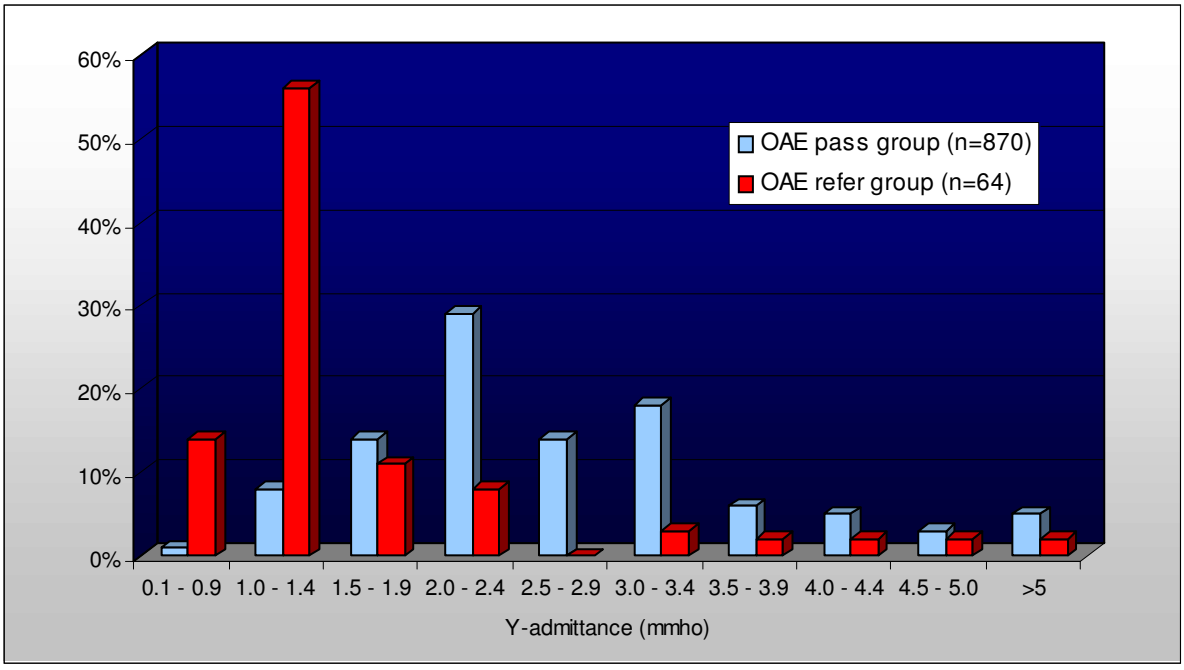


FIGURE 6.18 Distribution of maximum admittance values for ears with OAE pass and refer results (n=934)

The majority (77%) of admittance values for the OAE pass group were 2 mmho and larger compared to the majority (81%) of admittance values for the OAE refer group being less than 2 mmho. Although there is an overlap of results a clear trend toward lower Y-peak admittance values for the OAE refer group is evident from Figure 6.18. Previous studies on 1000Hz tympanometry only reported normal ranges of admittance results for subjects with OAE pass results (Margolis et al., 2003:384; Kei et al., 2003:23). The reported results do however confirm that normal middle-ear functioning is primarily related to higher admittance values in contrast to lower admittance values as also evidenced in this study (Margolis et al., 2003:389; Kei et al., 2003:25).

Figure 6.19 provides the distribution of tympanic peak pressure values for ears with OAE pass and refer results.

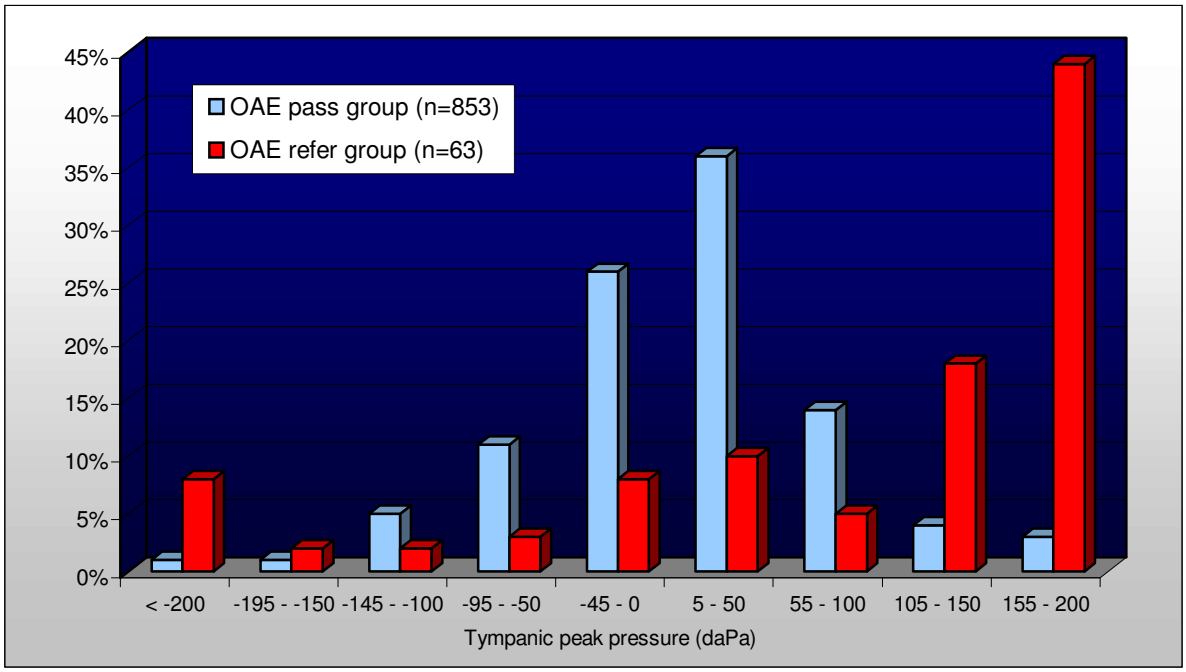


FIGURE 6.19 Distribution of tympanic peak pressure values for ears with OAE pass and refer results (n=916)

A clear pattern of findings is also visible for the tympanic peak pressure values presented in Figure 6.19. The majority (62%) of tympanic peak pressure values

for the OAE refer group was larger than 105 daPa compared to the majority (62%) of tympanic peak pressure values for the OAE pass group being between –45 and 50 daPa. Although there is a similar overlap pattern as for the admittance values in Figure 6.18 a clear trend indicating more positive pressure values for OAE refer, compared to OAE pass, results is visible. An interesting finding requiring investigation is an 8% incidence of tympanic peak pressure values less than –200 daPa for the OAE refer group compared to a 1% incidence among the OAE pass group. This indicates that not only are more positive peak pressure values exceeding 105daPa prone to OAE refer results but so are negative peak pressure results of –200 and smaller compared to pressure values for the OAE pass group. These results are in agreement with Thornton et al. (1993:321) who reported high positive middle-ear pressures (>150 daPa) to correspond with OAE failures.

Although the importance of peak pressure values for determining pathology in infant ears is not clearly understood and further studies have been recommended (Margolis et al., 2003:389) results from the current study indicates a statistically significant effect of middle-ear pressure values on OAE results. This association is also evident in the fact that 87% of ears with OAE pass results presented with peak pressure values larger than –100 daPa and smaller than 100 daPa compared to 26% of ears with OAE refer results presenting with peak pressure values larger than –100 daPa and smaller than 100 daPa. This is consistent with previous reports indicating a relationship between middle-ear pressure, using a 1000Hz probe tone, and OAE failure in neonatal ears (Owens et al., 1992:55; Thornton et al., 1993:322).

To establish reliable norms for 1000Hz immittance testing two criteria was set for including ears from the current sample to be used for compiling the normative data. The first criterion was an OAE pass result. The reason why this was not included as the only criterion was because previous reports have indicated that in a small number of cases with MEE a pass result may still be obtained with OAE (Van Cauwenberge et al., 1996:139). To assure reliable norms are specified, as far as the performed procedures accuracy allows, a second criterion

requiring a discernable tympanogram peak for inclusion was set. A recent report indicated that an OAE pass result was obtained in 5.7% of ears with no discernable tympanometric peak although reduced OAE amplitudes were observed (Kei et al., 2003:26). Since these cases may indicate a degree of compromised middle-ear functioning and a discernable tympanometric peak is generally accepted as indicative of normal middle-ear functioning with 1000Hz tympanometry for infants, this criterion was specified alongside an OAE pass result to ensure ears with normal middle-ear functioning was included (Purdy & Williams, 2000:18; Kei et al., 2003:22; Sutton et al., 1996:13).

According to the two criteria, normative data was compiled for 809 ears (52% male). Table 6.16 presents these norms for 1000Hz tympanometry for all ears compared to norms for male and female ears.

TABLE 6.16 1000Hz tympanometry norms for the sample

SAMPLE	***ALL EARS*** Y_a ***(n=809 ears)***		***MALE EARS*** Y_a ***(n=424 ears)***		***FEMALE EARS*** Y_a ***(n=385 ears)***	
VARIABLES	**Peak admittance**	**TPP (daPa)**	**Peak admittance**	**TPP (daPa)**	**Peak admittance**	**TPP (daPa)**
Mean	2.9	0	3.1	5	2.6	-5
Std Deviation	1.1	61	1.3	61	0.8	61
Max	9.6	185	9.6	160	8.7	185
Min	0.9	-275	1.1	-275	0.9	-205
5th Percentile	1.5	-110	1.7	-100	1.4	-115
50th Percentile Median	**2.6**	**5**	**2.9**	**10**	**2.4**	**5**
95th Percentile	4.9	90	5.4	95	4.2	90

The peak admittance values presented in Table 6.16 indicated a statistical significant difference between male and female ears with static admittance

higher for boys than girls. No statistically significant difference was obtained for tympanic peak pressure values between genders. A study by Palmu et al. (2001:182) investigating infant ears at 7 and 24 months of age with 226Hz probe tone tympanometry indicated similar results. A statistically significant difference was reported between static acoustic admittance values for male and female ears the admittance values for boys significantly higher than for girls. This was attributed to the difference in middle ear and tympanic membrane sizes (Palmu et al., 2001:183). Similar differences between male and female ears in adults have been widely reported for 226Hz probe tone tympanometry (Fowler & Shanks, 2002:178). It is therefore important to consider that 1000Hz probe tone tympanometry peak admittance values are significantly lower for females compared to males when assessing infant ears. The distribution of peak admittance values for this normative sample is presented in Figure 6.20.

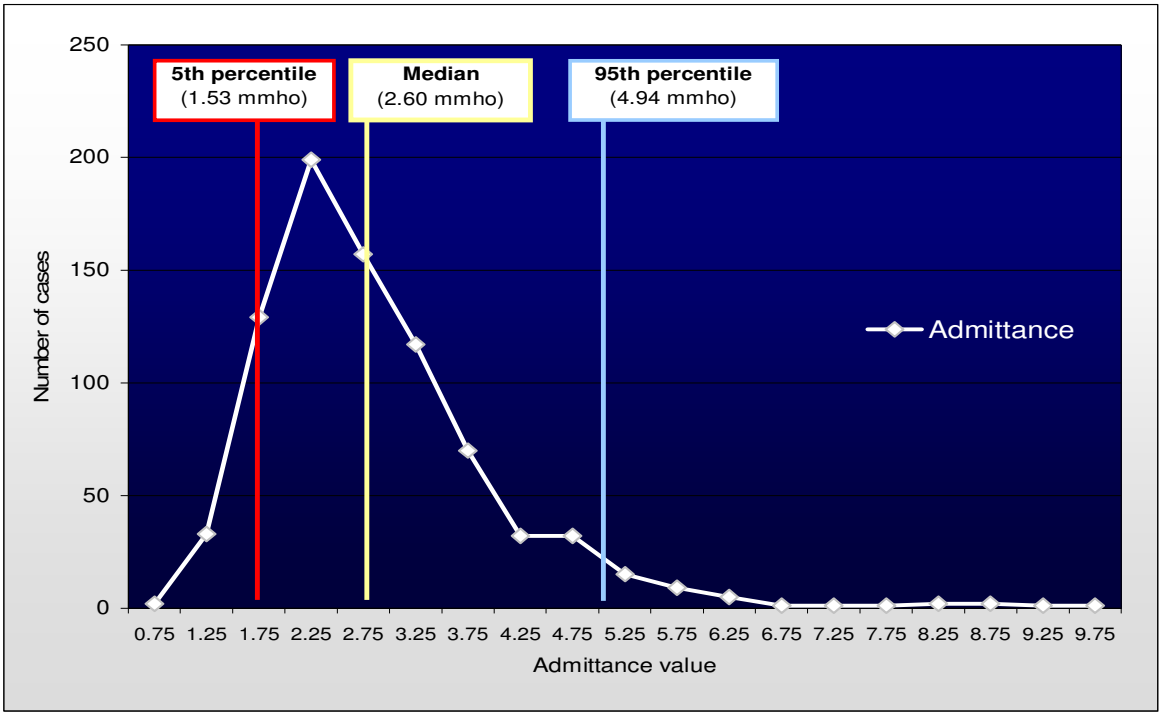


FIGURE 6.20 Distribution of peak admittance values for normative sample (n=809)

Another important aspect that must be considered is the fact that static acoustic admittance values have been shown to increase substantially with age and therefore normative data for different age groups becomes essential to avoid

high numbers of false-positive results due to inappropriate normative values (Palmu et al., 2001:183; Keefe & Levi, 1996:368; Meyer et al., 1997:192; Holte et al., 1991:12). The normative data was therefore calculated for neonates represented in Table 6.17 and for older infants in Table 6.18.

TABLE 6.17 1000Hz tympanometry norms for neonates

SAMPLE	*0 WEEKS OF AGE (n=73 ears)*		*1-4 WEEKS OF AGE (n=177 ears)*		*0-4 WEEKS OF AGE (n=250 ears)*	
VARIABLES	**Peak admittance**	**TPP (daPa)**	**Peak admittance**	**TPP (daPa)**	**Peak admittance**	**TPP (daPa)**
Mean	2.2	-10	2.4	5	2.4	-1
Std Deviation	0.9	48	0.7	49	0.8	49
Max	7.7	185	5.1	115	7.7	185
Min	1	-130	1.2	-185	1	-185
5th Percentile	1.2	-70	1.5	-80	1.4	-75
50th Percentile Median	**2.0**	**-10**	**2.3**	**5**	**2.2**	**-5**
95th Percentile	3.4	70	3.8	85	3.7	80

Table 6.17 presented normative peak admittance and tympanic peak pressure values for different age neonates whilst Table 6.18 provides the same norms for infants 5 weeks and older up to one year of age. Statistically significant differences were obtained for static peak admittance values between all age groups. Neonatal ears presented with the lowest mean and smallest standard deviation for peak admittance with a range of values from the 5th to 95th percentile of 2.3 mmho compared to 3.2 and 4.3 mmho for infants 5-16 weeks and 17-52 weeks of age, respectively. The admittance result therefore indicates increasingly higher peak admittance values with increasing age accompanied by an increasing range of variability as demonstrated by higher standard deviation values as infants become older.

TABLE 6.18 1000Hz tympanometry norms for infants 5-52 weeks of age

SAMPLE	*5-16 WEEKS OF AGE (n=361 ears)*		*17-52 WEEKS OF AGE (n=194 ears)*		*5-52 WEEKS OF AGE (n=555 ears)*	
VARIABLES	**Peak admittance**	**TPP (daPa)**	**Peak admittance**	**TPP (daPa)**	**Peak admittance**	**TPP (daPa)**
Mean	2.8	-3	3.5	8	3.1	1
Std Deviation	1.0	63	1.4	70	1.2	66
Max	6.4	155	9.6	170	9.6	170
Min	0.9	-275	1.2	-205	0.9	-275
5th Percentile	1.7	-120	1.9	-115	1.8	-120
50th Percentile Median	**2.5**	**5**	**3.3**	**15**	**2.8**	**10**
95th Percentile	4.9	90	6.2.	105	5.3	95

The peak admittance results for the different age groups are in agreement with previous reports indicating an increase in peak admittance with age (Palmu et al., 2001:183; Keefe & Levi, 1996:368; Meyer et al., 1997:192; Holte et al., 1991:12). The peak admittance norms for neonatal ears are similar to a recently reported sample of 46 neonatal ears evaluated with 1000Hz tympanometry (Margolis et al., 2003:386). This study reported a mean peak admittance of 2.7 mmho compared to 2.4 in the current study and a 5th to 95th percentile range of 1.2 – 4.8 mmho compared to 1.4 – 3.7 mmho in the current study. The close relationship between the 5th percentiles indicates the significance of this value as a more robust diagnostic criterion compared to the more variable 95th percentile which is not usually an indication of pathology in neonates (Margolis et al., 2003:389). The increase of the lower percentile peak admittance values with increasing age are primarily attributed to: an increase in size of the external and middle-ear cavity and mastoid; a change in the tympanic membrane orientation; fusion of the tympanic ring; a decrease in the overall mass of the middle ear due to changes in bone density and loss of mesenchyme; tightening of the ossicular

joints; closer coupling of the stapes to the annular ligament; and the formation of the bony ear canal wall (Purdy & Williams, 2000:9; Meyer et al., 1997:194; Holte et al., 1991:21).

The tympanic peak pressure values for neonates were significantly different compared to the rest of the infant ears. The neonatal ears presented with a narrower 90% tympanic peak pressure range (5^{th} to 95^{th} percentile) of 155 daPa compared to 215 daPa for infant ears between 5-52 weeks of age. Neonatal ears also indicated less variability for tympanic peak pressure values than infant ears with a standard deviation of almost 30% less than that of the infant ears. The mean pressure values were very similar with all age groups approximating 0 daPa. Although little is known regarding the significance of tympanic peak pressure in the infant population the results in the current study indicate a normal distribution of results for normal infant middle ears ranging around the 0 daPa with increasing variability with increasing age. These results are similar to the 90% range for static admittance (-133 – 113 daPa / 5^{th} – 95^{th} percentile) reported for neonatal ears using 1000Hz probe tone tympanometry reported by Margolis et al. (2003:386). The results of this study therefore demonstrate an increase in tympanic peak pressure ranges with increasing age, allowing more stringent criteria for normality in neonates especially for those in the first week of life.

It is clear that the effect of positive middle-ear pressure above 80 - 90 daPa strongly affects the presence of OAE and a discernable tympanometric peaks as also indicated by previous studies (Owens et al., 1992:55; Thornton et al., 1993:322). The results of the current study therefore suggest that increasingly positive middle-ear pressure may be an important indicator of the presence of MEE in neonates and infants. This phenomenon, however, requires further investigation to ensure that other conditions such as poor Eustachian tube functioning are not the cause of positive middle-ear pressures which lead to OAE refer results.

A summary of the normative tympanometric data for the different age groups is presented in Figure 6.21.

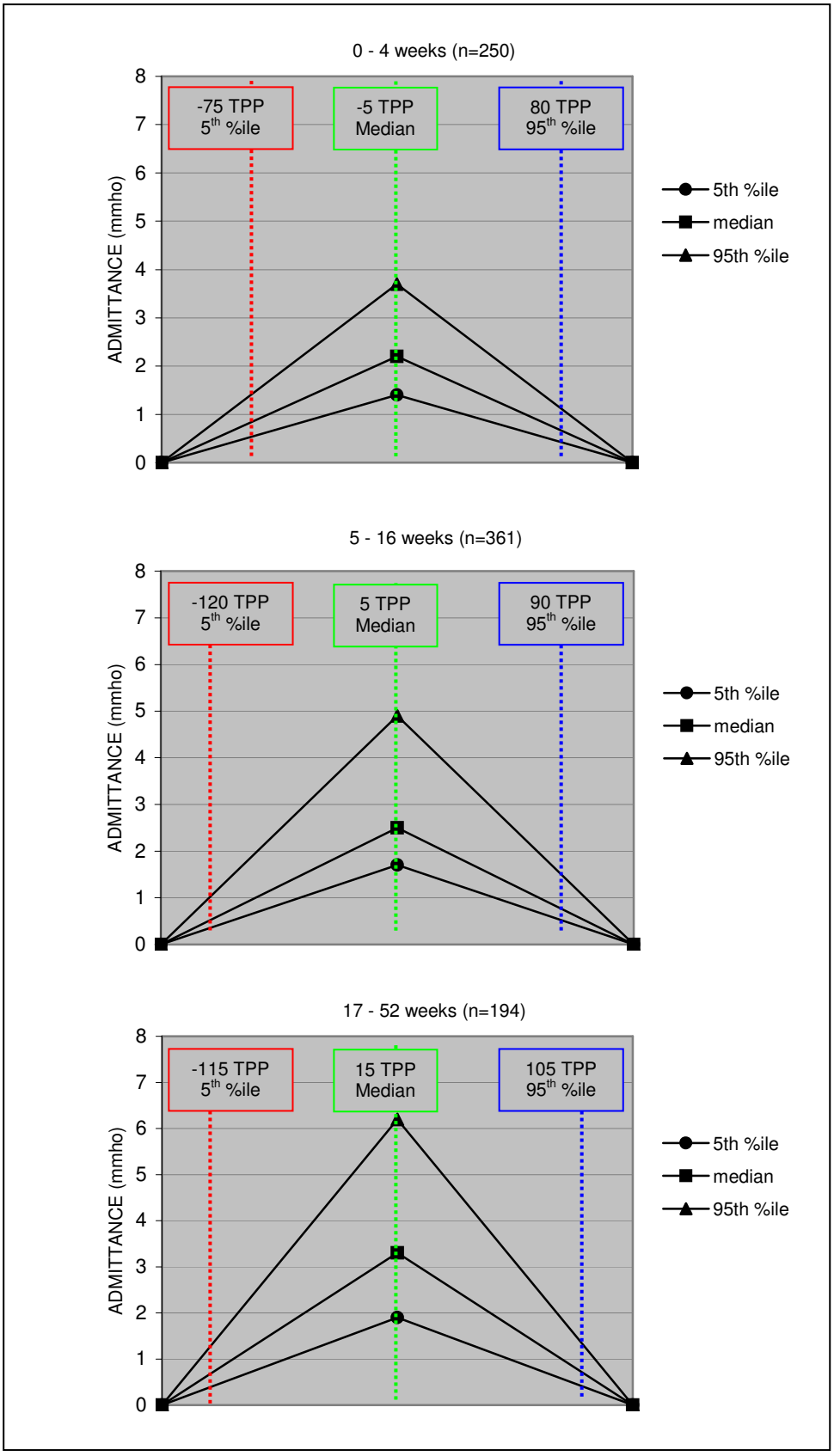


FIGURE 6.21 Peak admittance and tympanic peak pressure norms

Acoustic reflex threshold normative data for the current study was also investigated as part of the 1000Hz immittance norms. A summary of the acoustic reflex thresholds, compiled from 727 ears (52% male) and adhering to the two criteria set for including ears in normative data, is presented in Table 6.19.

TABLE 6.19 1000Hz probe tone acoustic reflex norms for the sample

SAMPLE	***MALE & FEMALE (n=727 ears)***	***MALE (n=379 ears)***	***FEMALE (n=348 ears)***
VARIABLES	**AR Threshold (dB)**	**AR Threshold (dB)**	**AR Threshold (dB)**
Mean	93	92	94
Std Deviation	9	9	9
Max	110	110	110
Min	60	65	60
5th Percentile	80	75	80
50th Percentile Median	**95**	**95**	**95**
95th Percentile	105	110	105

A high incidence of present reflexes was obtained and in the presence of a peaked tympanogram an acoustic reflex threshold was present in 94% of cases. Table 6.19 indicates that no significant difference was observed between reflex thresholds for male and female ears in contrast to peak admittance values for infants. Similarly no significant differences were indicated between the various age groups. Thus all ears were considered together indicating a mean threshold of 93dB with a 9dB standard deviation and a 90% range of 25dB (80 – 105dB). The 95th percentile for this group was at 105dB, which is close to the maximum output of the equipment (110dB), meaning that it does not seem to indicate any

diagnostic significance. Thus the value of the acoustic reflex normative data may be limited and its usefulness for infants should further be investigated in ears with pathology. The importance of the acoustic reflex seems to lie simply in the fact that its presence is usually reassuring of a normal middle ear (Gates et al., 1994:56; Purdy & Williams, 2000:14).

No large-scale studies reporting normative 1000Hz probe tone acoustic reflex thresholds have been reported previously. Although few reports are available results suggest that a 1000Hz probe tone is preferable for testing reflexes in newborns and young infants (Northern & Downs, 2002:228; Weatherby & Bennett, 1980:108; Purdy & Williams, 2000:14). The fact that reflex presence seems to be the important acoustic reflex criteria indicative of normal middle-ear functioning means that the most efficient stimuli for evoking the reflex should be used. Early 1000Hz probe tone reports indicated a 100% acoustic reflex presence in a small sample of newborns (n=35) using a broadband stimulus compared to a 92% presence in the OAE pass group of ears. Further research is however required to compare the different stimuli.

6.5.3. Protocol efficiency

Aspects indicative of the efficiency of the hearing screening protocol implemented at the two MCH clinics in the Hammanskraal community will be discussed in the following section. The efficiency aspects to be discussed include the coverage of the screening protocol using the various screening techniques and apparatus; the referral rate for the individual screening techniques and the protocol referral rate; and the follow-up process according to the specified protocol. The coverage of the population by the screening protocol will be presented and discussed firstly.

- **Screening protocol coverage**

The coverage of the screening protocol for the population of infants and caregivers enrolled over the 5 months of data collection at two MCH clinics in the Hammanskraal district is presented according to the HRR and test procedures

performed. Figure 6.22 provides a summary of the coverage of the HRR and each screening procedure for the population of 510 infants and caregivers.

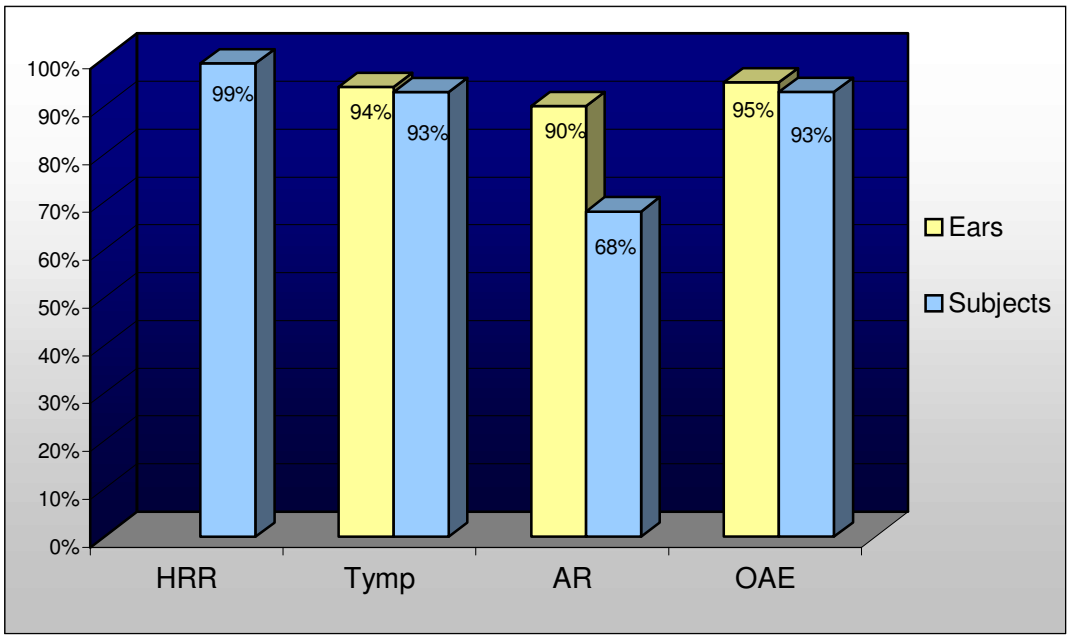


FIGURE 6.22 Coverage of population by HRR and test procedures

The coverage rates are discussed according to each individual procedure:

- *High-Risk Register*

  The HRR was conducted for almost all subjects (99%). This provides evidence for the recommendation by the South African year 2002 HSPS that TNHS be implemented at MCH 6-week immunisation clinics in 2005 (HPCSA, 2002:2). The high coverage rate for this procedure holds promise for its use as a way of identifying infants at increased risk of hearing loss to receive an electrophysiological hearing screening at these clinics. This type of screening is recommended as an intermediate step towards establishment of necessary systems and manpower to introduce UNHS in 2010 (HPCSA, 2002:2).

- *High frequency tympanometry*

  Evaluating middle-ear functioning bilaterally using high frequency tympanometry could be successfully performed on 93% of subjects and 94% of ears in this sample. A higher coverage of ears than subjects were reported because for a small number of subjects only one ear could be evaluated with tympanometry. The tympanometric coverage in this study falls within the range of reported success rates for conducting high frequency tympanometry on neonates and infants, which varies between 87 – 99% (Thornton et al., 1993:320; Sutton et al., 1996:11; Palmu et al., 1999:211; Kei et al., 2003:27).

  Primary reasons for an inability to obtain successful tympanometric results in infants are reported to be due to the lack of a secure seal because of infant movement or irritability (Kei et al., 2003:23; Sutton et al., 1996:11). A study investigating infants past the neonatal stage reported a better success rate for infants younger than 7 months compared to infants older than 7 months because older infants became restless faster, were shy of people outside their home and were also more suspicious of tests done by unfamiliar personnel (Palmu et al., 1999:211). Similar observations were made in the current study. The tympanometry coverage suggests that using a 1000Hz probe tone tympanometric results can successfully be conducted in almost all infants attending MCH clinics with higher success in younger infants. The fact that the South African year 2002 HSPS specifies hearing screening to be conducted 3 months of age improves the probability of obtaining successful tympanometric results (HPCSA, 2002:3).

- *Acoustic reflexes*

  The smaller percentage of successful acoustic reflex measurements compared to tympanometry measurements can primarily be attributed to the fact that reflex testing was conducted after OAE and tympanometry measurements. This caused some infants to be restless and irritable by the time reflex testing was conducted. A significant difference was also noted,

as illustrated in Figure 6.22, between conducting an acoustic reflex measurement on at least one ear (90%) compared to performing a bilateral acoustic reflex measurement (68%). This can similarly be attributed to the fact that acoustic reflex measurement proceeded after tympanometry and many infants endured reflex testing for the first ear but became too restless and irritable for bilateral testing. These results therefore suggest that successful 1000Hz probe tone reflex measurements can be made for the majority of ears (90%) in the population of infants attending the MCH clinics in Hammanskraal even if the procedure follows other procedures. Higher percentage coverage can be expected if both OAE and tympanometric testing do not precede reflex testing.

- *OAE screening*

  95% coverage for all ears and 93% coverage for bilateral screening of subjects in the sample was obtained. Some subjects could not be tested, or only one ear tested, due to irritability and restlessness. The JCIH (2000:15) recommends an OAE screening coverage benchmark of 95% for bilateral screening also accepted as benchmark by the South African year 2002 HSPS (HPCSA, 2002:4). This means that the coverage for bilateral measurements in the current study falls short of this benchmark by 2%. Reports on hearing screening coverage at primary healthcare clinics have not been previously reported since the vast majority of neonatal and infant hearing-screening programmes are hospital based. Although it is widely accepted that the majority of these programmes achieve an acceptable coverage of >95%, significant variability is also reported in certain cases (Watkin, 2003:168; White et al., 1997:227; Iwasaki et al., 2004:1100; Kennedy et al., 1998:1963). Initial screen coverage varying between 99.8% in a Japanese hospital and 87% reported for the Wessex trial in the UK has been reported (Iwasaki et al., 2004:1100; Kennedy et al., 1998:1963). Thus the coverage in the current study is close to the specified benchmark and within the range of reported coverage for hospital-based programmes. If the bilateral (93%) and small percentage of unilateral screens (3%) in the

current study are considered together a comprehensive coverage of 96%, adhering to the JCIH (2000:15) benchmark of 95%, is obtained.

- *AABR screening*

  According to the screening protocols specified in Chapter 5 the AABR was recommended for a small subset of infants in the sample including all NICU exposed infants and all infants referring the initial OAE screen. The AABR was therefore successfully performed for only 24% of the ears (22/90) requiring an AABR screening according to the specified protocol. This low percentage of successful AABR evaluations on infants attending the MCH clinics in this study can be attributed to the following factors already mentioned in paragraph 6.4.3. Firstly, infants requiring AABR screenings varied in age from birth to 52 weeks with a mean age of 18 weeks ± 14 weeks standard deviation. Since most of the subjects were older than 1 month it was difficult to prepare and test an infant without the infant becoming irritable and restless which made further screening impossible. Secondly, the AABR screening was performed after OAE and immittance measures were already conducted which contributed to infants already being restless and irritable. Lastly, those infants on whom AABR evaluations could not successfully be performed were referred to return within a week or two to complete the screening. Unfortunately very few mothers returned with their infants. These reasons make the AABR an inefficient screening option for use at MCH clinics. Despite its advantages in terms of identifying auditory neuropathy and being less sensitive to mild conductive hearing losses (Mehl & Thomson, 2002:6) the low success rate for its use in primary healthcare clinics on slightly older infants compared to newborns in hospital-based programmes make it unfeasible for screening in these clinics.

In general, reasonably high coverage rates were obtained for all procedures, except the AABR, especially in light of the number of procedures performed on each subject pair in the current study. The AABR was the only procedure that

proved to be inefficient for hearing screening at the MCH clinics investigated in this study.

- **Protocol referral rate**

The referral rate of the individual procedures performed in this study are summarised in Figure 6.23 according to the rate for the sample of ears and subjects according to the specified criteria of a unilateral refer result.

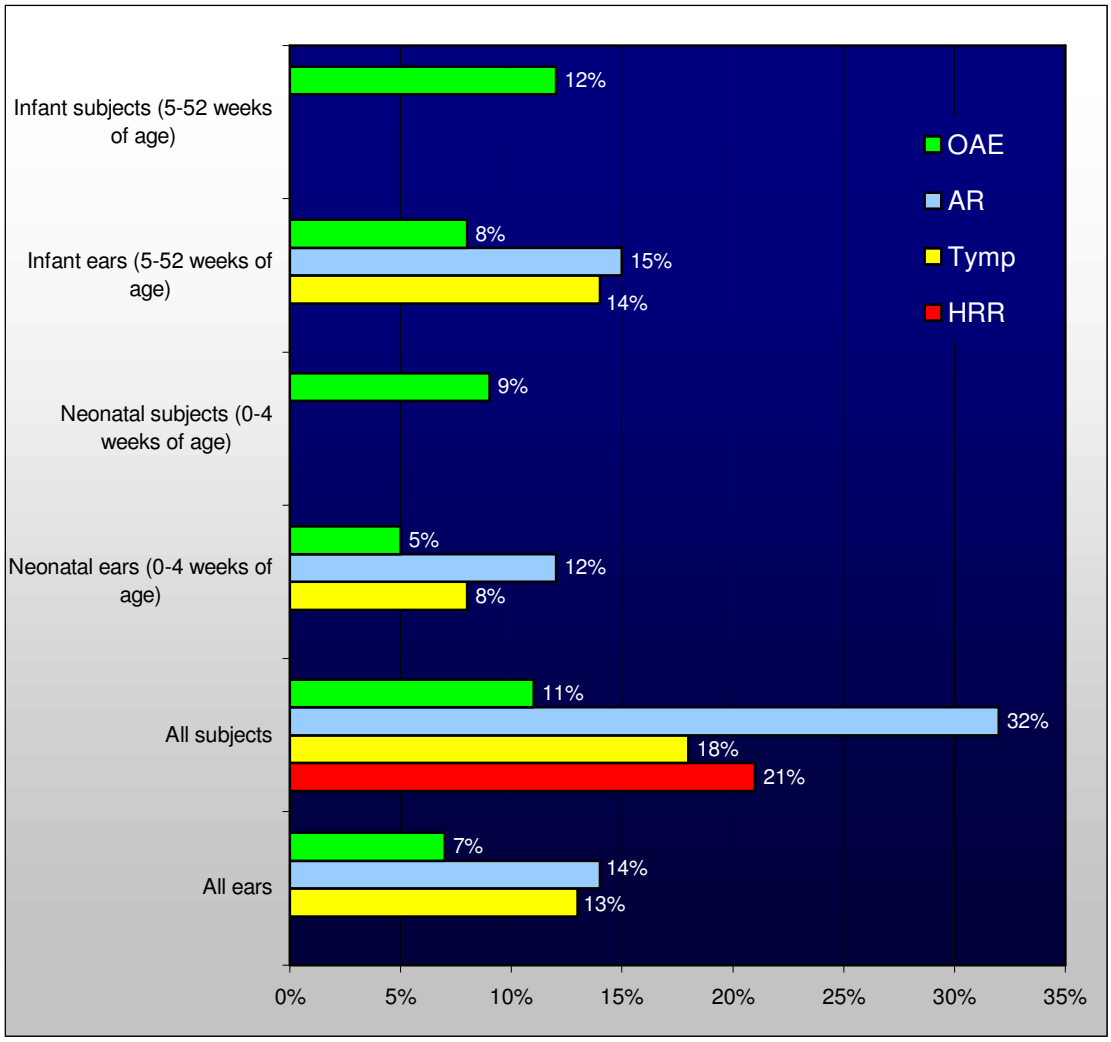


FIGURE 6.23 Refer results for procedures in terms of ears and subjects

The referral rates for the procedures in Figure 6.23 are summarised from the results of sub-aim #3. Since the hearing screening protocol of the current study was based on OAE and AABR screening tests the following discussion will focus on the referral results for the hearing screening protocol.

As illustrated in Figure 6.22, 11% of subjects for whom a bilateral OAE screen could be performed (93% of sample) were referred on a criteria requiring at least one refer result per subject. If subjects with at least one risk indicator for whom a bilateral OAE screen was performed are considered a slightly higher OAE referral rate of 12,5% was recorded compared to 11% for the rest of the sample. Thus a slightly higher incidence of risk factors (22%) was present in the group of subjects with OAE refer results compared to the group of subjects with OAE pass results (20%). Five of the subjects with bilateral OAE refer results (33%) had at least one risk factors compared to seven subjects with unilateral OAE refer results (18%). According to the OAE screening protocol specified in Chapter 5, which also took into account the referral of subjects for whom only one ear could be evaluated no matter what the outcome, the referral rate increases to 14%. This incidence rate is comprised of 8% who referred one ear, 3% referred who referred both ears and 3% were referred because only one ear was evaluated.

The subject referral rate for those receiving successful screens is close to the reported average of 8-11% of initial TEOAE referrals based on one or both ears referring (Watkin 2003:169). This is similar to a 10% referral rate reported by Vohr et al. (1998:355) for initial OAE screening and falls within the range of 9 - 18% initial referral rate reported for DPOAE protocols by Norton et al. (2000c:532). Although the initial OAE referral rate in the current study is similar to previous reports this figure is still significantly higher than the benchmark of a 4% follow-up referral rate recommended by the JCIH (2000:15) and the South African HSPS (HPCSA, 2002:3). Even though this benchmark is specified to be obtained with in one year of programme initiation and the current programme was only implemented for 5 months, a single OAE screen requires a second step screen to obtain acceptably low refer rates.

An AABR evaluation was required for 90 ears according to the screening protocol criteria specified in Chapter 5, of which only a small sample received successful AABR screens (24%). Despite this small number of second step AABR screens performed, the overall OAE refer rate was reduced from 7% to 6% for the group of ears. The subject referral rate for subjects for whom bilateral OAE results were obtained drops from 11% to 10% and for this same group including subjects with a unilateral screen no matter the result, dropped from 14% to 13%. This is similar to a recent report using a combined OAE and AABR screening device which indicated improved refer rates using both techniques in newborns (Hall et al., 2004:423). The AABR therefore proved effective in reducing the referral rate although it proved unsuccessful as a screening tool for the majority of infants requiring this type of screening at the MCH clinics investigated in this study.

If a screening protocol requiring only an OAE pass from one ear is applied to the current group of subjects, the referral rate drops from 14% to 3%, which is within the specified benchmark of the JCIH (2000:15) and South African HSPS of <5% (HPCSA, 2002:3). This means that if only a single ear OAE screening protocol was followed at these clinics, 22% of infants referring according to the bilateral hearing screening protocol would also refer for further testing using the unilateral screening policy. A unilateral screening protocol would therefore reduce the referral rate sevenfold resulting in 78% less follow-up evaluations. These two factors will significantly reduce the monetary and human resource requirements for a hearing screening programme and for this very reason certain hospitals have opted to implement such protocols (Hall et al., 2004:423).

The fact that a unilateral screening protocol will save resource expenditure must however, be evaluated against the cost of not identifying a group of infants with unilateral hearing loss. Although research shows that unilateral hearing loss does influences developmental and emotional outcomes in children (Bess et al., 1998:339), limited resources inevitably places a larger emphasis on identifying bilateral hearing loss above the more expensive identification of unilateral

hearing loss also (Lutman, 2000:368). The question of unilateral versus bilateral hearing loss detection becomes a compromise between the effectiveness of the treatment and the costs of the screening and the final decision of selecting a target disorder should be decided within the context of available resources. Considering the South African national health context with limited resources and health priorities skewed toward more life threatening diseases such as HIV and tuberculosis, a screening protocol for bilateral hearing loss may be a suitable initial option for this country.

- **Follow-up results**

A hearing screening result, in at least one ear, was obtained in 489 of the 510 subjects enrolled in this study. A small percentage (4%) of the 510 enlisted subjects attending the two MCH clinics during the 5-months of data collection did not receive any hearing screening. These subjects were lost during the initial screening process and therefore no referral for follow-up evaluations could be made. The remainder of the sample (n=489) resulted in 68 subjects referring according to OAE results, with 15 referring both ears and 39 referring either the left or right ear. The other 14 subjects in the follow-up group were subjects for whom OAE results could only be obtained for one ear. 13 of these subjects had a pass in the one ear and one subject presented with a refer result in one ear. When the AABR results are also considered the total number of subjects referring according to the protocols specified in this study comes to 61 subjects. The follow-up process and return rate for these 61 subjects is illustrated in Figure 6.24.

As illustrated in Figure 6.24 only 27 subjects returned for follow-up evaluations, which is less than half (44%) of the infants and caregivers at the two MCH clinics who were referred for a follow-up screen during the data collection period of this study. 33% of the subjects who returned for follow-up evaluations presented with risk factors. Risk factors were recorded for 9 subjects of whom 2 subjects presented with 2 risk factors and 1 subject presented with 3. Altogether 13 risk factors were recorded of which 7 were for a family history of hearing loss, 2 were

for NICU admittance for longer than 48 hours, and one recording of asphyxia, ototoxic medication and the presence of a syndrome was recorded.

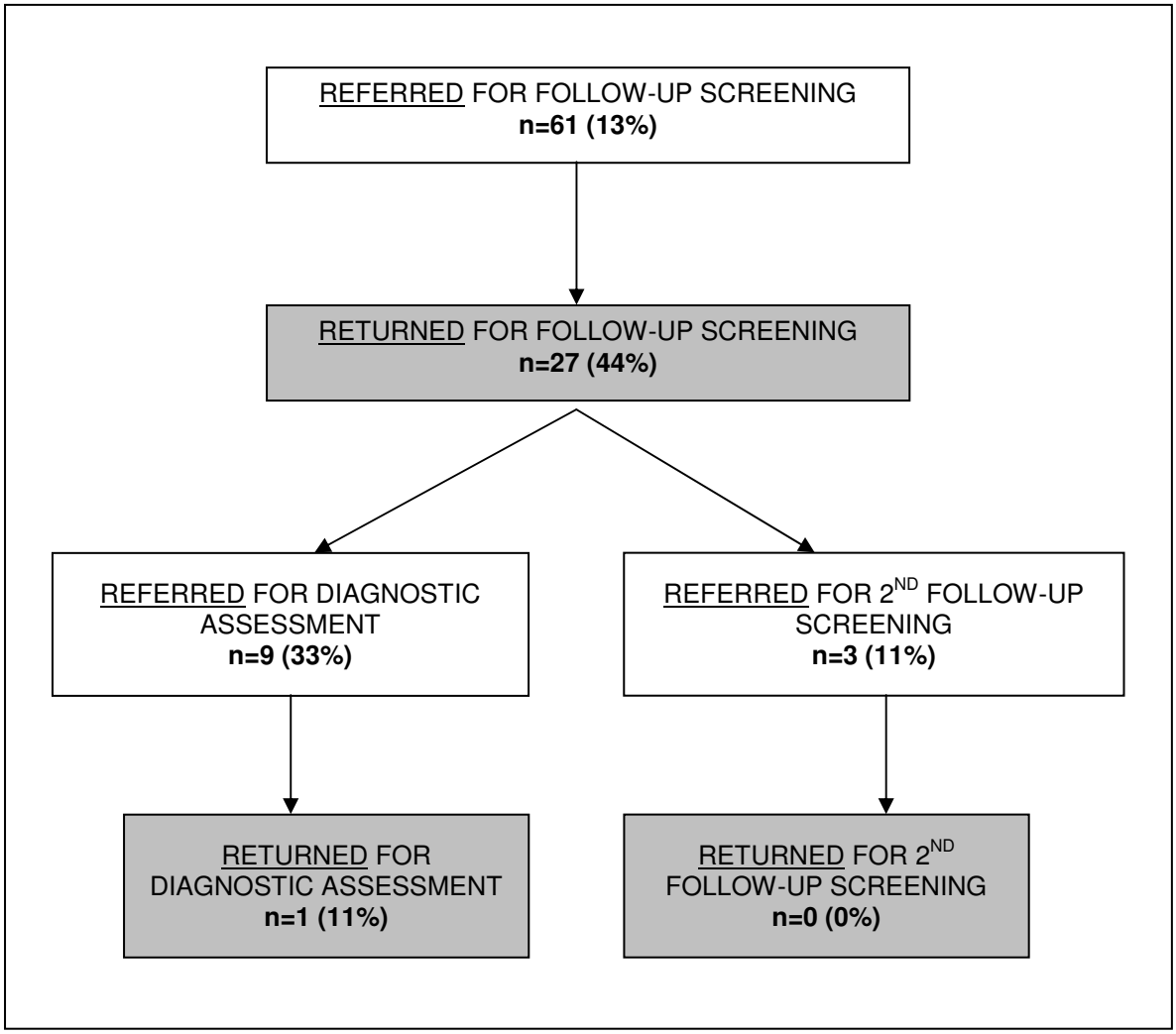


FIGURE 6.24 Results of the follow-up process

There was a significant increase in risk factor incidence for the group returning for follow-up (33%) compared to risk incidence in the sample (21%). The increased incidence of risk factors in the subjects returning for follow-up evaluations can be attributed to three facts. Firstly, there is a slightly higher incidence of risk factors present in subjects who referred (22%) compared to subjects who passed (20%) according to the OAE screen result. Secondly, there

is a slightly higher referral rate among the high-risk (12,5%) group compared to the no-risk group (11%) based on subjects receiving a bilateral OAE screen (n=475). This is similar to results reported by previous studies (Norton et al., 2000c:532). Lastly, caregivers cognisant of the fact that their infant has a risk factor for hearing loss may be more prone to return for a follow-up evaluation. All three these facts together may account for the increased prevalence of risk factors in the group of caregivers and infants returning for follow-up.

Of these 27 subjects returning for a follow-up evaluation, three (2 requiring a bilateral and 1 requiring a unilateral screen) could not be screened due to restlessness and irritability and were therefore referred for a 2nd follow-up screening. Of the follow-up ears that could be screened and which initially referred the OAE screen, 65% passed the follow-up OAE screen. This means that if OAE is considered a measure of external and middle-ear functioning transient MEE and/or external ear canal obstruction can account for approximately 65% of OAE refer results as determined in this sample of follow-up ears. Only 3 of the follow-up subjects with OAE refer results could be evaluated with the AABR. In each case only one ear could be evaluated revealing one pass and two refer results.

Considering tympanometric results in conjunction with the OAE results allows a closer investigation of the MEE and/or ear canal obstruction incidence in this sample. In 23 ears both OAE and tympanometry results were obtained for the initial and follow-up screen. 15 of these ears had an OAE pass for the follow-up screen and tympanogram results for these subjects were as follows, 1) five (33%) had an initial flat tympanogram result with a subsequent follow-up tympanogram peak, 2) three (20%) had an initial tympanogram peak result with a subsequent follow-up tympanogram peak, 3) seven (47%) had an initial flat tympanogram result with a subsequent flat tympanogram result for the follow-up screen. The first group (33%) clearly indicate transient MEE as explanation for the initial OAE referral. The third group (47%) may also indicate transient MEE in its resolution stage, with adequately resolved MEE to allow the recording of an OAE pass result but inadequate resolution for recording a tympanogram peak.

The second group (20%) is difficult to define but may have produced an OAE refer result due to an obstruction in the external ear canal which did not affect the tympanogram result. Published estimates of MEE prevalence in neonates and infants vary widely (Hall et al., 2004:423). The results for the current study does however indicate that more than 50% of OAE initial refer results for infants younger than one year of age may be due to MEE and/or obstruction of the external ear canal.

A second referral was made for 12 subjects after the follow-up screening. As illustrated in Figure 6.24 three of these subjects were referred for a 2nd follow-up screen because they could not be screened and the other 9 subjects were referred for diagnostic testing. No subjects returned for the 2nd follow-up screen and only one subject (11%) returned for diagnostic testing. This subject was assessed with a diagnostic ABR and revealed no sensori-neural hearing loss in either ear.

Follow-up return rates are primary indices of the efficiency and effectiveness of screening programmes (Gravel et al., 2000:132; Finitzo et al., 1998:1459). The poor follow-up return rates for the hearing screening programme implemented at the two MCH clinics in this study undermines the programmes ability to identify hearing loss. This is not an uncommon problem however, since most operational programmes identify inadequate follow-up return rates as the most significant challenge toward early identification of hearing loss (White, 2003:85). Great variability has been reported for follow-up rates with high follow-up rate reported for a UNHS programme in Brazil indicating an 82% follow-up rate compared to a 54% follow-up rate for a hospital-based UNHS programme in Bulgaria (Chapchap & Segre, 2001:34; Rouev et al., 2004:808).

The relatively short period of time in which the hearing-screening programme was implemented at the clinics is an important contributing factor to poor follow-up return rates. In one of the most successful state-wide screening programmes in the USA the initial follow-up rate was 48% for the first five years which is

similar to 44% for the currents study over a period of only 5 months (Mehl & Thomson, 2002:1). This follow-up return rate and has now improved to 76% with 9 hospitals achieving a 95% follow-up rate (Mehl & Thomson, 2002:1). It is clear therefore that as programmes develop and mature better tracking procedures are implemented which increases the follow-up rate.

The poor follow-up return rate in the current study is to be expected compared to the initial years of other programmes (Mehl & Thomson, 2002:1). The results only emphasise the importance of developing a comprehensive integrated system for tracking and follow-up within the South African national healthcare system. Ensuring high follow-up rates is a process that improves over time with the application of sustained effort and dedication.

6.5.4. Summary of results and discussion: sub-aim #4

A description of the performance and efficiency of the screening protocol implemented in this study reveals the following conclusions, presented in Table 6.20, regarding the procedures used in the protocol and the efficiency of the process as.

TABLE 6.20 Summary of results and discussion for sub-aim #4

Screening procedure performance

- A strong and highly significant association between all combinations of OAE, tympanometry and acoustic reflex result comparisons was found ($p < 0,0001$).

- High frequency immittance results proved reliable measures of middle-ear transmission especially for establishing normal functioning as measured by OAE. This is evident in the fact that both peaked tympanogram (98%) and present acoustic reflex (99%) results predicted an OAE pass result with a probability of approximately 100%.

- Results across various age groups of infants suggest significantly higher immittance sensitivity for infant ears compared to neonatal ears. In contrast increased tympanometry and decreased reflex specificity was found for neonatal ears compared with infant ears. Despite the smaller number of neonatal OAE referred ears and a higher OAE failure rate (8% compared to 5%) for older infants – which may contribute to this difference – results suggest that 1000Hz probe tone immittance testing is more reliable to correctly identify MEE in infants over 4 weeks of age than for neonates.

- Screening procedure performance in the current study suggest that a protocol using high frequency tympanometry and acoustic reflexes in conjunction with OAE may be useful in classifying ears into different risk categories for sensori-neural hearing loss and MEE.

High frequency immittance norms

- Peak admittance values for 1000Hz probe tone tympanometry in infants with normal middle-ear functioning are significantly lower for females compared to males whilst no statistically significant gender difference was obtained for tympanic peak pressure values. Similar results have been widely reported for 226Hz probe tone tympanometry (Palmu et al., 2001:182; Fowler & Shanks, 2002:178).

- Statistically significant different peak admittance values were evident for across infant age groups with higher peak admittance values and increasing variability with increasing age. The peak admittance results for the different age groups are in agreement with previous reports indicating an increase in peak admittance with age (Palmu et al., 2001:183; Keefe & Levi, 1996:368; Meyer et al., 1997:192; Holte et al., 1991:12).

- The tympanic peak pressure values for neonates were significantly different compared to the rest of the infant ears, presenting with a narrower 90% tympanic peak pressure range (5^{th} to 95^{th} percentile) and less variability with a standard deviation almost 30% less than for infant ears.

- The effect of positive peak tympanic pressure above 80 - 90 daPa strongly affected the presence of OAE and a discernable tympanometric peaks as also indicated by previous studies (Owens et al., 1992:55; Thornton et al., 1993:322). Thus results of the current study suggest that increasingly positive middle-ear pressure may be an important indicator of the presence of MEE in neonates and infants.

TABLE 6.20 Continued

- Acoustic reflexes revealed no significant differences for gender or infant age. A mean threshold of 93dB with a 9dB standard deviation and a 90% range of 25dB (80 – 105dB) was obtained for the sample of ears. The importance of the acoustic reflex seems to lie simply in the fact that its presence is usually reassuring of a normal middle ear as previously also reported (Gates et al., 1994:56; Purdy & Williams, 2000:14).

Protocol efficiency

- Reasonably high coverage rates were obtained for all procedures, except the AABR, especially in light if the number of procedures performed on each subject pair in the current study. The AABR was the only procedure that proved to be inefficient for hearing screening at the MCH clinics investigated in this study.

- Initial OAE screening coverage of 95%, adhering to the JCIH (2000:15) benchmark of 95%, was obtained when considering all subjects for whom a bilateral screen was performed (93%) and a small number of cases (3%) for whom only a unilateral screen could be performed.

- The AABR coverage was poor, having been successfully performed for only 24% of the ears (22/90) and requiring an AABR screening according to the specified protocol. This low percentage of successful AABR evaluations on infants attending the MCH clinics in this study can be attributed to several reasons related primarily to the infant age range in this study.

- Generally the OAE referral rate of the current study, 7% of all ears and 14% of subjects referring at least one ear or only having a unilateral screen, was within the range of reported values for an initial screening procedure (Norton et el. 2000c:532; Vohr et al., 1998:355; Watkin, 2003:169).

- Implementing a screening protocol only requiring a unilateral OAE pass result for the current group of subjects, cause the referral rate to drop from 14% to 3%, which is within the specified benchmark of the JCIH (2000:15) and South African HSPS of <5% (HPCSA, 2002:3). Such a protocol would reduce the referral rate sevenfold and result in 78% less follow-up evaluations. Considering the South African national health context with limited resources and health priorities skewed toward more life threatening diseases, a screening protocol for bilateral hearing loss may be a suitable initial option for this country.

- Poor follow-up return rates were obtained for the hearing screening programme at the two MCH clinics. Results, however, are similar to the initial refer rates of programmes that have become some of the most successful state-wide screening programmes in the USA (Mehl & Thomson, 2002:1). It is clear therefore that as programmes develop and mature better tracking procedures are implemented which increases the follow-up rate, The short 5-month data collection period at the MCH clinics did not allow enough time to develop appropriate tracking and follow-up systems.

- The follow-up OAE results indicated that if OAE is considered a measure of external and middle-ear functioning, transient MEE and/or external ear canal obstruction may account for approximately 65% of initial OAE refer results for this study.

The results and discussion of sub-aim #4 described the performance and efficiency of the screening protocol implemented in this study. The summary presented in Table 6.20 indicates that the screening protocol proved effective in the vast majority of cases except for the inefficiency of the AABR screening procedure and the follow-up return process.

6.6. RESULTS AND DISCUSSION OF SUB-AIM #5: INTERACTIONAL PROCESSES IN THE IMPLEMENTATION AND MAINTENANCE OF A SCREENING PROGRAMME IN MCH CLINICS

The last sub-aim of the study was to describe the interactional processes involved in the implementation and maintenance of a screening programme at the two MCH clinics in the Hammanskraal community. The descriptions were part of the less-dominant research method being qualitative in nature. All descriptions were recorded and analysed from field notes and critical reflections by the fieldworkers involved and was compiled according to three general themes for this sub-aim. These themes were, 1) collaboration with nursing staff, 2) experiences with caregivers and, 3) experiences with the screening of infants 0-12 months of age. A summary of the fieldworkers' descriptions according to these themes and classified in terms of positive and negative aspects are presented in Tables 6.21, 6.22, and 6.23.

6.6.1. Presentation and discussion of results for sub-aim #5

Table 6.21 presents a summary of the collaboration between the fieldworkers and nursing staff at the clinics.

TABLE 6.21 Summary of fieldworker and nursing personnel collaboration

COLLABORATION WITH CLINIC PERSONNEL

POSITIVE ASPECTS:

- For the most part nursing staff were cooperative, helpful, friendly and positive toward the screening project.
- Although the nursing staff were initially hesitant about the presence of the fieldworkers, this attitude later changed as the nurses themselves reported that it was reassuring for them to see that the screening project was continuing in a consistent manner for the specified period.
- Personnel were helpful in accommodating the fieldworkers with regard to workspaces and disposables such as gloves and disinfectant.
- Nurses were eager to share information regarding the clinic statistics once a mutual trust developed between the nurses and the fieldworkers over the first month of screening.
- The nurses encouraged the mothers to have their infants' hearing tested and explained the importance to the caregivers.
- Giving feedback to the nurses about the screening results encouraged a collaborative relationship and established an ownership of the screening project among the nursing staff.
- Demonstrating respect toward the nurses by greeting them first thing in the morning and greeting them when leaving in the afternoon was reported by the nurses to be greatly appreciated and fostered a healthy collaboration.
- The good relationships allowed freedom for the researchers in the managing and organising the screening programme within the existing structure of the clinic.
- In a few instances when the one fieldworker fluent in many of the South African languages was not present and a caregiver was interviewed who did not understand English, the nurses were willing to act as interpreters.

NEGATIVE ASPECTS:

- Initially nurses were hesitant toward the implementation of a new hearing screening project.
- Only in isolated cases did one or two nurses not cooperate in referring and motivating mothers to come for the hearing screening and these instances were for the most part confined to the first few weeks of the research project.
- Once or twice nurses enquired to find out if we were asking a fee for the hearing screening. When they were assured that it was a free service they were very pleased.
- Nurses did not indicate a desire to learn what the hearing screening procedure entailed and did not offer to help screen the infants.

In general a positive collaboration between nurses and fieldworkers was evident with a natural resistance to change only reported initially (Olusanya, 2000:169). The collaborative relationship was fostered over time by providing a consistent service and maintaining an open channel of communication accompanied by basic courteousness. The only persistent negative aspect regarding the collaboration was the nurses' complacency and lack of interest in learning more about the effect of infant hearing loss and the screening process. According to Olusanya (2000:169) this is a result of a natural resistance to change and an inherent complacency, which is encouraged by the invisible nature of hearing loss. The prospect of implementing widespread hearing screening programmes at these clinics will however, require nurses or volunteers to perform the screening. This therefore emphasises the importance of making nurses collaborative partners in the screening process.

Developing effective collaborative partnerships require that both partners possess common core knowledge and share a common philosophy about the outcome of their services (Moodley et al., 2000:26). Utilising interdisciplinary training programmes to improve nurses' knowledge regarding hearing loss and the hearing screening process are the only means of establishing effective partnerships that share a common philosophy regarding the outcome (Olusanya et al., 2004:302; Gopal et al., 2001:106; Moodley et al., 2000:37). It is essential to be proactive once the widespread implementation of hearing screening programmes are conducted in South Africa by accompanying this process by interdisciplinary training programmes to raise the awareness and collaboration of nurses. In so doing the effective implementation of screening programmes at these clinics will be ensured to a much greater extent (Moodley et al., 2000:37).

The experiences of the fieldworkers with the caregivers are summarised in Table 6.22.

TABLE 6.22 Summary of fieldworker experiences with caregivers

EXPERIENCES WITH THE CAREGIVERS
POSITIVE ASPECTS:
- The vast majority of caregivers were very positive about the screening of their infants and indicated a genuine thankfulness. Most were at ease after explanation of the procedure and reassurance that the screening is not painful. - The caregivers were very willing to share most of the information requested regarding identifying information and high risk indicators for hearing loss. - The vast majority of caregivers embraced a certain degree of ownership in the screening process by often calming their infants through breastfeeding so that the screening could be performed. - Waiting in line to have their infants' hearing screened did not seem to be a negative experience for the caregivers.
NEGATIVE ASPECTS:
- Language was a persistent barrier. Although most caregivers could speak and understand a little bit of English, many could not. Having two fieldworkers fluent in most of the official native languages in South Africa was an important asset. - Some of the young mothers were anxious initially about the screening of their infants' hearing. - The caregivers were sensitive about questions regarding sexually transmitted diseases. - Among some of the mothers a fatalistic attitude toward disability was experienced. One mother did not want to wait for the hearing screening and stated that "if my child is deaf, he's deaf". - Caregivers demonstrated very little insight into the implications of hearing loss and the importance of early intervention.

The interactional processes documented in Table 6.22 indicate that the caregivers generally had a positive attitude toward the hearing screening programme and demonstrated a certain degree of ownership by actively participating in the screening process. This active participation indicates an important asset in terms of assuming responsibility for the infant's hearing (Louw & Avenant, 2002:147). This is essential for effective transdisciplinary teamwork

with caregivers as the primary agents in the process of identification of hearing loss and subsequent intervention (Moodley et al., 2000:26).

A variety of barriers were identified with a significant barrier being poor awareness and ignorance among caregivers regarding hearing loss and the screening process in infants, which is not uncommon in the developing world (Olusanya et al., 2004:301). This was also the primary reason for initial anxiousness among some of the younger mothers during the screening even after the process was carefully explained. The poor awareness was also accompanied by a fatalistic attitude toward the possibility of having a hearing loss in a number of cases, which may reflect a cultural perception regarding disability (Louw & Avenant, 2002:146; Fair & Louw, 1999:20). Positive changes will therefore require culturally sensitive efforts towards enhancing public awareness in antenatal clinics and in communities regarding the benefits of early identification compared to lack of timely intervention (Bamford, 2000:365; Louw & Avenant, 2002:147).

Another important barrier was the reluctance of caregivers to report infection with sexually transmitted diseases such as HIV and syphilis. This was probably due to embarrassment and a negative social stigma associated therewith. Nursing staff may be better able to extract such sensitive information from caregivers. The recommendation by the year 2002 HSPS (HPCSA, 2002:3) to implemented HRR screening at MCH clinics specifies nurses to conduct the screening and this may therefore result in more accurate documentation of risk factors such as congenital infections.

The experiences of the fieldworkers in regards to the screening of infants between 0 – 12 months of age are summarised in Table 6.23.

TABLE 6.23 Summary of fieldworker experiences with the screening of infants 0-12 months

EXPERIENCES WITH THE SCREENING OF INFANTS 0-12 m
POSITIVE ASPECTS:
- Sleeping infants are much easier to test. It was noted that neonates and young infants were easier to screen because they sleep more often and more readily. - Testing the children who were restless while they breast-fed was an appropriate course of action in many instances. - If infants were extremely restless, it sometimes worked to send the caregiver outside to calm the infant and bring him/her back once he/she is asleep or more restful. - A technique that also worked for many infants who were awake was to distract them visually with moving objects in their field of vision (e.g. coloured objects, wriggling fingers etc.) to ease the insertion of the probe and occupy the infant for the duration of the test.
NEGATIVE ASPECTS:
- Awake and restless infants were a continual challenge. It was noted that older infants were often more difficult to evaluate because they were awake more often. - Infants visit the clinic for an immunisation. After they received the injection it was near impossible to screen them as they were very uncomfortable and were often crying. All infants were recommended to come for the hearing screening first before they go for immunisation. - Older children were also more wary of being screened because many of them had not seen a white person before and 3 of the 4 fieldworkers were white. - Although breastfeeding helped to calm the infants in some cases, it was in cases where infants were drinking fervently not possible to screen with OAE as the internal noise from the sucking action was too loud.

According to the summary of fieldworkers' experiences with screening infants at the MCH clinics, presented in Table 6.23, breastfeeding was often used as a way of calming infants allowing for subsequent screening. In certain cases, however, the sucking action also proved to be a barrier due to excessive internal noise prohibiting OAE recordings. An important deduction evident from the summary in

Table 6.20 is that in general, neonates and younger infants were easier to test than older infants. This is also the primary reason why the AABR screening did not prove efficient for this group of infants. Similar difficulties in testing older infants have been reported previously and indicated a better success rate for younger infants because older infants became restless faster, were shy of people outside their home and were also more suspicious of tests done by unfamiliar personnel (Palmu et al., 1999:211). Fortunately the proposed initial screening recommended by the year 2002 HSPS is for young infants attending their 6-week immunisation clinic (HPCSA, 2002:2). Follow-up evaluations when they are older may however prove more difficult than the initial screening.

6.6.2. Summary of results and discussion for sub-aim #5

A summary of the results and discussion for sub-aim #5 is provided in Table 6.24.

TABLE 6.24 Summary of results and discussion for sub-aim #5

- The interactional processes allowed for an effectively functioning screening programme at the two MCH clinics that were investigated in this study.
- Collaborative relationships were fostered over time by providing a consistent service and maintaining an open channel of communication accompanied by basic courteousness.
- Assuming an active responsibility for the hearing screening was also evident in the majority of caregivers, indicating promise for effective collaborative transdisciplinary teamwork with the caregivers as primary role players.

The **primary barriers** toward effective interaction processes according to the three specified themes were

- a complacency and lack of interest on behalf of the nurses to learn more about the effect of infant hearing loss and the screening process;
- poor awareness of the benefits of early intervention for hearing loss. accompanied by a fatalistic attitude toward the possibility of having a hearing loss in some cases; and
- older infants becoming more difficult to screen because they sleep less and are more shy of people outside their home.

Although the general interactional processes were satisfactory for a screening programme, the challenges must be addressed. This will require efforts towards enhancing public awareness in MCH clinics and in communities regarding the benefits of early identification compared to the negative impact of delayed intervention.

6.7. CONCLUSION

The current study described an early hearing detection programme at two MCH clinics in a developing, semi-urban, South African community to provide contextual data for the planning of future screening programmes in similar settings according to the year 2002 HSPS (HPCSA, 2002:5). Conducting such pilot studies are in line with the governmental priority to conduct Essential National Health Research (ENHR) and will provide a means of estimating the true costs and efficiency of implementing these programmes (Swanepoel et al., 2004:634). This information will serve to direct the development of an EHDI service delivery model at primary healthcare clinics for the provision of contextually relevant services to newborns and infants.

The results obtained in the empirical study revealed the potential uses of MCH clinics as a platform for conducting infant hearing screening and provided valuable information regarding the utilisation of different screening protocols and procedures suited to these settings. The findings challenged current recommendations by the year 2002 HSPS (HPCSA, 2002:5) and have generated a number of contextual recommendations toward implementing screening programmes and protocols that are efficient and effective within the primary healthcare clinic context of South Africa. The dearth of South African and international reports regarding the utilisation of primary healthcare centres as platforms for infant hearing screening programmes puts an important onus on the current results to serve as direction markers for future programme implementation. This is a first step in a process toward ensuring that South African infants with hearing loss, especially those from previously disadvantaged communities, are afforded the best opportunities for optimal development and societal integration through accountable EHDI services.

6.8. SUMMARY

This chapter provided a presentation and discussion of the results obtained in the empirical study. This included quantitative results, from the dominant data collection method, obtained from interview schedules and test procedures in conjunction with qualitative data, from the less-dominant data collection method, comprised from field notes and critical reflections. The results were presented and discussed according to the five sub-aims specified for this study aiming to address the main aim of the study. The discussions integrated the findings with the current body of knowledge to demonstrate the relevance thereof. The chapter was concluded with a conclusion and summary.

CHAPTER 7

CONCLUSIONS AND IMPLICATIONS

Aim: To draw general conclusions and derive implications from the research findings, critically evaluate the research, and make recommendations for future research

7.1. INTRODUCTION

Informed clinical practice is guided by applied research endeavours and clinical practice in turn stimulates these research activities (Fouché, 2002a:109). Such a reciprocal relationship is necessary to steer evidence-based practice, and in areas where there is an absence of clinical practice it should only be established based on applied contextual research endeavours.

The initiator of UNHS in the USA, Marion Downs, is confident that the Western world will soon see most newborns enrolled in UNHS programmes and has urged these countries to assist developing countries such as South Africa to follow suit (Downs, 2000:293). Developing audiological services is, however, reliant on research that meets the unique local demands of the South African population and context in a socially and economically justifiable manner (Hugo, 1998:12).

The current investigation of Maternal and Child Health (MCH) clinics being recommended as hearing screening contexts by the year 2002 Hearing Screening Position Statement (HPCSA, 2002:5), aims to address this responsibility by providing research-based recommendations for clinical practice. This exploratory study can therefore serve to initiate further research and guide

future clinical implementation of Early Hearing Detection and Intervention (EHDI) programmes at MCH clinics in a manner that improves hearing healthcare for South African infants in a cost-effective and accountable manner.

The aim of this chapter therefore, is to draw general conclusions and implications from the results of the empirical study, to critically evaluate the research, and to make specific recommendations from the theoretical and empirical research conducted during this study in the format of a proposed infant hearing screening service delivery model in MCH clinics in South Africa.

7.2. CONCLUSIONS

The recommendation by the South African year 2002 HSPS, namely to include MCH clinics as an infant hearing-screening context, was investigated in a developing peri-urban community during the current study. The empirical research was conducted according to five sub-aims, which resulted in the summarised conclusions that follow below.

Sub-aim #1 Description of MCH clinics as screening context

The two MCH clinics investigated in Hammanskraal provided a suitable context to screen infants for hearing loss despite prevailing contextual barriers that are characteristic of primary healthcare clinics in developing contexts of South Africa. A summary of the results and discussion that describe these clinics as screening contexts was provided in Table 6.2.

Sub-aim #2 Description of infants and caregivers attending clinics

Caregivers and infants attending these two MCH clinics demonstrated significant degrees of socio-economic depravity, which places the population at an increased risk for congenital hearing loss, poor participation in the hearing screening/follow-up process, and subsequent poor involvement in a family-focused early intervention process for infants identified with hearing loss. A

summary of the environmental risk factors that were prevalent among the infants and caregivers attending the clinics was provided in Table 6.4.

Sub-aim #3 Description of HRR and test procedure results

A significantly increased incidence of risk indicators for hearing loss was recorded. The immittance and OAE results also indicated similar pass/refer results that are indicative of a close relationship between their measuring specificity for middle-ear transmission and inner-ear integrity. A summary of the discussion of the High Risk Register (HRR) and test procedure results was provided in Table 6.11.

Sub-aim #4 Description of screening protocol performance and efficiency

The screening protocol effectively identified infants, placed them into risk categories for hearing loss and established useful norms for high frequency immittance in infants. The efficiency of the programme was acceptable, considering the short period for which it had been implemented; however, inefficient coverage with the AABR and poor follow-up return rates were obtained at the clinics. A summary of the results and discussion describing the screening protocol performance and efficiency was provided in Table 6.20.

Sub-aim #5 Description of interactional processes involved in implementing and maintaining a screening programme at MCH clinics

Interactional processes between fieldworkers, clinic staff and caregivers revealed that collaborative partnerships fostered by consistent service delivery, maintenance of an open channel of communication and basic courteousness, facilitated an effective initial infant hearing screening at the two clinics. A summary of the results and of the interactional processes involved in implementing and maintaining a screening programme at MCH clinics was provided in Table 6.24.

The two MCH clinics, despite identified barriers, demonstrated promise for such clinics to serve as platforms for widespread hearing screening programmes for infants in South Africa. The descriptions according to the specified sub-aims of

the screening programme implemented during the current study revealed valuable clinical implications and made recommendations for the structure of the screening process and protocols to serve as guide for the future planning of early hearing detection programmes.

7.3. CLINICAL IMPLICATIONS

The most prominent clinical implications that can be derived from the empirical results obtained in this study are presented according to the sub-aims of the research in the following paragraphs.

Sub-aim #1 Description of MCH clinics as screening context

- Primary healthcare contexts such as the MCH clinics have the potential to serve as practical hearing screening contexts that provide comprehensive coverage of infants in South Africa, especially those from disadvantaged communities (Solarsh & Goga, 2004:121). The recommendation by the year 2002 HSPS, namely to include 6-week immunisation clinics at MCH clinics as a major screening context alongside the Neonatal Intensive Care Units (NICUs) and well-baby nurseries (HPCSA, 2002:5) is therefore a practical solution to achieve widespread screening coverage in the South African context.

Sub-aim #2 Description of infants and caregivers attending clinics

- The increased risk of having a congenital hearing loss as a result of the socio-economic depravity (Kubba et al., 2003:125) that characterises this community (which is representative of large parts of the South African population), highlights the urgent need for early hearing detection and intervention (EHDI) services to be made available to these infants (Olusanya et al., 2004:298).

- Due to the poor socio-economic and low educational levels evident in this community (which is representative of many developing contexts), the

implementation of successful EHDI services with actively involved caregivers will require culturally sensitive efforts towards enhancing awareness and educating caregivers about the benefits of early identification compared to lack of timely intervention (Bamford, 2000:365; Louw & Avenant, 2002:147). The fact that early intervention services are based on the premise that a child's success is largely the result of family-focused intervention, emphasises the fact that the first step in the management process must be to actively involve the caregiver (Beckman, 2002:687). An EHDI system at these clinics must therefore include an educational component that conveys information to caregivers about the effect of undetected hearing loss, as well as about the benefits and process of early intervention. Such information must be conveyed in a culturally sensitive manner that empowers families (Beckman, 2002:688). This also ensures that the locus of decision making remains within the family and necessitates their active participation (Popich, 2003:34).

Sub-aim #3 Description of HRR and test procedure results

- Due to limited resources, the year 2002 HSPS recommended the screening of infants according to the HRR as an intermediate step towards controlling the number of necessary screenings (HPCSA, 2002:5). The significantly increased incidence of risk factors reported in this study indicates, however, that screening at-risk infants may result in a significantly larger number of infants requiring screening compared to risk incidence reported in developed countries (Mahoney & Eichwald, 1987:160; Kennedy et al., 1998:1959; Vohr et al., 2000b:380). This reveals an important limitation of HRR screening if it is used for the purposes of limiting resource expenditure on IHS in a developing context such as Hammanskraal. An alternative screening approach is provided in the proposed service delivery model in paragraph 7.6.

- If a HRR is to be implemented, documenting a family history of hearing loss will require a meticulous and conscientious approach since ascertaining an accurate description is difficult (Kountakis et al., 2002:136;

Northern & Downs, 2002:277). In the current study, this risk factor (family history of hearing loss) contributed the majority of risks that have a negative effect on the feasibility of implementing a HRR approach to screening as an intermediate step toward UNHS. This fact indicates the need for a more rigorous approach to recording risks or an alternative approach as suggested in paragraph 7.5.

- In this population the screening of neonates for sensori-neural hearing loss was more effective than the screening of infants, because the high frequency immittance and OAE results demonstrated more referrals for infants than for neonates younger than four weeks. Therefore, if a screening programme targets sensori-neural hearing loss, the screening of neonates and younger infants will result in less confounding influences from MEE than the screening of older infants. Screening neonates or younger infants will therefore be a more successful screening practice at MCH clinics as it will result in earlier identification, thereby allowing earlier initiation of intervention services to the benefit of both infants and families (Yoshinaga-Itano, 2003:200).

- Screening with an Automated Auditory Brainstem Response (AABR) apparatus proved not to be very effective with older neonates and especially with infants, due to the fact that the babies' restlessness increased with age (Palmu et al., 1999:211). An OAE screening is therefore recommended at MCH clinics for infants paying their 6-week immunisation visits. OAE screening also requires less disposable materials, which results in reduced costs and is a simpler procedure to conduct than AABR screening. These are important aspects to consider in the resource poor developing contexts of South Africa and they also underwrite the use of OAE as an initial screening procedure at MCH clinics.

Sub-aim #4 Description of screening protocol performance and efficiency

- Since 1000 Hz immittance results are highly correlated with OAE results in the current study as well as in previous reports, they can serve as a useful tool in classifying neonates and infants into varying degrees of risk for types of hearing loss. Conducting 1000 Hz immittance measurements on infants referring the OAE screen can therefore be used to distinguish sensori-neural hearing loss from middle-ear pathology for infants younger than seven months of age (Kei et al., 2003:21; Purdy & Williams, 2000:9; Margolis et al., 2003:384). In this way the need for the medical management of middle-ear disease, as well as the need for and timing of diagnostic audiological procedures can be determined, all of which can save unnecessary referrals and follow-up appointments (Margolis et al., 2003:384).

- 1000 Hz immittance measurements, although useful in neonates, are more reliable in correctly identifying middle-ear effusion (MEE) in infants older than four weeks of age. The importance of including 1000 Hz immittance measurements for screening infants at MCH clinics can therefore be attributed to the following two facts: 1) Results of this study indicate that approximately 65% of OAE refer results in the population of infants investigated at the MCH clinics are due to transient MEE and/or external ear canal obstruction and 1000 Hz immittance measurements can assist in differential diagnosis between sensori-neural and conductive pathology; 2) The proposed screening at MCH clinics is recommended to be conducted when infants attend their 6-week immunisation visit (HPCSA, 2002:5) which means they are older than four weeks and therefore 1000 Hz immittance measurements will be more reliable than for neonates.

- The normative 1000 Hz tympanometry data obtained in this study demonstrates the importance of using age-specific norms for the infants and neonate population. This is essential as the values change significantly with increasing age due to maturation of the outer-ear and

middle-ear structures (Purdy & Williams, 2000:9; Meyer et al., 1997:194; Holte et al., 1991:21).

- Results indicate that the value of 1000 Hz probe tone acoustic reflexes for infants simply lies in the fact that its presence is usually reassuring of a normal middle ear, as was reported previously (Gates et al., 1994:56; Purdy & Williams, 2000:14). High frequency acoustic reflexes must therefore be used and interpreted in conjunction with 1000 Hz probe tone tympanometry in neonates and infants.

- Considering the South African national healthcare context with its limited resources and healthcare priorities skewed toward more life-threatening diseases, a screening protocol at MCH clinics for identifying bilateral hearing loss may be a more suitable intermediate solution than HRR screening. Limited resources also place a greater emphasis on identifying bilateral hearing loss above the more expensive identification of unilateral hearing loss (Lutman, 2000:368; Davis et al., 1997:73). The proposed screening protocol is discussed in paragraph 7.5.

- Follow-up return rates should improve steadily over time, provided that a consistent and continuous service is rendered and parents are empowered to realise the importance of early identification and intervention (Mehl & Thomson, 2002:1; Beckman, 2002:688). Internationally, this is acknowledged to be the primary challenge for successful hearing screening programmes (White, 2003:85). Clinicians in South Africa should therefore implement safeguards to ensure the provision of continuous and consistent services, as well as awareness and educational programmes that will, in turn, encourage higher follow-up return rates.

Sub-aim #5 Description of interactional processes involved in the implementation and maintenance of a screening programme at MCH clinics

- An important challenge that needs to be addressed is the active involvement of all participants in the screening process. Both the caregivers/parents and the nursing staff at MCH clinics need to be empowered by recognising and building upon the strengths and assets that they exhibit. Culturally sensitive information furthermore needs to be provided to improve their awareness and knowledge of hearing loss and its effects (Beckman, 2002:688). It is essential to establish effective collaborative partnerships where all parties share a common philosophy about the need and consequence of services so as to improve the outcomes of the infant (Moodley et al., 2000:26; Popich, 2003:34).

The clinical results of the empirical research conducted in this study could guide the implementation of future EHDI services at MCH clinics in South Africa. The recommendations that have flowed from this study also have further research implications, which are presented below.

7.4. RESEARCH IMPLICATIONS

A research question answered raises a multitude of new questions to be answered and in this sense the current study was no exception. The results obtained in and conclusions drawn from the current study revealed several significant aspects that require further investigation. These are presented to provide guidelines and suggestions for future research endeavours.

- Large-scale longitudinal studies are necessary at different pilot MCH 6-week immunisation clinics to gather data in a systematic manner (Swanepoel et al., 2004:634). At these pilot sites, nurses and/or lay volunteers should be trained to conduct hearing screening, while experienced audiologists should manage the programme (HPCSA, 2002:4). Pilot studies will provide incidence figures for hearing loss as well

as for the presence of risk factors in South Africa (Mencher & DeVoe, 2001:20). These studies will also serve to establish an integrated programme for immunisations and hearing screening that can serve as a model at all immunisation clinics in the South African context.

- An assessment should be made of the trainability and attitude of nurses and lay volunteers who are to conduct screening programmes. These studies will measure their level of involvement and will provide information towards the adaptation of programmes so as to ensure their active involvement and professional ownership – something which is essential for the success of such programmes (Moodley et al., 2000:37).

- Pilot studies are also necessary for NICUs and well-baby nurseries – the other two screening contexts in South Africa specified by the year 2002 HSPS (HPCSA, 2002:2) – since hardly any research reports regarding hearing screening in these contexts could be traced (Swanepoel et al., 2004:634). The incidence of risk factors and hearing loss must be determined alongside the best practice in screening, tracking and follow-up protocols. These pilot sites could then be developed to become centres of excellence that may serve as examples to other sites in generating relevant research to guide accountable practice in these South African contexts.

- An important and unique aspect that requires investigation is the effect of HIV exposure and infection on the incidence of congenital, delayed onset, and progressive hearing losses (Matkin et al., 1998:152). The high prevalence of HIV-infected mothers in South Africa provides an opportunity to conduct large-scale studies to investigate the effect of the infection on infant hearing (Swanepoel et al., 2004:634). This will establish whether HIV should be added to the list of high risk indicators for hearing loss especially in a country like South Africa.

- Parental anxiety and perceptions regarding hearing screening among the South African population are two other very important aspects that require investigation. Parental anxiety can potentially interfere with maternal infant attachment and cause abnormal parenting behaviour and communication (Watkin, 2003:170). Although international reports indicate this cost to be manageable, no such studies have been conducted in South Africa to date (Watkin, 2003:170). The range of cultures in South Africa needs to be investigated to determine attitudes toward and perceptions of screening for each, in order that culturally appropriate approaches may be followed (Beckman, 2002:688).

- Immittance measurements using both 226 and 1000 Hz probe tones need to be investigated in a large group of infant ears over the first few months and controlled for normal and abnormal middle-ear functioning. This should provide comparative data to validate or reject 1000 Hz probe tone immittance as a valuable tool for ascertaining middle-ear functioning.

The empirical results of the current study have provided direction for future research priorities aimed at developing and promoting EHDI services to infants with hearing loss in the developing contexts of South Africa.

7.5. CRITICAL EVALUATION OF STUDY

A critical evaluation of an empirical research endeavour is important to ensure the appropriate interpretation of results within the framework of the strengths and limitations of the research (Mouton, 2001:125). The current investigation of MCH clinics as a hearing screening context has been the first of its kind to be conducted in South Africa. This is despite the year 2002 HSPS compiled by the Professional Board for Speech, Language and Hearing Professions, which recommended MCH clinics as one of three screening contexts for the widespread implementation of newborn and infant hearing screening programmes (HPCSA, 2002:5). Table 7.1 below provides a critical evaluation of

the empirical study based on the strengths and limitations of the data collection method and procedures, as well as of the research participants.

TABLE 7.1 Critical evaluation of the empirical study

DATA COLLECTION
Strengths: - A combined qualitative and quantitative method of triangulation was implemented. This approach of convergence and complementarity provides greater insight into a social reality, which allows for a more comprehensive study (De Vos, 2002a:364; Posavac & Carey, 1989:242). Both quantitative and qualitative data was therefore used to provide a wider description of MCH clinics as hearing screening contexts. **Limitations:** - Since no hearing screening programme was in existence at MCH clinics when the study was conducted, an existing programme could not be investigated. This means that a programme was implemented and conducted over a short period of five months, solely for the purposes of the study. The conclusions drawn are therefore representative of a newly implemented programme and not of any existing programmes. For an aspect such as the follow-up return rate this has important implications, since reports indicate improved follow-up rates with increasing numbers of years in operation (Mehl & Thomson, 2002:1; White, 2003:85). - During the five-month data collection period it was not possible to conduct screening every day. Therefore not all infants who visited the MCH clinic during this period were necessarily screened, whereas in an established programme screening would have been conducted more consistently. Although appointments were made for specific days on which to conduct follow-up screening and diagnostic evaluations, a consistent delivery of screening services offers a more flexible schedule for caregivers to return with their infants. Mehl and Thomson (2002:1) report that on-going services over time result in improved follow-up return rates. The lack of such a consistent service and the use of a system of specific appointments may have increased the number of caregivers who did not return for follow-up evaluations. - The HRR, completed by the fieldworkers, evidenced clear misreporting by caregivers in the congenital infection section. When compared to the national incidence of HIV at antenatal clinics, it was clear that HIV status was not reported accurately. This was most likely due to the stigma of HIV infection, which creates many barriers towards disclosing the diagnosis, but it may also be due to ignorance and unconfirmed diagnoses (Spiegel & Bonwit, 2002:134). Closer collaboration with the nursing staff in completing the HRR and informing caregivers of the importance of correct disclosure may have resulted in more reliable documentation of HIV incidence. It might also have helped if information was provided and requested in a culturally sensitive manner that still respects caregivers' rights not to disclose their HIV status. - The inclusion of 226 Hz probe tone immittance measurements that allow comparison between the results of high and low frequency probe tone immittance measurements would have contributed valuable information about the usefulness of both procedures in the population of infants (Margolis et al., 2003:389).

TABLE 7.1 Continued

RESEARCH PARTICIPANTS
Strengths: - All fieldworkers had a bachelor's degree or diploma qualification in the communication sciences and had previous experience with neonatal hearing screening and cross-cultural interviewing. Two fieldworkers were also fluent in two or more African languages, which allowed for the collection of biographical and HRR information in caregivers' native or second language. These strengths facilitate collaborative relationships that contribute to successful EHDI programmes (Beckman, 2002:688). - A large sample of subjects was enrolled during the data collection period, which ensured an improved degree of generalisability and representation of the community investigated (Strydom & Venter, 2002:198). The large number of ears from which high frequency measurements were made also increased the sensitivity of norms compiled from the sample acquired in this study. **Limitations:** - The fieldworkers who conducted the screening were not representative of the screening personnel recommended by the year 2002 HSPS (HPCSA, 2002:5), namely nurses and/or lay volunteers. Using such personnel may influence the results of the screening programme and as such the current study is therefore not representative of the recommended screening practice at MCH clinics (HPCSA, 2002:5). - Since, at the time of the data collection, no formal screening programme existed in conjunction with the immunisation programme, all infants between the age of 0 and 52 weeks were included and not only those attending for their 6-week immunisation visit. This means that although the MCH and immunisation clinics were investigated, the study was not confined to the 6-week immunisation clinics for initial screens as recommended by the year 2002 HSPS (HPCSA, 2002:5). The results therefore do not represent only the 6-week immunisation clinics, but rather the broader population of infants younger than one year of age who attended the particular two MCH clinics.

The study in hand succeeded in investigating an important and appropriate South African hearing screening context for young infants in a manner that provides empirical data that can guide contextually relevant clinical implementation and future research. This contributes a unique body of knowledge toward developing hearing screening services in South Africa and addresses the recent international call for developing and establishing EHDI services in the developing countries of the world (White, 2004:28; Downs, 2000:293).

7.6. SERVICE DELIVERY MODEL FOR INFANT HEARING SCREENING IN MCH CLINICS

The clinical and research implications of the empirical study, together with the critical review of the research, constitute an important foundation for the development of future EHDI services at MCH clinics in South Africa. These empirical implications, combined with a theoretical approach, may be used to construct a broader model of EHDI service delivery at these clinics. The exploratory research conducted at the MCH clinics was based on large numbers of subjects that can be generalised to guide clinical practice in the form of a theoretically-grounded service delivery model. Research informs clinical practice and the empirical evidence compiled during the current study can be used in conjunction with a theoretical foundation to develop a service delivery model that informs the clinical practice of IHS at MCH clinics (Fouché, 2002b:97). Such a theoretical model becomes a representation of formalised perspectives that may guide the development of hypotheses for scientific inquiry and the implementation of services or interventions (De Vos, 2002c:38; Fouché, 2002b:97).

The objective of this model is to serve as a working document to complement the year 2002 HSPS (HPCSA, 2002:1) in the form of contextual, evidence-based recommendations and proposed infrastructures. The clinical implications and recommendations generated by the theoretical and empirical research conducted in this study are therefore compiled and presented in the form of a preliminary service delivery model for infant hearing screening at MCH clinics.

The proposed model is a working construct that integrates contextual empirical research evidence with theoretical perspectives (van Dijk, 2003:321). It is presented on three levels, namely 1) service delivery structure, 2) role players and responsibilities, and 3) screening protocol. Figure 7.1 presents the components of this three-tiered service delivery model.

SERVICE DELIVERY STRUCTURE

IMMUNISATION PROGRAMME

Existing healthcare platform for hearing screening programme

- *Free healthcare for children younger than 6 years of age*
- *Legislative, managerial and consultative participant support required*

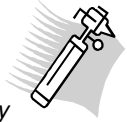
ROLE PLAYERS AND RESPONSIBILITIES

TRANSDISCIPLINARY TEAM APPROACH

Primary team members

Mother/caregiver

- *Essential and equal partner*
- *Active participants assuming responsibility*



Audiologist

- *Agent of change*
- *Programme manager*
- *Diagnostic assessment*
- *Intervention*
- *Training*

Nurse and/or volunteer

- *Screening*
- *Documenting risk indicators*
- *Educating mothers / caregivers regarding hearing loss and early intervention*

SCREENING PROTOCOL

Recommendations:

1. UNIVERSAL 2-STAGE OAE SCREEN

All infants are screened. A 2nd screen is scheduled for an initial refer result. For a 2nd referral a diagnostic evaluation is scheduled at secondary or tertiary levels

2. UNILATERAL PASS CRITERION

Only bilateral hearing losses are targeted. A single OAE pass is sufficient for an overall screening pass.

3. HIGH FREQUENCY IMMITTANCE

1000Hz probe tone tympanometry and acoustic reflexes for bilateral OAE refers. To classify ears into different risk categories for sensorineural hearing loss and MEE.

4. HIGH-RISK REGISTER

Risk indicators are used to identify infants requiring audiological surveillance for an increased risk of delayed onset or progressive hearing loss

FIGURE 7.1 Service delivery model for infant hearing screening at MCH clinics

7.6.1. Service delivery structure

The Department of Health has tasked MCH clinics to offer free healthcare for children up to six years of age. This package of free services includes immunisation, health surveillance and screening, identification of children with special needs, and basic elements of care and treatment for children with chronic illnesses (Children in 2001, 2000:42). The definition of services at MCH clinics seems to describe a very suitable and natural context for infant hearing screening and **the results of the current study have empirically demonstrated the appropriateness of these clinics as IHS contexts**. The specified services are comprehensive but unfortunately very little developmental screening is performed in actual practice (Baez, 2000:1). To create a workable system for establishing infant hearing screening will require a complete model for the adaptation of, and changes in, service provision at these clinics. This is in agreement with the philosophy of primary healthcare as a continuous process that develops over time and changes to meet new situations (Dennill et al., 1999:56). According to Dennil et al. (1999:56) this "is the only feasible means of meeting the health needs and improving the situation of the people of Southern Africa". To address this new situation, the following discussion proposes a preliminary service structure as part of the proposed infant hearing screening service delivery model.

The South African government has adopted the primary healthcare approach as the underlying philosophy for the restructuring of its health system. Due to this service delivery approach and the unique characteristics of the South African context, the relevance of early intervention service delivery models from developed contexts is limited (Fair & Louw, 1999:16). As a result, the integration of conventional early intervention models and a community-based model of service delivery as proposed by Fair and Louw (1999:21) is used to guide EHDI service delivery. The individual strengths of the two models are anticipated to be a powerful means of preventing primary, secondary and tertiary communication disorders through community participation (Fair & Louw, 1999:21). **The poor follow-up return rates documented in the current study emphasise the**

need for ensuring community participation through awareness and educational programmes about the effect of hearing loss and the benefits of early intervention.

However, as illustrated in Figure 7.1, the first step toward delivering EHDI services involves legislation and support for early intervention services by the managerial and consultative participants in the community-based intervention process (Fair & Louw, 1999:21). The South African year 2002 HSPS asserts this fact by stating that Provincial Directorates of Finance must accept full responsibility for ensuring that an adequate dedicated allocation of funds is made to enable hearing screening and intervention (HSPS, 2002:4). **Yet, the current study did not observe any hearing screening equipment at any of the clinics studied, despite the recommendation by the HSPS to have equipment available at all MCH clinics by 2005** (HSPS, 2002:5). Lobbying for governmental support is therefore essential to ensure that newborn and infant hearing screening and follow-up services are comprehensive and effective.

This type of support will allow for the implementation of widespread EHDI programmes in South Africa but will require contextual models of service delivery to ensure reliable implementation at all levels of healthcare. As indicated in Figure 7.1, an infant hearing screening service delivery model at MCH clinics will be at a primary healthcare level and should therefore utilise human resources at this level within the community-based intervention model to identify possible hearing losses (Fair & Louw, 1999:17). **Results from the current study indicate that nurses were helpful but disinterested in learning about either hearing loss or the screening process. Creating awareness and providing education programmes for nursing staff should therefore form an important element of introducing EHDI services at MCH clinics.**

Diagnostic services must be available at regional hospitals or health centres. The South African year 2002 HSPS recognises this when it recommends that hearing screening at MCH 6-week immunisation clinics should be integrated within the District Health Services model. The proposed service structure for an infant

hearing screening service delivery model at MCH clinics in South Africa is illustrated in Figure 7.2.

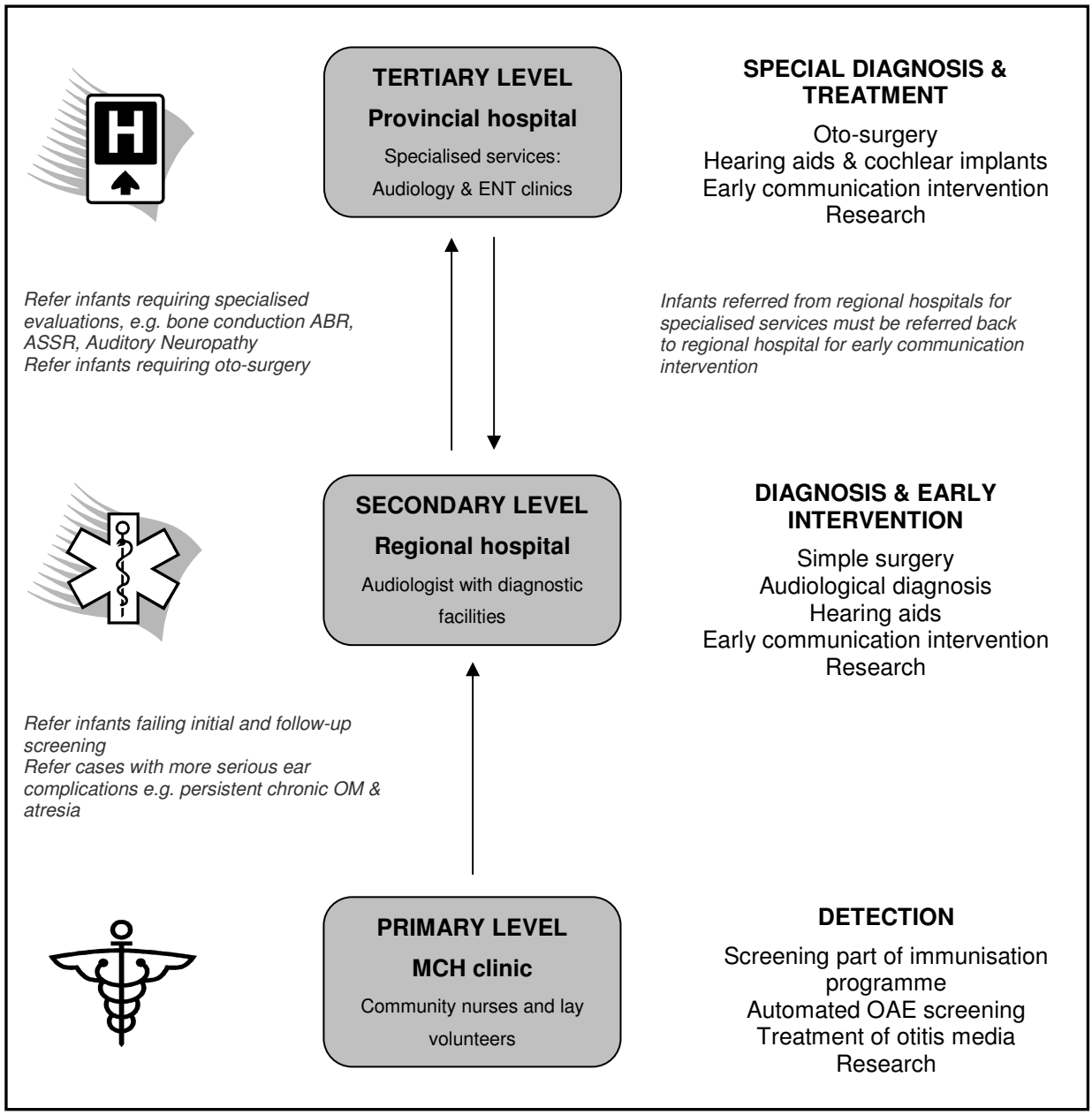


FIGURE 7.2 Service structure for infant hearing screening at MCH clinics

The national programmes of immunisation, as supported by the expanded programme on immunisation (EPI) initiative of UNICEF, can serve as an effective

existing healthcare platform from which a hearing screening service can be initiated (Olusanya et al., 2004:297). Using the immunisation programmes as a platform for hearing screening (as indicated in Figure 7.2) will ensure that a comprehensive coverage of infants is attained, seeing that only 2% of South African children between the ages of 12 and 23 months receive no vaccinations (*Children in 2001*, 2001:75). A recent report indicated that 79% of all infants in South Africa were fully immunised by one year of age (Solarsh & Goga, 2004:121). This percentage could ensure an almost 80% coverage for hearing screening before six months of age, as the first immunisation is recommended at 6 weeks of age. Follow-up screenings may also be scheduled alongside second immunisation visits at 14 weeks of age (3.5 months) to ensure high follow-up return rates (Day et al., 2004:404). **The fact that poor follow-up return rates were recorded during the current study emphasises the importance of arranging follow-up appointments for the 2nd stage OAE screen or a diagnostic evaluation to coincide with follow-up immunisation visits.**

A concern regarding the screening of infants who come for their immunisation visits, however, is that hearing loss may not be identified before the recommended three months of age (HPCSA 2002:5) since some of these infants may only be brought into the clinic for their first immunisation later on during the first year of life (*Children in 2001*, 2001:75). The Department of Health has fortunately put forward a recent strategic plan to ensure that full immunisations are achieved for all infants by one year of age, with an intermediate step of 90% national coverage by 2005 (Solarsh & Goga, 2004:113 & 122; *Children in 2001*, 2001:75).

Another concern is that, even when infants are screened at exactly six weeks of age on their first immunisation visit, it allows limited time for follow-up and confirmation of hearing loss before three months of age (JCIH, 2000:15). For hearing screening in well-baby nurseries and NICUs a cut-off age of three months old may be a reasonable benchmark for South Africa, but at MCH clinics this might prove very difficult to attain. Realistic benchmarks must therefore be

determined for ages at which hearing loss can be identified, that will coincide with immunisation visits to MCH clinics.

Generally the results from the current study indicate that, **despite obvious practical obstacles such as high noise levels, interruptions in electricity and water supply, as well as safety concerns, the MCH clinics provide an adequate platform for conducting hearing screening.** The healthcare system has also recently identified the need to upgrade these primary healthcare facilities, which promises to enhance the suitability of MCH clinics as a hearing screening context in the future (Day et al., 2004:345).

7.6.2. Role players and responsibilities

The implementation of comprehensive services for the early detection of hearing loss must rely on a transdisciplinary team approach that facilitates collaborations and that is essential for community-based early intervention services (Moddley et al., 2000:37). As indicated in Figure 7.1, the three primary role players in the infant hearing screening service delivery model at MCH clinics are identified as caregivers, audiologists, and nurses or volunteers.

- **Caregivers**

  Collaborative hearing services that are family friendly are necessary for success. This conviction is based on the premise that any success a child achieves will be through family intervention, and therefore the family must be an essential and equal partner in the hearing management team (Mencher et al., 2001:8). The South African HSPS acknowledges this when it states that the members of the transdisciplinary team includes first of all families, followed by the other professionals (HSPS, 2002:4). **Results from the current study indicate that the majority of caregivers evidenced a willingness to participate actively in the screening process and this is promising for effective collaborative transdisciplinary teamwork where caregivers are the primary role players**.

- **Audiologists**

  Audiologists are central to this service delivery model, as indicated in Figure 7.1, and should act as agents of change in the implementation thereof. Due to the advanced technological apparatus associated with the practice of audiology and a general lack of knowledge regarding the profession, it is occasionally wrongly assumed to be an unsuitable profession for PHC services. According to Moodley et al. (2000:37), however, it is imperative that audiologists be proactive in determining appropriate ways of delivering early intervention services at PHC clinics. Audiologists who serve infants and young children with hearing loss and their families must consider themselves to be early interventionists and, therefore, part of an early intervention team (English, 1995:117). The families together with the professionals render the necessary services within a family-focused, transdisciplinary team model (HSPS:2002:4). It is the audiologist, however, who supervises the screening programme in the capacity of programme manager (HSPS, 2002:4).

  In the proposed service delivery model illustrated in Figures 7.1 and 7.2, the audiologist provides services from a regional or provincial hospital but also manages, coordinates, and assesses the hearing screening programmes at the MCH clinics. The JCIH Year 2000 position statement (2000:13) specifies the role of the audiologist for the hearing screening component as "development, management, quality assessment, service coordination, and effective transition to evaluation, habilitative and intervention services". The audiologist must ensure that the services are effective and the referral system is efficient. A database must also be kept as part of a national information infrastructure. The following types of data must be collected: number of infants screened; number of infants referred for follow-up; number of infants referred for diagnostic assessments; number of infants with hearing loss, number of different types of hearing loss; number of infants whose hearing was evaluated before 3 month of age; the mean, median, and minimum age of diagnosis, etc. (HSPS, 2002:7).

For the follow-up component the audiologist's role entails "comprehensive audiologic assessment to confirm the existence of the hearing loss, evaluate the infant for candidacy for amplification and other sensory devices and assistive technology, and ensure prompt referral to early intervention programs" (JCIH, 2000:13). The poor follow-up return rate of the current study indicates that audiologists will have to be resourceful in finding ways through community participation to ensure that caregivers become active participants in returning their infants for follow-up appointments (Louw & Avenant, 2002:147). For the early intervention component the audiologist should provide "timely fitting and monitoring of amplification (sensory devices and assistive technology) with family consent, family education, counselling and ongoing participation in the infant's service plan" (JCIH, 2000:13).

Timely and efficient confirmation of hearing loss for infants screened during 6-week immunisation visits at MCH clinics will require an integrated multi-disciplinary follow-up system. The audiologist must play a key role in the process of developing a comprehensive integrated system for tracking and follow-up of referred infants and caregivers within the South African national healthcare system as illustrated in Figure 7.1. Poor follow-up rates are characteristic of programmes in the initial phases (Mehl & Thomson, 2002:1) and emphasise the responsibility of audiologists to strive for optimal follow-up rates by sustained effort and dedication as programme managers.

An important role of the audiologist will be to train the nurses and/or volunteers who will be conducting the screening. Interdisciplinary training programmes to empower the nurses and/or volunteers are necessary to ensure that the screening is conducted in an accountable manner (Moodley et al., 2000:36). **Results from the current study indicate that the interactional processes between nurses and audiologists are an essential part of ensuring successful screening programmes.** Training programmes need to address the fact that screening personnel should educate the mothers/caregivers about the importance of returning for follow-up appointments, the effect of late-identified hearing loss, and the benefits of

early identification and intervention. **The current study indicates that poor follow-up rates were a consistent obstacle in the way of successful hearing loss identification and this problem may be addressed by educating mothers and caregivers about the importance of early identification.** Mothers who are better educated are more likely to return for the full set of vaccinations and probably also for follow-up hearing screenings and evaluations (*Children in 2001*, 2001:75). Positive changes will require culturally sensitive efforts towards enhancing public awareness in antenatal clinics and in communities regarding the benefits of early identification and the disadvantages of lack of timely intervention (Bamford, 2000:365; Louw & Avenant, 2002:147).

- **Nurses and/or volunteers**

  According to this model it is recommended that community nurses and volunteers perform the initial hearing screening as illustrated in Figure 7.1 (HSPS, 2002:4). Community-based primary healthcare nurses are the frontline health professionals in the early intervention team, since they have direct contact with at-risk infants and are based at primary healthcare clinics that are accessible and affordable to the majority of the South African population (Moodley et al., 2000:26). The primary healthcare clinics therefore constitute the obvious place where infants should receive developmental screening and presents as an ideal context for identifying hearing loss early (Moodley et al., 2000:26). In addition, the community nurses outnumber the audiologists by more than ten times (Moodley et al., 2000:26). Nurses are key team members in identifying infants with hearing loss because almost all babies visit a clinic during their first three years of life (*Children in 2001*, 2001:75). **The current study reports that nurses are a valuable asset in ensuring that risk factors for hearing loss are documented accurately.** Although nurses already have many responsibilities, the gains that can be made by developmental screening (e.g. hearing screening) are so great that sustained efforts should be made to incorporate such screening into a community nurse's day (Baez, 2003:2).

Lay volunteers have also proved to be a valuable human resource in neonatal hearing screening programmes (Downs, 2002: personal communication). This could be of significant value in South Africa where resources are already limited and there is a lack of healthcare professionals who are fluent in African languages. A community volunteer can be any person as long as he/she is motivated, has literary skills and a positive, respectful attitude towards all people (McConkey, 1995:72). The volunteer must receive appropriate training according to SAQA accredited training modules and should be presented by speech-language therapists or audiologists (HSPS, 2002:4). The training must empower the screening personnel to educate mothers and caregivers about the importance of returning for follow-up appointments, the effect of late-identified hearing loss, and the benefits of early identification and intervention **in order to ensure a higher follow-up return rate than the number reported in the current study** (*Children in 2001*, 2001:75). According to McConkey (1995:71) the quality of the training will often determine the quality of the programme.

7.6.3. Screening protocol

A hearing screening protocol, based on the outcomes of both the theoretical and empirical investigations conducted during this study and illustrated in Figure 7.1, is recommended for use in MCH 6-week immunisation clinics. The recommended protocol is a working suggestion for the initial implementation of hearing screening in MCH 6-week immunisation clinics in response to the recommendations by the year 2002 HSPS (HPCSA, 2002:2). As illustrated in Figure 7.1, the protocol recommends the following: 1) universal 2-stage OAE screen, 2) a unilateral pass criterion, 3) high frequency immittance measures to classify degrees of risk, 4) High-Risk Register (HRR) for audiological surveillance. The rationale for these recommendations as compared to the year 2002 HSPS recommendations and evidenced in the current study is discussed in the following paragraphs.

Instead of screening only the high risk infants who attend clinics, as recommended by the year 2002 HSPS (HPCSA, 2002:5), a universal screening using a unilateral pass criterion is recommended. In the past, targeted screening was recommended as a way of screening a small percentage (~10%) of infants to obtain a significant (~50%) yield of present hearing losses in a birth cohort. **Although excellent coverage (99%) based on the HRR was obtained during the current study, there are serious concerns about such a targeted infant hearing screening programme at the MCH clinics in South Africa.**

The current study suggests that the prevalence of risk factors in primary healthcare clinics in South Africa may be twice as high as in developed countries (Kennedy et al., 1998:1959; Mahoney & Eichwald, 1987:161; Vohr et al., 2000b:380). If HIV status is considered as an additional risk factor for hearing loss, this figure will rise even more significantly. This increased prevalence of risk factors implies that a large number of infants will require thorough bilateral screening, which calls for more human and economic resources. **The current study shows that if only high risk infants were screened, 77% of infants with bilateral OAE refer results would have been missed.** This means that two-thirds of the infants at highest risk for bilateral hearing loss would not have been identified by the risk factors. Furthermore, infants identified through targeted NHS have a significantly higher incidence of secondary disabilities than infants without risk indicators. This means that the children presenting with hearing loss only, in other words those who have the highest potential for success, are most likely to be missed (Yoshinaga-Itano, 2004:462).

Since it is recommended that the OAE equipment be made available at the MCH clinics to conduct targeted screening (HPCSA, 2002:5), it may well prove more productive to screen all infants who attend the clinics by using an efficient unilateral OAE pass criterion. This will ensure that existing resources are used (OAE equipment recommended for targeted screening by the year 2002 HSPS) to identify bilateral hearing loss, which impacts most significantly on a child's development, for the entire population. A unilateral pass criterion implies a much-reduced screening time, since only one ear is required to pass and therefore in

the majority of cases only one ear will require a screen. In addition to this, by applying a unilateral OAE pass criterion, the monetary and human resource requirements for conducting follow-up evaluations would be reduced significantly. **In the current study the referral rate dropped from 14% to 3% when a unilateral pass criterion instead of a bilateral pass criterion was applied** – which is within the specified benchmark of the JCIH (2000:15) and the South African HSPS of a <5% referral rate (HPCSA, 2002:3).

The fact that a screening protocol for bilateral hearing losses will curb resource expenditure must however be evaluated against the cost of not identifying a group of infants with unilateral hearing loss. Although research shows that unilateral hearing loss does in fact influence developmental and emotional outcomes in children (Bess et al., 1998:339), limited resources and a lack of research to demonstrate the effectiveness of early intervention for unilateral hearing loss inevitably accord a higher priority to the identification of bilateral hearing loss over the more expensive identification of unilateral hearing loss (Lutman, 2000:368; Davis et al., 1997:73). Considering the South African national health context with its limited resources and health priorities skewed toward more life-threatening diseases such as HIV and tuberculosis, a screening protocol for bilateral hearing loss only may be a suitable initial option. More comprehensive services may subsequently be built upon such initial programmes and there is still a place for the HRR to identify infants who are at risk for delayed-onset and progressive hearing loss (JCIH, 2000:21).

Based on the results of the current study, the recommended screening equipment to be used at MCH clinics is OAE rather than AABR instrumentation. The screening protocols that were implemented revealed the inadequacy of AABR screening at these clinics in contrast with the efficiency of OAE screening. Conducting an AABR screening on infants past neonatal age becomes increasingly difficult since the babies are more restless and irritable and they become less trusting of unfamiliar personnel as they grow older (Palmu et al., 1999:211). Since the AABR requires more preparation in the form of placing the electrodes and ensuring sufficient impedance, it becomes more

difficult to test the infants, whereas a simple OAE procedure requires only a probe placement, which results in a shorter average test time. Although the AABR may provide a lower refer rate in newborns (Hall et al., 2004:423), **the AABR procedure could only be performed successfully on 26% of the ears that required an assessment in the current study. This fact demonstrates the AABR's inefficiency in respect of older infants to be screened at MCH clinics**.

As illustrated in Figure 7.1, a two-stage OAE screening is recommended. This implies that all infants are screened with OAE and those requiring follow-up appointments are screened for a second time using the same procedure. An OAE refer result for a second-time screen will lead to the scheduling of a diagnostic evaluation at a secondary or tertiary hospital. In addition to OAE, **the use of high frequency immittance measurements may be useful in classifying ears into different risk categories for sensori-neural hearing loss and MEE.** Based on this information it will be possible to determine the need for medical management, as well as the need for and timing of follow-up hearing assessment procedures that will also require initial referrals to either otorhinolaryngologists or audiologists (Margolis et al., 2003:384). Although additional research is required, preliminary risk categories according to 1000 Hz probe tone results of the current study are as follows:

- If a peaked tympanogram is obtained and an acoustic reflex is present, normal middle-ear functioning is strongly indicated.
- If the tympanometry indicates a flat tympanogram and an absent acoustic reflex threshold, it will be strongly indicative of a middle-ear conduction problem such as MEE.
- A mixed result indicating an OAE refer, tympanogram peak and absent reflex will be a high-risk combination for sensori-neural hearing loss.
- An absent OAE and a flat tympanogram with a present reflex are rare and more difficult to interpret. Such a result may be due to a mild conductive MEE that could lead to an OAE refer and a flat tympanogram, but that presents with a present reflex at maximum intensities.

Reliance on a single infant hearing screening technology makes it virtually impossible to identify dysfunction secondary to middle-ear disorders (Hall et al., 2004:423). Although the inclusion of an AABR can help to make this distinction, this procedure has not proved effective in the population of infants attending MCH clinics. Reliance on a faster and more efficient technique such as high frequency immittance will be more valuable at these clinics.

The above infant hearing screening service delivery model is proposed in response to the recommendations by the Year 2002 HSPS (HPCSA, 2002:5) as a feasible step toward providing more comprehensive infant hearing screening programmes for the majority of South African infants to the benefit of those infants with hearing loss, their families and society in general.

7.7. FINAL COMMENTS

The basic rationale behind newborn and infant hearing screening is that "early detection followed by early intervention maximises the benefits the child, family, and society will receive" (Diefendorf, 2002:469). Ensuring these benefits remains a challenge, especially in a resource-poor country like South Africa where a non life-threatening yet debilitating condition such as hearing loss does not receive the institutional support, research funding and political advocacy that it deserves (Swanepoel et al., 2004:634).

It is the responsibility of the audiological community in South Africa to meet the challenge of developing early hearing detection programmes for the entire population in order to ensure that infants with hearing loss may develop to their maximum potential. This must be achieved primarily through contextual research that reveals the extent and impact of hearing loss alongside the standard and scope of otological and audiological services in South Africa. These endeavours are required to gain governmental support and will ensure a contextually relevant course of action towards implementing widespread newborn and infant screening

programmes that are incorporated into primary and secondary healthcare, thus becoming an integral part of a national health and education system.

In the pursuit of comprehensive First World hearing healthcare for South African infants, the audiological community must be content to start with small-scale infant hearing screening (IHS) services against the backdrop of a country with no formalised public healthcare screening programmes to identify infants with hearing loss. This must, however, be accompanied by a relentless quest for continued growth and improvement in IHS services delivery over time. Initial steps toward comprehensive services need to start with pilot screening programmes that take the lead in providing feasible and accountable services, which can serve as examples for future programme implementation on a wider scale. These pilot sites will provide an infrastructure that can serve as a platform for contextual research and further improvements in service provision suited to each context. In line with these ideals, the current exploratory study provides data that indicates the usefulness of MCH clinics as an IHS context and suggests working recommendations for the future direction of early identification and intervention services for infants with hearing loss in South Africa.

The ultimate goal is to have “screening programmes that improve hearing healthcare for all infants in a cost-effective and accountable manner” (Swanepoel et al., 2004:635). EHDI programmes have proved that “hearing loss need not impede typical development, place an individual at a functional disadvantage, or alter ultimate outcome” (Herer et al., 2002:224). It is time that the hearing loss barrier be minimised for children in South Africa, and that the benefits and improvement of quality of life associated with early identification and intervention become a reality for the infants who suffer hearing loss in South Africa. Children with hearing loss are as much part of the future of the country as those with normal hearing and it is through effective EHDI services that the active participation of these children will be secured among their hearing peers to change, influence and direct the future of South Africa.

"The problems of deafness are deeper and much more complex, if not more important, than those of blindness. Deafness is a much worse misfortune, for it means the loss of the most vital stimulus – the sound of the voice that brings language, sets thought astir, and keeps us in the intellectual company of man."

Helen Keller (Keller, 1910)

REFERENCES

Alberti, P.W. 1999. Pediatric ear, nose and throat services' demands and resources: a global perspective. *International Journal of Pediatric Otorhinolaryngology*, 49(Suppl.1):S1-S9.

American Academy of Pediatrics. 1999. Task Force on Newborn and Infant Hearing. Newborn and infant hearing loss: detection and intervention. *Pediatrics*, 103:527-30.

American Speech-Language-Hearing Association. 1997. *Guidelines for audiologic screening: Panel on audiologic assessment*. Rockville, MD: American Speech-Language-Hearing Association.

Arehart, K.H., Yoshinaga-Itano, C., Thomson, V., Gabbard, S.A., & Stredler Brown, A. 1998. State of the States: The status of universal newborn hearing screening, assessment, and intervention systems in 16 States. *American Journal of Audiology*, 7:101-114.

Australian National Hearing Screening Committee. 2001. Australian consensus statement on neonatal hearing screening. http://www.hgsa.com.au/policy/UNHS.html (Date of access: 17 September 2004).

Babbie, E. 2001. *The practice of social research*. 9th ed. Belmont: Wadsworth.

Baez, C. 2000. Child health in South Africa: Developmental screening in children. *Update,* 52:1-2. http://www.hst.org.za/update/52/isds.html

Bailey, H.D., Bower, C., Krishnaswamy, J. & Coates, H.L. 2002. Newborn hearing screening in Western Australia. *Medical Journal of Australia*, 177(4):180-185.

Bamford, J. & Davis, A. 1998. Neonatal hearing screening: a step towards better services for children and families. *British Journal of Audiology*, 32:1-6.

Bamford, J. 2000. Infrastructure supporting infant hearing screening programs. *Seminars in Hearing*, 21(4):359-366.

Balkany, T.J., Berman, S.A., Simmons, M.A. & Jafek, B.W. 1978. Middle ear effusion in neonates. *Laryngoscope*, 88:398-405.

Bam, I., Kritzinger, A. & Louw, B. 2003. Die vroeë kommunikasieontwikkeling van ‘n groep babas met pediatriese MIV/VIGS in sorgsentrums. *Health SA Gesondheid*, 8(2):34-47.

Bankaitis, A.E., Christensen, L.A., Murphy, G., & Morehouse, C.R. 1998. HIV/Aids and Auditory Evoked Potentials. *Seminars in Hearing,* 19(2):177-193.

Baroch, K.A. 2003. Universal newborn hearing screening: fine-tuning the process. *Otolaryngology & Head & Neck Surgery*, 11(6):424-428.

Barringer, D.G., & Mauk, G.W. 1997. Survey of parents' perceptions regarding hospital-based newborn hearing screening. *Audiology Today*, 1:18-19.

Barsky-Firkser, L. & Sun, S. 1997. Universal newborn hearing screenings: A three-year experience. *Pediatrics*, 99:E4.

Bastos, I., Mallya, J., Ingvarsson, L., Reimer, A. & Andreasson, L. 1995. Middle ear disease and hearing impairment in northern Tanzania: A prevalence study of school children in the Moshi and Monduli districts. *International Journal of Pediatric Otorhinolaryngology*, 32:1-12.

Beckman, P.J. 2002. Providing family-centered services. In: M.L. Batshaw (Ed.) *Children with Disabilities*. 5th ed. Baltimore: Paul H. Brookes Publishing Co. 683-691.

Beighton, P., Sellars, S.L., Goldblatt, J. & Beighton, G. 1987. Childhood deafness in the Indian population of Natal. *South African Medical Journal*, 72:209-211.

Berlin, C.I. 1999. Auditory Neuropathy. *Seminars in Hearing*, 20(4):307-315.

Berman, S.A., Balkany, T.J. & Simmons, M.A. 1978. Otitis media in the neonatal intensive care unit. *Pediatrics*, 62:198-202.

Bess, F.H., Dodd-Murphy, J. & Parker, R.A. 1998. Children with minimal sensorineural hearing loss: prevalence, educational performance and functional status. *Ear and Hearing*, 19(5):339-54.

Bhana, R. 2004. Youth risk behaviour. *South African Health Review 2003/04*. http://www.hst.org.za/publications/423 (Date of access: 3 August 2004).

Bless, C. & Higson-Smith, C. 2000. *Fundamentals of social research methods*, Cape Town: Juta.

Boohla, D. & Hugo, S.R. 1995. Prevalence: outer and middle ear disorders in black and Indian preschool children from Durban. *The South African Journal of Communication Disorders,* 42:19-27.

Brookhouser, P.E., Worthington, D.W. & Kelly, W.J. 1991. Unilateral hearing loss in children. *Laryngoscope*, 101:1264-1272.

Calderon, R. & Naidu, S. 2000. Further support of the benefits of early identification and intervention with children with hearing loss. *Volta Review*, 100(5):53-84.

Campbell, N., Hugo, R., Uys, I., Hanekom, J. & Millard, S. 1995. Early recurrent otitis media, language and central auditory processing in children. *The South African Journal of Communication Disorders*, 42:73-84.

Carney, A.E. & Moeller, M.P. 1998. Treatment efficacy: hearing loss in children. *Journal of Speech Language and Hearing Research*, Suppl. 41:61-84.

Celliers, C., Rossouw, D., Meyer, S. & Hurter, M. 1988. Die aard en voorkoms van middeloorpatologieë in laerskole vir normaalhorende blanke kinders. *South African Journal of Communication Disorders,* 35:35-37.

Census 1996. 1996. Population Census for South Africa. http://www.statssa.gov.za/census96/html (Date of access: 16 August 2004).

Census 2001. 2003. Population Census for South Africa. http://www.statssa.gov.za/SpecialProjects/Census2001/Census2001.htm

Centner, L. 2000. A service analysis of speech – Language/hearing services in four districts of the west coast – winelands region. Unpublished B. Speech and Hearing Therapy dissertation. Department of Logopaedics: University of Cape Town.

Central Statistics. 1998. *Living in South Africa: Selected findings of the 1995 October household survey*. Pretoria: Central Statistical Service, 1-44.

Chan, D., Absher, D. & Sabatier, S. 2002. Recipients in need of ancillary services and their receipt of HIV medical care in California. *AIDS Care*, 14:S73-S83.

Chapchap, M.J. & Segre, C.M. 2001. Universal newborn hearing screening and transient evoked otoacoustic emission: new concepts in Brazil. *Scand Audiol*, 30(Suppl. 53):33–36.

Children in 2001. 2001. *A Report on the State of the Nation's Children*. Department of Health. Pretoria: Government Printer.

Chu, K., Elimian, A., Barbera, J., Ogburn, P., Spitzer, A. & Quirk, J.G. 2003. Antecedents of Newborn Hearing Loss. *Obstetrics and Gynecology*, 101:584-588.

Cilliers, G. 1980. *'n Beroepstudie van spraakterapeute en oudioloë*. Pretoria: RGN. Verslagnr. MM79.

Claesen, F.A.P., Van Boxtel, C.J., Perenboom, R.M., Tange, R.A., Wetseijn, J.C.F.M. & Kager, P.A. 1998. Quinine pharmacokinetics: ototoxic and cardiotoxic effects in healthy Caucasian subjects and in patients with falciparum malaria. *Tropical Medicine and International Health*, 3(6):482-489.

Clemens, C.J., Davis, S.A. & Bailey, A.R. The false-positive in universal newborn hearing screening. *Pediatrics* 2000:106. www.pediatrics.org/cgi/content/full/106/1/e7. (Date of access: 13 July 2004).

Cone-Wesson, B., Vohr, B.R., Sininger, Y.S., Widen, J.E., Folsom, R.C., Gorga, M.P. & Norton, S.J. 2000. Identification of neonatal hearing impairment: Infants with hearing loss. *Ear & Hearing*, 21(5):488-507.

Cox, L.C. & Toro, M.R. 2001. Evolution of a universal infant hearing screening program in an inner city hospital. *International Journal of Pediatric Otorhinolaryngology*, 59:99-104.

Creswell, J.W. 1994. *Research design: qualitative and quantitative approaches*. Thousand Oaks: Sage.

Culpepper, B. 2004. Survey of early hearing detection and intervention (EHDI) guidelines for infant audiology services. International Conference on Newborn Hearing Screening Diagnosis and Intervention, May 27-29, Abstract book 162.

Curotta, J.H. 1997. Managing acute otitis media. *Modern Medicine of South Africa*, 3:27-36.

Dalzell, L., Orlando, M., McDonald, M., Berg, A., Bradley, M., Cacace, A., Campbell, D., DeCristofaro, J., Gravel, J., Greenberg, E., Gross, S., Pinheiro, J., Regan, J., Spivak, L., Stevens, F. & Prieve, B. 2000. The New York State universal newborn hearing screening demonstration project: Ages of hearing loss identification, hearing aid fitting and enrolment in early intervention. *Ear & Hearing*, 21:118-130.

Davis, A., Bamford, J., Wilson, I., Ramkalawan, T., Forshaw, M. & Wright, S. 1997. A critical review of the role of neonatal hearing screening in the detection of congenital hearing impairment. *Health Technol Assessment*, 1(10):1-177.

Davis, A., Bamford, J. & Stevens, J. 2001. Performance of neonatal and infant hearing screens: sensitivity and specificity. *British Journal of Audiology*, 35:3-15.

Davis, A. & Hind, S. 2003. The newborn hearing screening programme in England. *International Journal of Pediatric Otorhinolaryngology*, 67(Suppl.1):S193-S196.

Davis, A.C. & Wood, S. 1992. The epidemiology of childhood hearing impairment: factors relevant to planning of services. *British Journal of Audiology*, 26:77-90.

Davis, J.M., Elfenbein, J.L., Schum, R. & Bentler, R. 1986. Effects of mild and moderate hearing impairments on language, educational, and psychosocial behavior of children. *Journal of Speech and Hearing Disorders*, 51:53-62.

Davis-McFarland, E. 2002. Pediatric HIV/AIDS: issues and strategies for intervention. *ASHA leader*, 7(4):10.

Day, C., Reagon, G., Irlam, C. & Levin, J. 2004. Facilities Survey 2003. *South African Health Review 2003/04*. http://www.hst.org.za/publications/423 (Date of access: 13 August 2004).

Delport, C.S.L. 2002. Quantitative data collection methods. In: A.S. de Vos (Ed.*). Research at Grass Roots*. 2nd ed. Pretoria: Van Schaik. 165-196.

Dennil, K., King, L. & Swanepoel, T. 1999. *Aspects of Primary Health Care*. 2nd ed. Cape Town: Oxford University Press Southern Africa.

Department of Education. 2001. *Education white paper no 6: Special needs education and training system*. Pretoria: Department of Education.

Department of Health. 1997. White paper: Transformation of the health system. http://www.anc.org.za/

Department of Health. 1999. South African Demographic and Health Survey. http://www.doh.gov.za/facts/1998/sadhs98/ (Date of access: 17 August 2004).

Department of Health. 2000. Prevention of hearing impairment due to otitis media. *The Primary Health Care Package for South Africa – a set of norms and standards*. http://www.doh.gov.za/docs/policy/norms/part1t.html (Date of access: 17 August 2004).

Department of Health. 2001. Guideline for the prevention of hearing impairment due to otitis media at clinic level. 1-22. http://www.doh.gov.za/docs/factsheets/guidelines/hearing.pdf (Date of access: 21 October 2003).

Department of Health. Statistical Notes. 2000. *Tuberculosis and HIV*, 2(18):1-9.

Department of Health. Statistical Notes. 2001. *Malaria*, 3(5):1-9.

Department of National Health and Population Development. 1992. *Strategy for primary health care in South Africa*. Pretoria: Government Printer.

Department of Health. 2002. National HIV and Syphilis Sero-prevalence Survey of Women Attending Public Antenatal Clinics in South Africa – 2001. Summary Report. http://www.doh.gov.za/docs/reports/2000/hivreport.html (Date of access: 23 October 2003).

De Vos, A.S. 2002a. Combined quantitative and qualitative approach. In: AS de Vos (Ed.) *Research at Grass Roots*. 2nd ed. Pretoria: Van Schaik. 363-372.

De Vos, A.S. 2002b. Qualitative data analysis and interpretation. In: AS de Vos (Ed.) *Research at Grass Roots*. 2nd ed. Pretoria: Van Schaik. 339-355.

De Vos, A.S. 2002c. Scientific theory and professional research. In: AS de Vos (Ed.) *Research at Grass Roots*. 2nd ed. Pretoria: Van Schaik. 28-48.

Diefendorf, A.O. 1999. Screening for hearing loss in infants. *The Volta Review*, 99(5):43-61.

Diefendorf, A.O. 2002. Detection and assessment of hearing loss in infants and children. In: Katz, J. (Ed.) *Handbook of Clinical Audiology*. Baltimore: Lippincott Williams & Wilkens. 469-480.

Doctoroff, S. 1995. Providing early intervention services in rural areas: meeting the challenge. *Infant-Toddler Intervention: The Transdisciplinary Journal,* 5(4):339-352.

Doherty, T. & Colvin, M. 2004. HIV / AIDS. *South African Health Review 2003/04*. http://www.hst.org.za/publications/423 (Date of access: 13 August 2004).

Downs, M.P. & Sterrit, G.M. 1964. Identification audiometry for neonates: A preliminary report. *Journal of Auditory Research*, 4:69-80.

Downs, M.P. & Hemenway, W.G. 1969. Report on the hearing screening of 17,000 neonates. *International Audiology*, 8:72-76.

Downs, M.P. 2000. The quest for early identification and intervention. *Seminars in Hearing*, 21(4):285-294.

Downs, M.P. 2002. Personal communication. August 2002.

Druck, E., & Ross, E. 2002. Training, Current Practices and Resources of a Group of South African Hospital-Based Speech-Language Therapists and Audiologists Working with Patients Living with HIV/AIDS. *South African Journal of Communication Disorder*, 49:3-16.

El-Refaie, A., Parker, D.J. & Bamford, J.M. 1996. Otoacoustic emission versus ABR screening: The effect of external and middle ear abnormalities in a group of SCBU neonates. *British Journal of Audiology*, 30:3-8.

Elssmann, S.A., Matkin, N.D., & Sabo, M.P. 1987. Early identification of congenital sensorineural hearing impairment. *The Hearing Journal*, 40(9):13-7.

Engel, J., Mahler, E., Anteunis, L., Marres E. & Zielhuis, G. 2001. Why are NICU infants at risk for chronic otitis media with effusion? *International Journal of Pediatric Otorhinolaryngology*, 57:137-144.

English, K.M. 1995. *Educational audiology across the lifespan*. Baltimore: Paul H Brookes Publishing Co.

Fair, L. & Louw, B. 1999. Early communication intervention within a community-based intervention model in South Africa. *The South African Journal of Communication Disorders*, 46:13-23.

Feinmesser, M., Tell, L. & Levi, H. 1986. Etiology of childhood deafness with reference to the group of unknown cause. *Audiology,* 25:65-69.

Finitzo, T., Albright, K. & O'Neal, J. 1998. The newborn with hearing loss: Detection in the nursery. *Pediatrics*, 102:1452-1460.

Fitzland, R.E. 1985. Identification of hearing loss in newborns: results of eight years' experience with a high risk hearing register. *The Volta Review*, 87:195-203.

Folsom, R.C., Widen, J.E., Vohr, B.R., Cone-Wesson, B., Gorga, M.P., Sinninger, Y.S. & Norton, S.J. 2000. Identification of neonatal hearing impairment: Recruitment and follow-up. *Ear & Hearing*, 21:462-470.

Fortnum, H.M., Summerfield, A.Q., Marshall, D.H., Davis, A.C. & Bamford, J.M. 2001. Prevalence of permanent childhood hearing impairment in the United Kingdom and implications for universal neonatal hearing screening: questionnaire based ascertainment study. *British Medical Journal*, 323:1-5.

Fortnum, H.M. 2003. Epidemiology of permanent childhood hearing impairment: Implications for neonatal hearing screening. *Audiological Medicine*, 1:155-164.

Fouché, C.B. 2002a. Problem formulation. In: A.S. de Vos (Ed.) *Research at Grass Roots*. 2nd ed. Pretoria: Van Schaik. 104-113.

Fouché, C.B. 2002b. Selection of a researchable topic. In: A.S. de Vos (Ed.) *Research at Grass Roots*. 2nd ed. Pretoria: Van Schaik. 95-103.

Fowler, C.G. & Shanks, J.E. 2002. Tympanometry. In: Katz, J. (Ed.) *Handbook of Clinical Audiology*. Baltimore: Lippincott Williams & Wilkens. 175-204.

Gallaudet University Center for Assessment and Demographic Study. 1998. Thirty years of the annual survey of deaf and hard of hearing children and youth: A glance over the decades. *American Annals of the Deaf*, 142(2):72-76.

Gates, G.A., Stewart, I.A., Northern, J. L., Downs, M.P., Ferrer, H.P., Hannley, M., Karma, P., Marchant, C.D., Renvall, U., Ruben, R.J. & Teele, D.W. 1994. Recent advances in otitis media: Diagnosis and screening. *Annals of Otology, Rhinology, and Laryngology Supplement*, 103:53-57.

Gelfand, S.A. 2002. The acoustic reflex. In: Katz, J. (Ed.) *Handbook of Clinical Audiology*. Baltimore: Lippincott Williams & Wilkens. 205-232.

Gell, F.M., Whilte, E.M., Newel, K., Mackenzie, I., Smith, A., Thompson, S. & Hatcher, J. 1992. Practical screening priorities for hearing impairment among children in developing countries. *Bulletin of the World Health Organization*, 70(5):645-655.

Gopal, R., Hugo, S.R, & Louw, B. 2001. Identification and follow-up of children with hearing loss in Mauritius. *International Journal of Pediatric Otorhinolaryngology*, 57:99-113.

Gorga, M.P. 1999. Predicting auditory sensitivity from auditory brainstem response measurements. *Seminars in Hearing*, 20(1):29-43.

Gorga, M.P. & Neely, S.T. 2003. Cost-effectiveness and test-performance factors in relation to universal newborn hearing screening. *Mental Retardation and Developmental Disabilities Research Reviews*, 9:103-108.

Gracey, K. 2003. Current concepts in universal newborn hearing screening and early hearing detection and intervention programs. *Advances in Neonatal Care,* 3(6): 308-317.

Grandori, F. 1998. European Consensus statement on neonatal hearing screening. *Journal of Laryngology & Otology*, 112:1219.

Gravel, J., Berg, A., Bradley, M., Cacace, A., Campbell, D., Dalzell, L., DeCristofaro, J., Greenberg, E., Gross, S., Orlando, M., Pinheiro, J., Regan, J., Spivak, L., Stevens, F. & Prieve, B. 2000. New York State universal newborn hearing screening demonstration project: Effects of screening protocol on inpatient outcome measures. *Ear & Hearing*, 21(2):131-140.

Hadjikakou, K. & Bamford, J. 2000. Prevalence and age of identification of permanent childhood hearing impairment in Cyprus. *Audiology*, 39:198-201.

Hanh, M., Lamprecht-Dinnesen, A., Heinecke, A., Hartmann, S., Bűlbűl, S., Schrőder,G., Steinhard, J., Louwen, F. & Seifert, E. 1999. Hearing screening in healthy newborns: feasibility of different methods with regard to test time. *International Journal of Pediatric Otorhinolaryngology*, 51:83-89.

Hanneke de Ridder-Sluiter, J.G., Kauffman-de Boer, M.A., Uilenburg, N.N., Schuitema, T., Vinks, E., Van der Ploeg, C.P.B. & Verkerk, P.H. 2004. Neonatal hearing screening in the youth health care of the Netherlands; state of the art in hearing screening, diagnostics and intervention of very young children. International Conference on Newborn Hearing Screening Diagnosis and Intervention, May 27-29, Abstract book 9.

Hakim, C. 2000. *Research design: successful designs for social and economic research*. London: Routledge.

Hall III, J.W. 2000, Handbook of Otoacoustic Emissions. San Diego: Singular Publishing Group.

Hall III, J.W. 2000. Infant hearing impairment and universal hearing screening. *Journal of Perinatology*, 20:S112-S120.

Hall III, J.W., Smith, S.D. & Popelka, G.R. 2004. Newborn hearing screening with combined otoacoustic emissions and auditory brainstem responses. *Journal of the American Academy of Audiology*, 15:414-425.

Harrison, M. & Roush, J. 2000. Age of suspicion, identification, and intervention for infants and young children with hearing loss: a national study. *Ear & Hearing*, 17:55-62.

Health Professions Council of South Africa. 2002. Professional Board for Speech, Language and Hearing Professions: Hearing Screening Position Statement Year 2002: 1-8.

Health Professions Council of South Africa. 2003. Personal correspondence. Professional Board for Speech, Language and Hearing Professions Manager, Msibi, R. (E-mail: 2003-11-27).

Healthy People 2000. 1990. *National Health Promotion and Disease Prevention Objectives*. Washington DC: US Department of Health and Human Service, US Government Printing Office.

Herer, G.R., Knightly, C.A. & Steinberg, A.G. 2002. Hearing: sounds and silences. In: M.L. Batshaw (Ed.) *Children with Disabilities*. 5th ed. Baltimore: Paul H. Brookes Publishing Co. 193-227.

Hergils, L. & Hergils, A. 2000. Universal neonatal hearing screening – parental attitudes and concern. *British Journal of Audiology*, 34:321-327.

Herrmann, B.S., Thornton, A.R., & Joseph, J.M. 1995. Automated infant hearing screening using the ABR: development and validation. *American Journal of Audiology*, (2):6-14.

Hess, M., Finckh-Kramer, U., Bartsch, M., Kewitz, G., Versmold, H. & Gross, M. 1998. Hearing screening in at-risk neonate cohort. *International Journal of Pediatric Otorhinolaryngology*, 46:81-89.

Höll, C. 1997. Die praktyk van neonatale gehoorsifting in staatsgesubsidieerde hospitale. Ongepubliseerde verhandeling in B. Kommunikasiepatologie. Departement Kommunikasiepatologie, Universiteit van Pretoria.

Holte, L., Margolis, R.H. & Cavanaugh, R. 1991. Developmental changes in multifrequency tympanograms. *Audiology*, 30:1-24.

Hugo, S.R., Louw, B. & Meyer, S.E. 1991. Aard, voorkoms en implikasies van middleoorpatologie op hoërisikogroepe. RGN-projek No.15/1/3/3/791.

Hugo, R. 1998. Communication Pathology: The way in Africa. *The South African Journal of Communication Disorders*, 45:3-9.

Hugo, R. 2004. Kommunikasiepatologie as beroep in die Suid-Afrikaanse konteks. *CLINICA: Applications in Clinical Practice of Communication Pathology*, 5-9.

Hunter, L.L. & Margolis, R.H. 1992. Multifrequency tympanometry: Current clinical application. *American Journal of Audiology*, 1:33-43.

Jacob, A., Rupa, V., Job, A. & Joseph, A. 1997. Hearing impairment and otitis media in a rural primary school in South India. *International Journal of Pediatric Otorhinolaryngology*, 39:133-138.

Jacobson, J.T. & Jacobson, C.A. 1987. Application of test performance characteristics in newborn auditory screening. *Seminars in Hearing*, 8(2):133-141.

Jewet, D., & Williston, J. 1971. Auditory evoked far fields averaged from the scalp of humans. *Brain*, 94:681-696.

Johnson, J.L., Mauk, G.W., Takekawa, K.M., Simon, P.R., Sia, C.C.J., & Blackwell, P.M. 1993. Implementing a statewide system of services for infants and toddlers with hearing disabilities. *Seminars in Hearing*, 14(1):105-119.

Johnson, J.L., Kuntz, N.L., Sia, C.C, White, K.R. & Johnson, R.L. 1997. Newborn hearing screening in Hawaii. *Hawaii Medical Journal*, 56(12):352-5.

Joint Committee on Infant Hearing. 1982. Joint Committee on Infant Hearing Position Statement. *ASHA*, 24:1017-1018.

Joint Committee on Infant Hearing. 1994. 1994 Position Statement. *Audiology Today*, 6(6):6-9.

Joint Committee on Infant Hearing. 2000. Year 2000 position statement: Principles and guidelines for early hearing detection and intervention programs. *American Journal of Audiology*, 9:9-29.

Iwasaki, S., Hayashi, Y., Seki, A., Nagura, M., Hashimoto, Y., Oshima, G. & Hoshino, T. 2004. A model of two-stage newborn hearing screening with automated auditory brainstem response. *International Journal of Pediatric Otorhinolaryngology*, 67:1099-1104.

Kankkunen, A. 1982. Preschool children with impaired hearing. *Acta Otolaryngologica*, Suppl. 391:1-124.

Kathrada, R. 2000. Universal neonatal hearing screening: perspectives from health professionals. Unpublished B. Speech and Hearing Therapy dissertation. Department of Logopaedics, University of Cape Town.

Kawashiro, N., Tsuchihashi, N., Koga, K., Kawano, T. & Itoh, Y. 1996. Delayed post-neonatal intensive care unit hearing disturbance. *International Journal of Pediatric Otorhinolaryngology*, 34:35-43.

Keefe, D.H. & Levi, E. 1996. Maturation of the middle and external ears: acoustic power-based responses and reflectance tympanometry. *Ear & Hearing*, 17:361-373.

Kei, J., Allison-Levick, J., Dockray, J., Harrys, R., Kirkegard, C., Wong, J., Maurer, M., Hegarty, J., Young, J. & Tudehope, D. 2003. High-frequency (1000 Hz) tympanometry in normal neonates. *Journal of the American Academy of Audiology*, 14(1):21-28.

Keller, H. 1910. Letter to Dr John Kerr Love, dated 31 March. Reprinted in: Kerr Love, J. (Ed.) *Helen Keller in Scotland, a personal record written by herself*. London: Methuen (1933).

Kemp, D.T. 1978. Stimulated acoustic emissions from within the human auditory system. *Journal of the Acoustical Society of America*, 12:17-24.

Kennedy, C.R., Kimm, L., Dees, D.C., Evans, P.I.P., Hunter, M., Lenton, S. & Thornton, R.D. 1991. Otoacoustic emissions and auditory brainstem responses in the newborn. *Archives of Disease in Childhood*, 66:1124-1128.

Kennedy, C.R., Kimm, L., Cafarelli-Dees, D., Campbell, M.J. & Thornton, A.R.D. 1998. Controlled trial of universal neonatal screening for identification of permanent childhood hearing impairment. *The Lancet*, 352:1957-1964.

Kenworthy, O.T. 1990. Screening for hearing impairment in infants and young children. *Seminars in Hearing*, 11:315-332.

Kezirian, E.J., White, K.R., Yueh, B. & Sullivan, S.D. 2001. Cost and cost-effectiveness of universal screening for hearing loss in newborns. *Otolaryngology-Head and Neck Surgery*, 124:359-367.

Kile, J. 1993. Identification of hearing impairment in children: A 25 year review. *The Transdisciplinary Journal*, 3(3):155-164.

Klein, J.O. 1994. Lessons from recent studies on the epidemiology of otitis media. *The Pediatrics Infectious Disease Journal*, 13(11):1031-1034.

Knock, A. 2002. The Strengths and Weaknesses Of Modernisation Theories. http://www.ixyl.co.uk/poli/intro_developing_world (Date of access: 24 September 2004).

Koivun, P., Uhari, M., Laitakari, K., Alho, O.P. & Luotonen, J. 2000. Otoacoustic emissions and tympanometry in children with otitis media. *Ear & Hearing*, 21(3):212-217.

Kopp, P. 2000. Community nurses' knowledge of and perceived need for speech-language pathology and audiology services. Unpublished B.Communication Pathology dissertation. Department of Logopaedics, University of Cape Town.

Kountakis, S.E., Skoulas, I., Phillips, D. & Chang, C.Y.J. 2002. Risk factors for hearing loss in neonates: a prospective study. *American Journal of Otolaryngology*, 23(3):133-137.

Krefting, L. 1991. Rigor in qualitative research: the assessment of trustworthiness. *The American Journal of Occupational Therapy*, 45(3):214-222.

Kritzinger, A.M. 2000. Establishing a computer-based data system for early communication intervention in South Africa. Unpublished D.Phil. Communication Pathology Thesis. Department Communication Pathology, University of Pretoria.

Kubba, H., MacAndie, C., Ritchie, K. & MacFarlane, M. 2004. Is deafness a disease of poverty? The association between socio-economic deprivation and congenital hearing impairment. *International Journal of Audiology*, 43:123-125.

Kumar, S. 2001. Who tackles hearing disabilities in developing world? *The Lancet*, 358:219.

Leedy, P.D. & Ormrod, J.E. 2001. *Practical Research: Planning and Design*. 7th ed. New Jersey: Prentice Hall.

Lin, H., Shu, M., Chang, K. & Bruna, S.M. 2002. A universal newborn hearing screening program in Taiwan. *International Journal of Pediatric Otorhinolaryngology*, 63: 209–218.

Lincoln, Y.S. & Guba, E.G. 1985. Naturalistic inquiry. Beverly Hills, CA: SAGE. In: Denzin, N.K. & Lincoln, Y.S. (Eds.) *Handbook of qualitative research*. Thousand Oaks: Sage.

Louw, B. & Avenant, C. 2002. Culture as context for intervention: developing a culturally congruent early intervention program. *International Pediatrics*, 17(3):145-150.

Low, W.K., Ho, L.Y., Bee, L.S., Roy, J. & Pang, W. 2004. Universal newborn hearing screening: a national programme in Singapore. International Conference on Newborn Hearing Screening Diagnosis and Intervention, May 27-29, Abstract book 29.

Lutman, M., Davis, A., Fortnum, H. & Wood, S. 1997. Field sensitivity of targeted neonatal hearing screening by transient-evoked otoacoustic emissions. *Ear & Hearing*, 18:265-276.

Lutman, M.E. & Grandori, F. 1999. Screening for neonatal hearing defects European consensus statement. *European Journal of Pediatrics*, 158:95-96.

Lutman, M.E. 2000. Techniques for neonatal hearing screening. *Seminars in Hearing*, 21(4):367-378.

Madriz, J.J. 2000. Hearing impairment in Latin America: an inventory or limited options and resources. *Audiology*, 39:212-220.

Madriz, J.J. 2001. Audiology in Latin America: hearing impairment, resources and services. *Scandinavian Audiology*, 30(Suppl. 53):83-92.

Mahoney, T.M., Eichwald, J.G. 1987. The ups and "DOWNS" of high-risk hearing screening: the Utah statewide program. *Seminars in Hearing*, 8:55-164.

Mäki-Torkko, E. 2003. Current issues on aetiological evaluation of hearing-impaired infants. *Audiological Medicine*, 1:185-190.

Malherbe, K.E.S. 1999. Are speech-language therapy and audiology PHC compliant? Unpublished B. Speech and Hearing Therapy dissertation. Department of Logopaedics, University of Cape Town.

Margolis, R.H., Bass-Ringdahl, S., Hanks, W.D., Holte, K. & Zapala, D.A. 2003. Tympanometry in Newborn Infants - 1 KHz Norms. *Journal of the American Academy of Audiology*, 14:383-392.

Martin, J.A.M. 1982. Aetiological factors relating to childhood deafness in the European community. *Audiology*, 21:149-158.

Martineau, G., Lamarche, P.A., Marcoux, S. & Bernard, P.M. 2001. The effect of early intervention on academic achievement of hearing-impaired children. *Early Education & Development*, 12(2):275-289.

Mason, S., Davis, A., Wood, S. & Farnsworth, A. 1997. Field sensitivity of targeted neonatal hearing screening using the Nottingham ABR screener. *Ear & Hearing*, 19:91-102.

Mason, J.A. & Herrmann, K.R. 1998. Universal infant hearing screening by automated auditory brainstem response measurement. *Pediatrics*, 101(2):221-228.

Matkin, N.D., Diefendorf, A.O. & Erenberg, A. 1998. Children: HIV/AIDS and Hearing Loss. *Seminars in Hearing*, 19(2):143-154.

Mauk, G. W., & White, K. R. 1995. Giving children a sound beginning: the promise of universal newborn hearing screening. *The Volta Review*, 97:5-32.

Maxon, A. B., White, K. R., Behrens, T. R., & Vohr, B. R. 1995. Referral rates and cost efficiency in a universal newborn hearing screening program using transient evoked otoacoustic emissions (TEOAE). *Journal of the American Academy of Audiology*, 6:271-277.

McCandles, G.A. & Allred, P.L. 1978. Tympanometry and emergence of the acoustic reflex in infants. In: Harford, E.R., Bess, F.H., Bluestone, C.D. et al. (Eds.) *Impedance screening for middle ear disease in children*. New York: Grune & Stratton. 56-67.

McConkey, R. 1995. Early intervention in developing countries. In: Zinkin, P. & McConachie, H. (Eds.). *Disabled Children and Developing Countries*. London: Mac Keith Press, 63-83.

McKinley, A.M., Grose, J.H. & Roush, J. 1997. Multifrequency tympanometry and evoked acoustic emissions in neonates during the first 24 hours of life. *Journal of the American Academy of Audiology*, 8:218-223.

McPherson, B., & Swart, S.M. 1997. Childhood hearing loss in sub-Saharan Africa: a review and recommendations. *International Journal of Pediatric Otorhinolaryngology*, 40:1-18.

Mehl, A. & Thomson, V. 1998. Newborn hearing screening: The great omission. *Pediatrics*, 101(1):1-6. http://www.pediatrics.org/cgi/content/full/101/1e4

Mehl, A. & Thomson, V. 2002. The Colorado newborn hearing screening project, 1992-1999: On the threshold of effective population-based universal newborn hearing screening. *Pediatrics*, 109(1):1-8.

Mehl, A. 2002. Selecting appropriate technology for universal newborn hearing screening. Oral presentation. National Symposium on Hearing in Infants, Breckenridge, CO, USA, July 31 – August 3.

Meier, S., Narabayashi, O., Probst, R. & Schmuziger, N. 2004. Comparison of currently available devices designed for newborn hearing screening using automated auditory brainstem and/or otoacoustic emission measurements. *International Journal of Pediatric Otorhinolaryngology*, 68:927-934.

Mencher, G.T. 2000. Challenge of epidemiological research in the developing world: Overview. *Audiology*, 39:178-183.

Mencher, G.T., Davis, A.C., DeVoe, S.J., Beresfor, D. & Bamford, J.M. 2001. Universal neonatal hearing screening: Past, present, and future. *American Journal of Audiology*, 10:3-12.

Mencher, G.T. & DeVoe, S.J. 2001. Universal newborn screening: a dream realized or a nightmare in the making? *Scandinavian Audiology*, 30(Suppl 53):15-21.

Messner, A.H., Price, M., Kwast, K., Gallagher, K. & Forte, J. 2001. Volunteer-based universal newborn hearing screening program. *International Journal of Pediatric Otorhinolaryngology*, 60:123-130.

Meyer. S., Hurter, M. & Van Rensburg, F. 1987. Gehoorsiftingsresultate van ‘n groep kleurlingkinders. *The South African Journal of Communication Disorders*, 34:43-47.

Meyer, S. & Van den Berg, C. 1985. Die voorkomsfrekwensie van oor- en gehoorpatologie by kinders in die afgesonderde gemeenskap van Tsikunda-Malema. *The South African Journal of Communication Disorders*, 32:71-75.

Meyer, S.E., Jardine, C.A. & Deverson, W. 1997. Developmental changes in tympanometry: a case study. *British Journal of Audiology*, 31:189-195.

Mngadi, S. 2003. HIV prevalence in South Africa. Spokesperson for the Minister of Health. 3 July 2003. http://www.doh.gov.za/docs/pr/2003/pr0703.html

Moeller, M.P. 2000. Early intervention and language development in children who are deaf and hard of hearing. *Pediatrics*, 106(3):1-9.

Mohr, P.E., Feldman, J.J. & Dunbar, J.L. 2000. The societal costs of severe to profound hearing loss in the United States. Policy Analysis Brief: Project Hope Center for Health Affairs. April 2000:1-4.

Moodley, L., Louw, B. & Hugo, S.R. 2000. Early identification of at-risk infants and toddlers: a transdisciplinary model of service delivery. *The South African Journal of Communication Disorders*, 47:25-40.

Mouton, J. & Marais, H.C. 1990. *Basic concepts in the methodology of the social sciences*. Pretoria: Human Sciences Research Council.

Mouton, J. 1996. *Understanding Social Research.* Pretoria: Van Schaik. 1-272.

Mouton, J. 2001. *How to succeed in your Master's & Doctoral studies*. Pretoria: Van Schaik.

Municipal Demarcation Board. 2003. District Municipality Information. Pretoria. http://www.demarcation.org.za/

National Health Plan for South Africa. 1994. First published by the African National Congress (ANC). Johannesburg, South Africa.

National Institutes of Health. 1993. Early identification of hearing impairment in infants and young children. *NIH Consensus Statement*, 11(1):1-24. http://text.nlm.nih.gov/nih/cdc/www/92txt.html

National Center for Hearing Assessment & Management (2004). Early Hearing Detection and Intervention Information & Resource Centre. http://www.infanthearing.org/resources/index.html (Date of access: 17 November 2004).

Nel, M., Odendaal, W., Hurter, M., Meyer, S. & van der Merwe, A. 1988. Die voorkoms en aard van gehoorprobleme en middeloorpatologieë by 'n groep swart stedelike kinders in graad 1. *South African Journal of Communication Disorders,* 35:25-29.

Neuman, W.L. 1997. *Social Research Methods: Qualitative and Quantative Approaches*. 3rd ed. Boston: Allyn and Bacon.

Newton, V.E., Macharia, I., Mugwe, P., Ototo, B., & Kan, S.W. 2001. Evaluation of the use of a questionnaire to detect hearing loss in Kenya pre-school children. *International Journal of Pediatric Otorhinolaryngology*, 57:229-234.

Northern, J.L. & Hayes, D. 1996. Universal screening for infant hearing impairment: Necessary, beneficial, and justifiable. *Audiology Today*, 6(3):10-13.

Northern, J.L., Downs, M.P. 2002. *Hearing in Children*. 5th ed. Baltimore MA: Lippincott Williams & Wilkens.

Norton, S.J., Gorga, M.P., Widen, J.E., Folsom, R.C., Sinninger, Y.S., Cone-Wesson, B., Vohr, B.R. & Fletcher, K. 2000a. Identification of neonatal hearing impairment: a multi-center intervention. *Ear and Hearing*, 21(5):348-356.

Norton, S.J., Gorga, M.P., Widen, J.E., Folsom, R.C., Sinninger, Y.S., Cone-Wesson, B., Vohr, B.R. & Fletcher, K. 2000b. Identification of neonatal hearing impairment: evaluation of transient evoked otoacoustic emission, distortion product otoacoustic emission, and auditory brainstem response test performance. *Ear and Hearing*, 21(5):508-528.

Norton, S.J., Gorga, M.P., Widen, J.E., Folsom, R.C., Sinninger, Y.S., Cone-Wesson, B., Vohr, B.R. & Fletcher, K. 2000c. Identification of neonatal hearing impairment: summary and recommendations. *Ear and Hearing*, 21(5):529-535.

Nyman, R. 1999. The tender years in a harsh society. *Rights Now*, 6:4-5.

Olusanya, B.O. 2000. Hearing impairment prevention in developing countries: making things happen. *International Journal of Pediatric Otorhinolaryngology*, 55:167-171.

Olusanya, B.O. 2001. Early detection of hearing impairment in a developing country: what options? *Audiology*, 40:141-147.

Olusanya, B.O., Luxon, L.M. & Wirz, S.L. 2004. Benefits and challenges of newborn hearing screening for developing countries. *International Journal of Pediatric Otorhinolaryngology*, 68:287-305.

Oosthuizen, I. 1986. Die aard en voorkoms van gehoorpatologieë in laerskole vir normaalhorende Venda kinders. Ongepubliseerde BLog-verhandeling. Universiteit van Pretoria.

Owens, J.J., McCoy, M.J., Lonsbury-Martin, B.C. & Martin, G.K. 1992. Influence of otitis media on evoked otoacoustic emissions in children. *Seminars in Hearing*, 13:53-56.

Padarath, A., Ntuli, A. & Berthiaume, L. 2004. Human Resources. *South African Health Review 2003/04*. http://www.hst.org.za/publications/423 (Date of access: 13 August 2004).

Palmu, A., Puhakka, H., Rahko, T. & Takala, A.K. 1999. Diagnostic value of tympanometry in infants in clinical practice. *International Journal of Pediatric Otorhinolaryngology*, 49:207-213.

Palmu, A., Puhakka, H., Huhtala, H., Takala, A.K. & Kilpi, T. 2001.Normative values for tympanometry in 7- and 24-month-old children. *Audiology*, 40:178-184.

Parving, A. 1985. Hearing disorders in childhood, some procedures for detection, identification and diagnostic evaluation. *International Journal of Pediatric Otorhinolaryngology*, 9:31-57.

Parving, A. 2002. Looking for the hearing impaired child: past, present and future. In R.C. Seewald & J.C. Gravel (Eds.), *A Sound Foundation through Early Amplification 2001* (pp.251-259). UK: Immediate Proceedings Limited.

Parving, A. 2003. Guest Editorial. *Audiological Medicine*, 1:154.

Plante, S., Kiernan, B. & Betts J.D. 1994. Method or methodology: the qualitative/quantitative debate. *Language, Speech, and Hearing Services in Schools*, 25:52-54.

Popich, E. 2003. Chapter 3: the prevention of communication disorders. *The Development of a tool for parents for the stimulation of communication skills in infants (0-12 months).* Unpublished D.Phil. Communication Pathology Thesis. Department Communication Pathology, University of Pretoria.

Population Census Key Results. 2003. Statistics South Africa. July 2003. http://www.statssa.gov.za/SpecialProjects/Census2001/HTML/Key%20results.ppt

Posavac, E.J. & Carey, R.G. 1989. *Program evaluation: methods and case studies*. 3rd ed. New Jersey: Prentice Hall.

Prasansuk, S. 2000. Incidence/prevalence of sensorineural hearing impairment in Thailand and Southeast Asia. *Audiology*, 39:207-211.

Pratt, H., Aber, P., Al Masari, M., Attias, J. & Jebara, R. 2004. Unique findings and constraints in early detection of hearing loss in the Middle-East: the joint Israeli, Jordanian, and Palestinian experience. International Conference on Newborn Hearing Screening Diagnosis and Intervention, May 27-29, Abstract book 28.

Prescott, C.A.J. 1995. Should routine screening of neonates for deafness be introduced in South Africa? *South African Medical Journal*, 85(1):7-8.

Pretorius, A. 1985. Aard en voorkoms van gehoorpatologieë in 'n laerskool vir normaalhorende kleurlingkinders. Ongepubliseerde BLog-verhandeling. Universiteit van Pretoria.

Prieve, B. & Stevens, F. 2000. The New York State Universal Newborn Screening Project: introduction and overview. *Ear & Hearing*, 21:85-91.

Prieve, B., Dalzell, L., Berg, A., Bradley, M., Cacace, A., Campbell, D., DeCristofaro, J., Gravel, J., Greenberg, E., Gross, S., Orlando, M., Pinheiro, J., Regan, J., Spivak, L. & Stevens, F. 2000. The New York State universal newborn hearing screening demonstration project: Outpatient outcome measures. *Ear & Hearing*, 21:104-117.

Prince, C.B., Miyashiro, L., Weirather, Y. & Heu, P. 2003. Epidemiology of early hearing loss detection in Hawaii. *Pediatrics*, 111(5):S1202-1206.

Psarommatis, I.M., Tsakanikos, M.D., Diamantopoulou, P.M., Douniadakis D.E. & Apostolopoulos, N.K. 2001. Towards a universal newborn hearing screening. *Scand Audiol*, 30(Suppl.52):25–27.

Purdy, S.C. & Williams, M.J. 2000. High Frequency tympanometry: a valid and reliable immittance test protocol for young infants? *New Zeeland Audiological Society Bulletin*, 10(3):9-24.

Rabbitt-Park, K. 2003. Issues for successful universal newborn hearing screening. Oral presentation. American Academy of Audiology convention, San Antonio, TX, USA, 2-5 April.

Radziszewska-Konopka, M. & Owsiak, J. 2004. Universal newborn hearing screening organized by the great orchestra of Christmas charity in Poland. International Conference on Newborn Hearing Screening Diagnosis and Intervention, May 27-29, Abstract book 30.

Rance, G., Beer, D.E., Cone-Wesson, B., Shepherd, R.K., Dowell, R.C., King, A., Riskards, F.W. & Clark, G.M. Clinical findings for a group of infants and young children with auditory neuropathy. *Ear & Hearing*, 21:85-91.

Rangasayee, R. 2004. Early identification and intervention towards inclusive education of children with hearing impairment in India. International Conference on Newborn Hearing Screening Diagnosis and Intervention, May 27-29, Abstract book 30.

Rao, R.S.P., Subramanyam, M.A., Nair, N.S., & Rajashekhar, B. 2002. Hearing impairment and ear disease among children of school age in rural South India. *International Journal of Paediatric Otorhinolaryngology*, 64:105-110.

Reagon, G., Irlam, J., Levin, J. 2004. The National Primary Health Care Facilities Survey 2003. Durban: Health Systems Trust, The Equity Project and Department of Health. http://www.hst.org.za/publications/617/ (Date of access: 16 August 2004).

Reid, A. & Gough, S. 2000. Guidelines for reporting and evaluating qualitative research: What are the alternatives? *Environmental Education Research*, 6(1):59-90.

Rhodes, M.C., Margolis, R.H., Hirsch, J.E. & Napp, A.P. 1999. Hearing screening in the newborn intensive care nursery: Comparison of methods. *Otolaryngology Head and Neck Surgery*, 120:799-808.

Robertson, C.M.T., Tyebkhan, J.M., Hagler, M.E., Cheung, P.Y., Peliowsky, A. & Etches, P.C. 2002. Late-onset, progressive sensorineural hearing loss after severe neonatal respiratory failure. *Otol. Neurotol*, 23:353-356.

Robson, C. 1993. *Real World Research: A Resource for Social Scientists and Practitioner-Researchers*. Oxford: Blackwell Publishers Ltd.

Roizen, N.J. 1998. Why universal newborn hearing screening? *Seminars in Hearing*, 19(3):235-245.

Rossetti, L.M. 1996. *Communication Intervention Birth toThree*. San Diego, CA: Singular Publishing Group.

Rouev, P., Mumdzhiev, H., Spiridonova, J. & Dimov, P. 2004. Universal newborn hearing screening in Bulgaria. *International Journal of Pediatric Otorhinolaryngology*, 68(6):805-10.

Roush, J. 2001. *Screening for Hearing Loss and Otitis Media in Children*. San Diego: Singular-Thompson Publishing Group.

Russ, S. 2001. Measuring the prevalence of permanent childhood hearing impairment: Editorial. *British Medical Journal*, 323:525-526.

Russo, I.C.P. 2000. Overview of audiology in Brazil: state of the art. *Audiology*, 39:202-206.

Salata, J.A., Jacobson, J.T., & Strasnick, M. 1998. Distortion-product otoacoustic emissions hearing screening in high-risk newborns. *Otolaryngology – Head and Neck Surgery*, 118(1):37-43.

Savage, K. 1998. The constitution and the poor. In: Barberton, C., Blake, M. & Kotzé, H. (Eds.) *Creating Action Space*. Cape Town: IDASA. 63-75.

Seeff, B.K. & Bortz, M.A. 1994. Caregiver-child interaction in a rural village in South Africa. *The South African Journal of Communication Disorders*, 41:73-83.

Sehlin, P., Holmgren, G. & Zakrisson, J. 1990. Incidence, prevalence and etiology of hearing impairment in children in the county of Vasterbotten, Sweden. *Scandinavian Audiology*, 19:193-200.

Sellars, S., Beighton, G., Horan, F. & Beighton, P.H. 1977. Deafness in black children in the Cape. *South African Medical Journal*, 51:309-312.

Sellars, S. & Beighton, P. 1978. The aetiology of partial deafness in childhood. *South African Medical Journal*, 54:811-813.

Sellars, S. & Beighton, P. 1983. Childhood deafness in Southern Africa: An aetiological survey of 3 064 deaf children. *Journal of Laryngology and Otology*, 97:885-889.

Sellars, S. & Beighton, P. 1997. Surveying a nation's deaf (Southern Africa). *Hearing International,* 6(1):15.

Sellars, S., Groeneveldt, L. & Beighton, P. 1976. Aetiology of deafness in white children in the Cape. *South African Medical Journal*, 50:1193-1197.

Sellars, S., Napier, E. & Beighton, P. 1975. Childhood deafness in Cape Town. *South African Medical Journal*, 49:1135-1138.

Silverman, F.H. & Moulton, R. 1997. First-class clinical services are possible in a developing country: Speech, language and hearing in the Gaza strip. *American Journal of Speech-language Pathology*, 6(2):5-7.

Singh, A., Georgalas, C., Patel, N. & Papesch, M. 2003. ENT presentations in children with HIV infection. *Clinical Otolaryngology & Allied Sciences*, 28 (3):240-243.

Sinninger, Y.S. Identification of auditory neuropathy in infants and children. *Seminars in Hearing*, 23(3):193-199.

Smit, G.J. 1983. *Navorsingsmetodes in die gedragswetenskappe*. Pretoria: HAUM Opvoedkundige Uitgewers.

Smit, J., Beksinska, M., Ramkissoon, A., Kunene, B. & Penn-Kekana, L. 2004. Reproductive health. *South African Health Review 2003/04*. http://www.hst.org.za/publications/423 (Date of access: 13 August 2004).

Solarsh, G. & Goga, A. 2004. Child health. *South African Health Review 2003/04*. http://www.hst.org.za/publications/423 (Date of access: 13 August 2004).

Sorri, M. & Rantakallio, P. 1985. Prevalence of hearing loss at the age of 15 in a birth cohort of 12 000 children from northern Finland. *Scandinavian Audiology*, 14:203-207.

Spiegel, H.M.L. & Bonwit, A.M. 2002. HIV infection in children. In: ML Batshaw (Ed.) *Children with Disabilities*. 5th ed. Baltimore: Paul H. Brookes Publishing Co. 123-139.

Spivak, L., Dalzell, L., Berg, A., Bradley, M., Cacace, A., Campbell, D., DeCristofaro, J., Gravel, J., Greenberg, E., Gross, S., Orlando, M., Pinheiro, J., Regan, J., Stevens, F. & Prieve, B. 2000. The New York State universal newborn hearing screening demonstration project: inpatient outcome measures. *Ear & Hearing*, 21:92-103.

Stach, B.A. & Santilli, C.L. 1998. Technology in newborn hearing screening. *Seminars in Hearing*, 19(3):247-261.

Stach, B.A. 2003. *Comprehensive dictionary of Audiology: illustrated*. 2nd ed. New York: Delmar Learning.

Stappaerts, L. & Van Kerschaver, E. 2004. A five-year retrospective evaluation of a mature universal newborn hearing: key components of success. International Conference on Newborn Hearing Screening Diagnosis and Intervention, May 27-29, Abstract book 9.

Statistics South Africa. 1999. Thematic report on children based on Census '96. Unpublished draft. Pretoria.

Statistics South Africa. 2002. Measuring rural development: Baseline statistics for the integrated sustainable rural development strategy. Pretoria: Statistics South Africa. 1-155.

Statistics South Africa. 2003. *Bulletin of statistics*, 37(3):1-280.

Stein, 1999. Factors influencing the efficacy of universal newborn hearing screening. *Pediatric Clinics of North America*, 46(1):95-105.

Strachan, K. 1999. Working as a nurse in a rural clinic. *Update,* 46:1-2. http://www.hst.org.za/update/46/isds.htm

Strydom, H. 2002a. Information collection: participant observation. In: AS de Vos (Ed.) *Research at Grass Roots*. 2nd ed. Pretoria: Van Schaik. 278-290.

Strydom, H. 2002b. Ethical aspects of research in the social sciences and human service professions. In: AS de Vos (Ed.) *Research at Grass Roots*. 2nd ed. Pretoria: Van Schaik. 62-76.

Strydom, H. & Venter, L. 2002. Sampling and sampling methods. In: AS de Vos (Ed.) *Research at Grass Roots*. 2nd ed. Pretoria: Van Schaik. 197-209.

Sutton, G.J., Gleadle, P. & Rowe, S.J. 1996. Tympanometry and otoacoustic emissions in a cohort of special care neonates. *British Journal of Audiology*, 30:9-17.

Swanepoel, D., Delport, S. & Swart, J.G. 2004. Universal newborn hearing screening in South Africa – a first-world dream? *South African Medical Journal*, 94(8):634-635.

Swanepoel, D. 2004. A review of the South African context: information for community-based speech-language and hearing services. *CLINICA: Applications in Clinical Practice of Communication Pathology*, 11-16.

Swart, S.M., Van Rooy, C., Ross, M. & Bellinghan, A. 1996. Prevalence of hearing loss and ear disease in first year entry schoolchildren in the industrial areas of Witbank and Kwa Guqa, SA. *Journal of Comprehensive Health*, 7(2):95-100.

Tau, W. 2003. National Coordinator of Provincial Health Departments. Personal communication, 2003-12-09.

Taylor, C.L. & Brooks, R.P. 2000. Screening for hearing loss and middle-ear disorders in children using TEOAEs. *American Journal of Audiology*, 9:50-55.

Thornton, A.R.D., Kimm, L., Kennedy, C.R. & Cafarelli-Dees, D. 1993. External- and middle-ear factors affecting evoked otoacoustic emissions in neonates. *British Journal of Audiology*, 27:319-327.

Tshwane 2020 Plan. 2002. Integrated development plan: first revision. http://www.tshwane.gov.za/documents/idp2020/index.htm (Date of access: 15 September 2004).

Tuomi, S.K. 1994. Speech-language pathology in South Africa: A profession in transition. *American Journal of Speech-Language Pathology: A Journal of Clinical Practice*, 3(2): 5-8.

UNAIDS/UNDP. 1998. HIV/AIDS and Human Development in South Africa. Pretoria. www.undp.org.za/docs/pubs/hdr.overview.htm

UNAIDS. 2003. Global AIDS epidemic shows no sign of abating. http://www.who.int/mediacentre/news/releases/2003/prunaids/en/ (Date of access: 30 September 2004).

United Nations. 2003. List of least developed countries. http://www.un.org/special-rep/ohrlls/ldc/list.htm (Date of access: 24 September 2004).

US Department of State. 2004. Background note: South Africa. http://www.state.gov/r/pa/ei/bgn/2898.htm (Date of access: 26 September 2004).

US Preventative Services Task Force. 2001. *Newborn hearing screening: recommendations and rationale*. Rockville, MD: Agency for Healthcare Research and Quality. http://www.ahrq.gov/clinic/3rduspstf/newbornscreen/newhearrr.pdf

Uus, K. & Davis, A.C. 2000. Epidemiology of permanent childhood hearing impairment in Estonia: 1985-1990. *Audiology*, 39:192-197.

Uys, I.C. 1993. Communication Pathology: Teaching for the Future. *The South African Journal of Communication Disorders*, 40:3-9.

Uys, I.C. & Hugo, S.R. 1997. Speech-language pathology and audiology: transformation in teaching, research and services delivery. *Health SA Gesondheid*, 2(2):23-29.

Van Cauwenberge, P.B., Vinck, B., De Vel, E., Dhooge, I. 1996. Tympanometry and click evoked otoacoustic emissions in secretory otitis media: are C-EOAEs consistently absent in B-tympanograms? In: Lim, D.J., Bluestone, C.D., Casselbrandt, M., Klein, J.O., Ogra, P.L. (Eds.) *Recent advances in otitis media*. Hamilton, Ontario: B.C. Decker. 139-141.

Van der Watt, H. 2002. The incidence of hearing loss in very low birth weight infants born at Kalafong hospital. Unpublished Mmed (Paed) research report, Department of Paediatrics, University of Pretoria.

Van Dijk, C.A. 2003. An educational audiology service delivery model: needs of teachers of children with hearing loss. Unpublished D.Phil. Communication Pathology degree. University of Pretoria.

Ventry, I.R. & Schiavetti, N. 1980. *Evaluating research in speech pathology and audiology*. Massachusetts: Addison-Wesley Publishing Company.

Ventura, S.J., Curtin, S.C. & Mathews, T.J. 1998. Teenage births in the United States: national and state trends, 1990-1996. *National Vital Statistics System*. Hyattsville, MD: National Center for Health Statistics. 12/98.

Vohr, B.R., Carty, L.M., Moore, P.E. & Letourneau, K. 1998. The Rhode Island Hearing Assessment Program: Experience with statewide hearing screening (1993-1996). *The Journal of Pediatrics*, 133(3):353-357.

Vohr, B.R., Simon, P. & Letourneau, K. 2000a. Public health implications of universal hearing screening. *Seminars in Hearing*, 21(4):295-307.

Vohr, B.R., Widen, J.E., Cone-Wesson, B., Sinninger, Y.S., Gorga, M.P., Folsom, R.C. & Norton, S.J. 2000b. Identification of neonatal hearing impairment: Charactersitics of infants in the neonatal intensive care unit and well-baby nursery. *Ear & Hearing*, 21:373-382.

Vohr, B.R., Oh, W., Stewart, E.J., Bentkover, J.D., Gabbard, S., Lemons, J., Papile, L.A. & Pye, R. 2001a. Comparison of costs and referral rates of 3 universal newborn hearing screening protocols. *The Journal of Pediatrics*, 139(2):238-244.

Vohr, B.R., Letourneau, K., McDermott, C. 2001b. Maternal worry about neonatal hearing screening. *Journal of Perinatology*, 21:15-20.

Wake, M.A. 2002. Newborn hearing screening: decision time for Australia. *Medical Journal of Australia*, 177:172-173.

Wansbury, V. 2002. An investigation into the demand for affordable hearing aids and their possible supply in the South African context. Unpublished B. Communication Pathology research report. Department of Communication Pathology, University of Pretoria.

Watkin, P.M. 2003. Neonatal hearing screening – methods and outcome. *Audiological medicine*, 1:165-174.

Watkin, P.M., Baldwin, M. & Laoide, S. 1990. Parental suspicion and identification of hearing impairment. *Archives of Disease in Childhood*, 65:846-850.

Watkin, P.M., Baldwin, M. & McEnery, G. 1991. Neonatal at risk screening and the identification of deafness. *Archives of Diseases in Childhood,* 66:1130-1135.

Watkin, P.M., Beckman A. & Baldwin, M. 1995. The views of parents of hearing impaired children on the need for hearing screening. *British Journal of Audiology*, 29:259-62.

Watkin, P.M. 1996. Neonatal otoacoustic emission screening and the identification of deafness. *Archives of Diseases in Childhood Fetal and Neonatal Edition,* 74(1):F16-25.

Watkin, P.M., Baldwin, M., Dixon, R. & Beckman, A. 1998. Maternal anxiety and attitude to universal hearing screening. *British Journal of Audiology*, 32:27-37.

Weatherby, L.A. & Bennett, M.J. 1980. The neonatal acoustic reflex. *Scandinavian audiology*, 9:103-110.

Whiston, T.G. 1994. *Research Policy in the Higher Education Sector of South Africa.* Pretoria: Foundation for Research Development.

White, K.R. 2002. Status of early hearing detection and intervention in the United States. Oral presentation. National Symposium on Hearing in Infants. Breckenridge, CO, USA, July 31 - August 3 2002.

White, K.R. 2003. The current status of EHDI programs in the United States. *Mental Retardation and Developmental Disabilities Research Reviews*, 9:79-88.

White, K.R. 2004. Where we've been… Where we're going. Interactive discussion on contemporary issues in screening, diagnosis and intervention. International Conference on Newborn Hearing Screening Diagnosis and Intervention, May 27-29, Abstract book 28.

White, K.R., Behrens, T.R. & Strickland, B. 1995. Practicality, validity, and cost-efficiency of universal newborn hearing screening using transient evoked otoacoustic emissions. *Journal of Childhood Communication Disorders*, 17(1):9-14.

White, K.R., Mauk, G.W., Culpepper, N. B., & Weirather, Y. 1997. Newborn hearing screening in the United States: Is it becoming the standard of care? In: L. Spivak (Ed.) *Neonatal hearing screening*. New York: Thieme. 225-255.

White, K.R., Vohr, B.R., Maxon, A.B., Behrens, T.R., McPherson, M.G. & Mauk, G.W. 1994. Screening all newborns for hearing loss using transient evoked otoacoustic emissions. *International Journal of Pediatric Otorhinolaryngology* 28:203-217.

White Paper on an Integrated National Disability Strategy. 1997. Office of the Deputy President T.M. Mbeki. Cape Town: Rustica Press. www.polity.org.za/htmlgovdocs/white_papers/disability1.html?rebookmark=1

Widerstorm, A.H., Mowder, B.A. & Sandall, S.R. 1997. *Infant Development and Risk*. 2nd ed. Maryland: Paul H Brookes Publishing Co.

Williams, M., Trutty, L.M. & Grinnel, R.M. 1995. *Research in social work: an introduction*. Itasca: Peacock.

Woolard, I. & Barberton C. 1998. The extent of poverty and inequality. In: Barberton, C., Blake, M. & Kotzé, H. (Eds.) *Creating Action Space*. Cape Town: IDASA. 13-39.

World Bank. 2004. *Introduction to Selected World Development Indicators. World Development Report 2004*. London: Oxford University Press. 249-271.

World Health Organisation. 1995. Prevention of hearing impairment. Resolution of the 48th World Health Assembly, 12 May, WHA 48:9.

World Health Organisation. 1997. Executive Summary. World Health Report 1997. Geneva: WHO. http://www.who.int/whr2001/2001/archives/1997/exsum97e.htm. (Date of access: 19 July 2004).

World Health Organisation. 2001. Who calls on private sector to provide affordable hearing aids in developing world? Press release WHO/34,11 July 2001. http://www.who.int/inf-pr-2001/en/pr2001-34.html (Date of access: 19 July 2004).

World Health Organisation. 2001. Guidelines for hearing aids and services for developing countries. Geneva: WHO. http://www.who.int/pbd/pdh_home.htm. (Date of access: 19 July 2004).

World Trade Organisation. 2004. Development: definition. http://www.wto.org/english/tratop_e/devel_e/d1who_e.htm (Date of access: 24 September 2004).

Yeo, S.W., Park, S.N., Park, Y.S. & Suh, B.D. 2002. Effect of middle-ear effusion on otoacoustic emissions. *The Journal of Laryngology & Otology*, 116:794-799.

Yoshinaga-Itano, C. 1995. Efficacy of early identification and intervention. *Seminars in Hearing*, 16:115-120.

Yoshinaga-Itana, C. & Apuzzo, M. 1995. Early identification of infants with significant hearing loss and the Minnesota child development inventory (MCDI). *Seminars in Hearing*, 16:124-135.

Yoshinaga-Itano, C., Sedey, A., Coulter, D. & Mehl, A. 1998. Language of early- and later-identified children with hearing loss. *Pediatrics*, 102:1161-1171.

Yoshinaga-Itano , C. & Appuzo, M.L. 1998. Identification of hearing loss after 18 months is not early enough. *American Annals of the Deaf*, 143(5):380-387.

Yoshinaga-Itano, C. 2000. Successful Outcomes for Deaf and Hard-of-Hearing children. *Seminars in Hearing*, 21(4), 309-325.

Yoshinaga-Itano, C. & Gravel, J.S. 2001. The evidence for universal newborn hearing screening. *American Journal of Audiology*, 10:62-64.

Yoshinaga-Itano, C., Coulter, D. & Thomson, V. 2001. Developmental outcomes of children with hearing loss born in Colorado hospitals with and without universal newborn hearing screening programs. *Seminars in Neonatology*, 6(6):521-529.

Yoshinaga-Itano, C. 2002. Cochlear implantation before 12 months of age: Challenges and Considerations. In: Schauwers, K., Govarts, P., Gillis, S. (Eds.) *Language Acquisition in Young Children with a Cochlear Implant*. Antwerp Papers in Linguistics. 102:61-76.

Yoshinaga-Itano, C. 2003. Universal newborn hearing screening programs and developmental outcomes. *Audiological Medicine*, 1:199-206.

Yoshinaga-Itano, C. 2004. Levels of evidence: universal newborn hearing screening (UNHS) and early hearing detection and intervention systems (EHDI). *Journal of Communication Disorders*, 37:451-465.

APPENDICES

APPENDIX A

PRINCIPLES OF NEWBORN HEARING SCREENING

Screening principles for hearing impairment (Davis et al. 1997:8)

1. The hearing impairment to be screened for should be an important health problem
2. There should be an accepted rehabilitation means for cases of permanent childhood hearing loss identified by the screen
3. Facilities for assessment, diagnosis and rehabilitation should be available
4. The hearing impairment should be recognisable at an early stage
5. A suitable hearing screening test should be available at the proposed age for the screen (it should be quick, with good sensitivity, good specificity, and easy to interpret)
6. The hearing screening test should be acceptable to both child and parents
7. The natural history of childhood hearing impairments should be known and understood
8. There should be an agreed policy on whom to treat as patients with hearing impairment
9. The cost of hearing screening (including all assessments consequent on screening) should not be disproportionate to other healthcare costs incurred by a hearing impaired child
10. Finding cases of childhood hearing impairment should be viewed as a continuous process
11. The incidental harm resulting because of hearing screening programmes, e.g. stress to parents, should be small in relation to overall benefits
12. There should be guidelines on how to explain results of hearing screening, together with transitional counselling support for those parents of children who have been screened and are concerned
13. All hearing screening arrangements should be reviewed in light of changes in demography, epidemiology and other factors
14. Costs and effectiveness of hearing screening should be examined in a stratified manner, and benefit maximised in each stratum

APPENDIX B

DATA COLLECTION SHEET

DATA SHEET

ID NO.												

Respondent no				

V1					1-4

SECTION A ~ IDENTIFYING INFORMATION

a) Gender

Male	1	Female	2

V2		5

b) Child's Age

Weeks		

V3			6-7

c) Mother's Age

Years		

V4			8-9

d) Home Language

Tswana	1
Sepedi	2
Shangaan	3
Zulu	4
English	5
Afrikaans	6
Other	7

V5		10

e) Race

Black	1
Coloured	2
Indian	3
White	4

V6		11

f) Primary Caregiver

Mother	1
Father	2
Both	3
Grandparents	4
Extended family	5
Foster parents	6

V7		12

g) Educational Qualifications

i. Biological Mother

< St. 6	1
St. 6-8	2
St. 8-10	3
Diploma/Degree	4
Postgraduate	5

V8		13

ii. Biological Father

< St. 6	1
St. 6-8	2
St. 8-10	3
Diploma/Degree	4
Postgraduate	5

V9 [ ] 14

h) Average Household Income (p/m)

<R500	1
R501 – R1000	2
R1001 – R2000	3
R2001 – R 5000	4
R5000+	5

V10 [ ] 15

i) No. of children (Biological mother)

Born		
Still living		

V11 [ ] [ ] 16-17
V12 [ ] [ ] 18-19

j) Marital status of Biological parents

Married	1
Never married	2
Divorced	3
Widow	4

V13 [ ] 20

k) Housing

Own house/flat	1
Informal housing	2
Renting	3
With others	4

V14 [ ] 21

SECTION B ~ RISK INDICATORS

a) Family History of childhood Hearing loss

Yes	1	No	2	Info unavailable	3

V15 [ ] 22

b) Hyperbillirubinemia
Levels requiring blood transfusion/exchange

Yes	1	No	2	Info unavailable	3

V16 [ ] 23

If levels are known, are they in excess of the following amounts,

Birth weight (grams)	Bili level
≤ 1000	10.0
1001 – 1250	10.0
1251 – 1500	13.0
1501 – 2000	15.0
2001 – 2500	17.0
2500 +	18.0

Yes	1	No	2	Info unavailable	3

V17 [ ] 24

c) Congenital infections

Yes	1	No	2	V18		25

If 'Yes', specify:

	YES	NO			
Toxoplasmosis	1	2	V19		26
Cytomegalovirus	1	2	V20		27
Syphillis	1	2	V21		28
Herpes	1	2	V22		29
Rubella	1	2	V23		30
Measles	1	2	V24		31
HIV	1	2	V25		32
Malaria	1	2	V26		33

d) Craniofacial defects (Head and neck)

Yes	1	No	2	V27		34

e) Birth weight < 1500g

Yes	1	No	2	Info unavailable	3	V28		35

f) Bacterial meningitis

Yes	1	No	2	Info unavailable	3	V29		36

g) Asphyxia
Apgar 0-4 at 1min and/or 0-6 at 5min

Yes	1	No	2	Info unavailable	3	V30		37

If 'Yes' specify at:

1 min			V31		38-39
5 min			V32		40-41

h) Ototoxic medications
Used for more than 5 days (e.g. gentamycin, tobramycin, kanamycin, streptomycin, aminoglycosides and loop diuretics combined with amino's)

Yes	1	No	2	Info unavailable	3	V33		42

i) Persistent pulmonary hypertension / persistant fetal circulation. Prolonged mechanical ventilation ≥ 5 days

Yes	1	No	2	Info unavailable	3	V34		43

j) Syndrome present

Yes	1	No	2	V35		44

If 'yes', specify syndrome:

_____ V36 | | | 45 - 46

k) Admitted to the NICU

Yes	1	No	2	V37		47

If 'Yes', for how long?

No of days			

V38				48-50

SECTION C ~ IMMITTANCE

a) 1000 Hz Tympanogram

i. Y – Admittance

	RIGHT		LEFT	
i.i Performed	Yes	No	Yes	No
i.ii Discernable peak	Yes	No	Yes	No
i.iii Admittance (mmho)	,		,	
i.iv Pressure (daPa)				
i.v Double peak	Yes	No	Yes	No
i.vi Time taken (min)				

V39R				51
V39L				52
V40R				53
V40L				54
V41R	,			55-58
V41L	,			59-62
V42R				63-66
V42L				67-70
V43R				71
V43L				72
V44R				73-74
V44L				75-76

ii. B – Susceptance

	RIGHT		LEFT	
ii.i Performed	Yes	No	Yes	No
ii.ii Admittance (mmho)	,		,	
ii.iii Pressure (daPa)				

V45R				77
V45L				78
V46R	,			79-82
V46L	,			83-86
V47R				87-90
V47L				91-94

iii. G– Conductance

	RIGHT		LEFT	
iii.i Performed	Yes	No	Yes	No
iii.ii Admittance (mmho)	,		,	
iii.iii Pressure (daPa)				

V48R				95
V48L				96
V49R	,			97-100
V49L	,			101-104
V50R				105-108
V50L				109-112

b) 1000 Hz Probe Tone Reflex

	RIGHT		LEFT	
i. Performed	Yes	No	Yes	No
ii. Threshold present	Yes	No	Yes	No
iii. Threshold value (dB)				

V51R		113
V51L		114
V52R		115
V52L		116
V53R		117-119
V53L		120-122

SECTION D ~ HEARING SCREENING

a) First Screen

	RIGHT		LEFT	
i. OAE	Pass	Refer	Pass	Refer
ii. AABR	Pass	Refer	Pass	Refer

V54R		123
V54L		124
V55R		125
V55L		126

iii. Time taken:

iii.i OAE

		min

V56			127-128

iii.ii AABR

		min

V57			129-130

b) Follow-up Screen

i. Returned?

Yes	1	No	2

V58		131

	RIGHT		LEFT	
ii. OAE	Pass	Refer	Pass	Refer
iii. AABR	Pass	Refer	Pass	Refer

V59R		132
V59L		133
V60R		134
V60L		135

SECTION E ~ DIAGNOSTIC ASSESSMENT

a) Returned?

Yes	1	No	2

V61 [ ] 136

b) Hearing loss?

None	1	Bilateral	2	Unilateral	3

V62 [ ] 137

c) Type of hearing loss?

S/N	1
Conductive	2
Mixed	3
AN	4

V63 [ ] 138

d) Ear

Left	1	Right	2	Both	3

V64 [ ] 139

e) Degree of hearing loss?

i. Right ear

Mild (15-30 dB)	1
Moderate (31-50dB)	2
Severe (51-70dB)	3
Profound (71dB+)	4

V65 [ ] 140

ii. Left ear

Mild (15-30 dB)	1
Moderate (31-50dB)	2
Severe (51-70dB)	3
Profound (71dB+)	4

V66 [ ] 141

COMMENTS

APPENDIX C

CRITICAL REFLECTION SHEET

A CRITICAL REFLECTION

TO: Fieldworkers of the Hammanskraal infant hearing screening project

Please document and describe your experiences at the MCH clinics in Hammanskraal according to the following headings:

- ✓ **The clinics as screening contexts (facilities, barriers, positive aspects etc.)**
- ✓ **Collaboration with personnel and nurses (Attitudes, contact, involvement, etc.)**
- ✓ **Experience with caregivers (attitudes, collaboration, insight, language abilities etc.)**
- ✓ **Experience with babies 0-12 months in the performance of hearing screening tests**

APPENDIX D

LETTER TO CAREGIVERS - DESCRIPTION OF THE PROJECT AND INFORMED CONSENT

University of Pretoria

Pretoria 0002 Republic of South Africa Tel 012-420-2357 / 012-420-2816 Fax 012-420-3517 *http://www.up.ac.za*

Department of Communication Pathology
Speech, Voice and Hearing Clinic

Date:

Dear parent:

A HEARING TEST FOR YOUR BABY

The Department of Communication Pathology at the University of Pretoria is doing a research project at the Refentse and Eersterus clinics to test the hearing of young babies. We have equipment that can test your baby's hearing in 5 minutes by putting a soft probe in his/her ear. The hearing test does not hurt and every baby gets his own soft probe to make sure that the testing is clean and hygienic. The testing is free and if the baby needs more testing this will also be provided free of charge. The results of your baby's test will be used for research purposes as part of a large project to improve services to young babies. His/her name will not be used and all the results will be completely confidential.

If you want to have your baby's hearing screened please fill in and sign the consent form below. If you have any questions please contact us at the Communication Pathology Department, University of Pretoria, Tel: (012) 420 2357.

Thank you.

_____
Mr. De Wet Swanepoel

University of Pretoria
Department Communication Pathology

Surname:_____ Name:_____

Age:_____ First language:_____

I hereby consent to participate as a research subject in the hearing screening project at the Refentse/Eersterus clinics:

_____ Date:_____
Signature

APPENDIX E

FOLLOW-UP APPOINTMENT LETTER

University of Pretoria

Pretoria 0002 Republic of South Africa Tel 012-420-2357
/ 012-420-2816 Fax 012-420-3517 http://www.up.ac.za

Department of Communication Pathology
Speech, Voice and Hearing Clinic

Date:

Dear parent of _____

We have screened the hearing of your baby. The test results indicate that your baby must come back for another test to make sure that he/she hears all sounds. The follow-up hearing test is scheduled on the _____ at the Refentse clinic. We look forward to seeing you and your baby on this day.

Thank you,

DeWet Swanepoel
Audiologist/Lecturer
Tel: 420 5152

APPENDIX F

LETTER OF ETHICAL CLEARANCE - ETHICS COMMITTEE, FACULTY OF HUMANITIES, UNIVERSITY OF PRETORIA

Universiteit van Pretoria

Pretoria 0002 Republiek van Suid-Afrika Tel (012) 420-4111
Faks (012) 362-5168 / 362-5190 *http://www.up.ac.za*

Fakulteit Geesteswetenskappe

Departement Maatskaplike Werk
Faks (012) 420-2093 Tel (012) 420-2325

Prof. Renè Hugo
Departement Kommunikasie Patologie
Navorser: Mnr. D.C.D Swanepoel

06-12-2002

Geagte Prof. Hugo

GOEDKEURING VAN ETIESE AANSOEK: Mnr. D.C.D Swanepoel

Titel van navorsing: Infant hearing screening in two rural South African communities.

Die betrokke navorsing is op 6 Desember 2002 op 'n ad hoc basis deur Prof. Danie Prinsloo en Dr. C.S.L. Delport goedgekeur nadat die nodige toestemmingsbrief vanaf die Departement Gesondheid ingedien is.

Vriendelike groete

Dr. C.S.L Delport
012 420 2394

APPENDIX G

LETTER OF ETHICAL CLEARANCE - ETHICAL COMMITTEE, DISTRICT DEPARTMENT OF HEALTH, NORTH WEST PROVINCE

NORTH WEST PROVINCE
DEPARTMENT OF HEALTH

MORETELE DISTRICT

Mr. D.E. Baloyi
Tel: 012 717 2079/7925
Fax: 012 717 8712

Private Bag X454
Hammanskraal
0400

18 November 2002

Dr De Wet Swanepoel
Department of Community Pathology
University of Pretoria
Pretoria

RESEARCH CLEARANCE AT REFENTSE AND EESTERUS CLINICS

1. **I refer to your letter dated 11/11/2002 in connection with the above matter.**
2. **Approval is hereby granted.**
3. **May I take this opportunity to request you to copy us your findings for our records and possible interventions?**

Thanks

District Manager