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Early Intervention in Audiology: Exploring the Current Status from a Developing Country Context

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Authors' contributions

This work was carried out in collaboration between both authors. Author KKS supervised and co-designed the study, co-performed the statistical analysis, co-wrote the protocol with author GM and wrote all drafts of the manuscript. Author GM managed the data collection and analyses of the study with both authors managing the literature searches. Author KKS read and approved the final manuscript.

Original Research Article

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ABSTRACT

Aims: Analysis of the current audio logical management protocols for children with hearing impairment in South Africa's Gauteng state hospitals was investigated in this study.
Study Design and Methods: A retrospective record review was conducted, with 70 files/medical records of paediatric patients between the ages of birth and three years. These records came from three state hospitals' audiology clinics where full audio logical and otological services were available.
Results: Findings of this study revealed concerning trends. Firstly, findings indicated that on average children were identified with a hearing loss at 23.65 months. Secondly, they received amplification 7.11 months after diagnosis and were only introduced into aural rehabilitation at the average age of 31.2 months. However, 81% of children received appropriate audio logical tests; with 85.7% of children who were identified with a hearing loss receiving amplification. All children identified with a bilateral hearing loss in the current sample were aided bilaterally. As far as communication development was concerned, 48.57% of the children identified with a hearing loss received the auditory verbal therapy approach, with 18.57% receiving sign language as a means of

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communication, while 11.43% received a total communication approach. A significant number (14.29%) were not receiving aural rehabilitation therapy.
Conclusion: Findings raise important implications for the success of early hearing detection and intervention (EHDI) initiatives in South Africa. Improved and concerted efforts in the form of systematic planning and implementation of EHDI protocols are required.

Keywords: Audiological management; early intervention; paediatric; state hospitals; South Africa.

1. INTRODUCTION

Early intervention is defined as intervention practices for children from the ages of birth until three years of age [1]. In the 2007 position statement by the Health Profession Council of South Africa (HPCSA) it is stated that: “Early hearing detection and intervention programmes are recommended to identify, diagnose and treat newborns and infants with a disabling hearing loss as early as possible to ensure that optimum, cost effective solutions, that enable persons to communicate effectively, allowing them to develop to their maximum potential, and thereby to secure their full participation in and contribution to, society and the country’s economy” [2].

Studies have indicated that undetected hearing loss can lead to irreversible speech, language, and cognitive delays [3]. It is therefore vital for early hearing detection and intervention (EHDI) to take place prior to6 months of age so that the child is able to maintain age appropriate development with regards to language skills [3]. The most critical time for development of the brain’s hearing centres is during the first few months of life [4]. Failure to detect a hearing loss early may result in a profound delay of 2-4 years with regards to development of language abilities and skills [3]. Hearing loss is the most frequent occurring birth defect, although not life threatening, failure to intervene in time will severely affect one’s quality of life [5].

Universal Newborn Hearing Screening (UNHS) programmes have proven to be beneficial as they allow for early detection of a hearing loss in children and subsequent intervention leads to linguistic, speech and cognitive development that is comparable to their normally hearing peers [6]. Because of this benefit, early detection and intervention for infants with hearing loss has become standard practice in developed countries [7], such as the United States and the United Kingdom. In countries such as America and the United Kingdom, up until 1990 children born with a hearing loss would have only been identified by the ages of 2.5 to 3 years old [4]. However, with the implementation of EHDI services and UNHS, the average age of identification and confirmation of hearing impairment in these countries has decreased to 2-3 months [4]. The situation is different for developing countries where the issue of costs and burden of disease priorities are still challenging. A bulk of the health expenditure is usually spent on curative measure as well as treatment of life-threatening conditions; with rehabilitation and preventative care arguably receiving lesser financial attention – although cost-effectiveness of such programmes have been well established.National priorities in developing countries will often be geared towards higher profile issues and cost-effectiveness arguments in such severely resource-constrained settings can therefore be ineffective. Arguably, the achievement of EHDI goals in developing countries depends on a strong political will in the form of allocation of funds committed to EHDI, and this is often not the case in many developing countries; South Africa included.

It is unfortunate that widespread implementation of EHDI programmes has not carried over to the developing world which is home to two thirds of the world's children with hearing loss [8]. In places such as India, China and South Africa where UNHS has not been implemented, hearing loss is often detected as a consequence of parental concerns regarding delays in speech and language development [9]. In such countries the detection period usually only occurs from two years of age and extends well into the adolescent years [9].

A study by Swanepoel and Storbeck [10], regarding the prevalence of hearing loss in South Africa, within both the private and public health care settings. Revealed that, in the private sector, which services 15% of the total population, the prevalence of hearing loss is 3 in every 1000 births, which translates to an annual rate of 496 and a daily rate 1.5 of people born with a hearing loss [10]. In the public sector which services up to 85% of the population, the prevalence of hearing loss is 6 in every 1000 births which is an annual rate of 5620 and a daily rate of 15.5 per day of people born with a hearing loss [10].

With such a high prevalence of hearing loss in the public health sector in South Africa, there currently is a dearth of published research into the early intervention services provided to this population [11]. Limited human resources in the form of audiologists employed in the public health sector when compared to those in private practice possibly has a role. Thereis a reported low audiologist-to-patient-ratio as well as heavy clinical service load, particularly in the public sector [11]. The majority of audiologists work in the private health care sector which services only the minority of the population [11]; hence attention to public healthcare EHDI research issues is not a priority.

According to Storbeck and Pitman [3], for comprehensive EHDI program implementation; there are three stages that need to be included. The first stage is that of identification, which comprises of screening for hearing loss. The second stage is that of referral for diagnostic tests [3] in order to confirm, describe and categorize the hearing impairment. The final stage of EHDI involves intervention services [3]. The current study therefore aimed to explore the audio logical management of paediatric patients through all three stages.

Infants with hearing loss and their families should enrol in aural rehabilitation; which is intervention geared towards minimizing and alleviating the communication difficulties associated with a hearing loss [12]. There are a variety of approaches to long-term intervention for these infants [13]. Most programmes and approaches aim to equip the child's parents with the skills and tools needed to facilitate the child's communication abilities. Most of the assistance focuses on language development, which often includes auditory stimulation [13]. For infants and families to benefit from such programs, adherence to the treatment plan is vital; and that includes follow-up.

Follow-up has been reported as the most difficult aspect of an EHDI programme, and it has been advocated that any obstacles to follow-up be identified [14] and managed timeously. Audiologists and other health care professionals can help ensure follow-up return rates by providing good and relevant communication to caregivers [14]. Communication with caregivers can include education and counseling regarding the risk factors for hearing loss, the importance of early identification, the significance of follow-up visits, and the implications of undetected hearing loss [14].

Variables such as age of diagnosis, nature of intervention and rehabilitation have not yet been comprehensively examined within the South African context, where the nature of early

intervention is affected by the country being classified as having both developed and developing country qualities [14]. While extensive literature is available on the practices and models of early intervention in developed countries, little information is available in developing countries where policies and practices are arguably largely inadequate [14]; hence the current study.

The primary aim of the current study was to investigate the current audiological management protocols for the paediatric population in Johannesburg, Gauteng; with the following being the secondary objectives:

- To establish the age of identification of children with hearing impairment
- To determine the audio logical assessment tools utilized with this population
- To determine if amplification is provided in children identified with a hearing impairment
- To establish the time period between diagnosis of hearing loss and provision of amplification
- To determine the type of amplification provided
- To determine if bilateral amplification was provided where indicated.
- To determine what mode of communication is being utilized in therapy with this population.

2. METHODOLOGY

2.1 Design of the Study

Following ethical clearance from the University's Medical Ethics Committee, this study adopted a retrospective record review. A retrospective study is designed to examine data that is already on file; therefore, the researcher makes observations and can provide descriptive statistics from this data [15]. A spread sheet depicting data directly related to the specific objectives of the study was formulated and used to capture the data from the files.

2.2 Files Reviewed

2.2.1 Description of files

2.2.1.1 Sample size

The Sample Size consisted of 70 files, with 20 files from Hospital A, 10 files from Hospital B and 40 files from hospital C. All three hospitals have fully resourced audiology clinics. It is important to note that only audiology files of patients who had been cleared from the Ear, Nose and Throat Specialists in terms of absence of middle ear disease were included in the sample.

2.2.1.2 Gender

The gender breakdown of the participant files reviewed comprised of 60% males and 40% females.

2.2.1.3 Types of hearing loss in the sample

Standard audiology protocol dictates that all patients presenting with abnormal auditory function, findings be categorized into type of hearing loss; symmetry of the hearing loss, as well as severity or degree of the loss. The hearing losses are classified into the three well-documented types of hearing losses (conductive - CHL; mixed - MHL; and sensorineural - SNHL). Symmetry of hearing loss is examined where the audiologist established whether the hearing loss was unilateral or bilateral, and whether it was symmetrical or asymmetrical. The degree of hearing loss is determined using the classification of Magnitude of Hearing Impairment. This classification system proposes that impaired hearing function begins at an average hearing level of 25 dB HL, and is categorized as seen in Table 1.

Table 1. System of classification of hearing loss in terms of degree of loss used in the current study

Average Hearing Level dB	Description
< 26 dB	Normal range
26dB – 40 dB	Mild hearing loss
41dB – 55 dB	Moderate hearing loss
56dB – 70 dB	Moderately severe hearing loss
71dB – 90 dB	Severe hearing loss
>91 dB	Profound hearing loss

Adopting the standard protocol described above, analysis of the data in the files yielded the following results, as depicted in Table 2 below.

Table 2. Description of Hearing test results in the sample (N=70)

Description of hearing test results	Percentage of participants
Bilateral severe to profound SNHL	29%
Bilateral profound SNHL	20%
Bilateral severe SNHL	17%
OAE bilateral fail (absent OAEs bilaterally)	10%
Bilateral moderate to severe SNHL	7%
Bilateral moderate SNHL	4%
Unilateral moderate to severe SNHL	3%
Unilateral severe SNHL	3%
Bilateral mild to moderate SNHL	3%
Unilateral profound SNHL	1%
OAE unilateral fail (absent OAEs unilaterally)	1%
Unilateral moderate SNHL	1%

Key: SNHL=sensorineural hearing loss; OAE=otoacoustic emissions

From Table 2 above, it is evident that the types of hearing loss of the children whose files were included in the current study ranged from unilateral to bilateral, mild hearing losses to profound losses; with nature being only sensorineural hearing loss. Bilateral profound hearing losses were the most common types of hearing loss found. This may be due to the fact that a profound loss is easier to identify for parents and caregivers than a moderate or

mild hearing loss; and so in the absence of UNHS; these are the children seen for intervention. Often, parents bring their children in for an audiological assessment at this stage because of concerns regarding delays in speech and language development.

2.3 Data Analysis and Statistical Procedures

This study made use of descriptive statistics. Descriptive statistics are utilized to observe group differences, developmental trends or relationships among variables that can be measured by the researcher [15]. "Research of this type provides an empirical picture of what was observed at one time or of observed changes over a period of time, without the manipulation of independent variables by the researcher" [15]. The independent variables in this study were age, gender, type of hearing loss, audiological assessments, amplification, age at introduction into aural rehabilitation and mode of communication. The data were then generated into graphical/tabular representation where the values of each variable were plotted against the number of times it occurred; and this allowed the researcher to provide and organize scores and observations into a summarized fashion [16].

3. RESULTS AND DISCUSSION

3.1 Age of Identification of Hearing Loss

In addressing the specific aim of establishing the age of identification of children with hearing impairment, results indicated significantly delayed age of identification. Current findings indicated the children's ages of hearing loss identification ranged from 2 weeks to 3 years 3 months, with a mean age of identification being 23.65 months, the median age was 26 months and the mode age was 36 months. The HPCSA position statement states that children should be identified by the age of 3 months [2]; a recommendation which was not realized in the data from the current study where children were identified much later than 3 months of age. Literature has advocated that the best way to identify hearing loss as early as possible is via UNHS [9]; however, this is not the common practice in the Gauteng state hospitals, or across the country. Instead, the current study findings suggested that hearing loss was being mainly detected as a result of parental concerns as opposed to via UNHS; and consequently the detection period may be from 2 years of age until as late as adolescents [9]. Current findings not only highlight the importance of UNHS; but also raise an implication for improved parental awareness programs where parents are educated about signs and symptoms of hearing impairment much earlier than the age of twoyears; awareness about risk factors to hearing loss; as well as the importance of observing and facilitating pre-linguistic development.

Swanepoel [17], states that there are insufficient numbers of audiologists in the country; and that these audiologists are unequally distributed between the private and public sector, with the public sector being significantly under-staffed for the population size they serve. The low audiologist to patient ratio can possibly be the biggest challenge in the provision of adequate audiological services in South Africa [17]; and so there is heavy reliance on referrals from the doctors, nurses, and other allied medical disciplines. This therefore has implications for improved multi and inter-disciplinary team work; with an increased need for the audiologist to conduct awareness campaigns within the teams. Failure to detect a hearing loss may result in significant consequences for the child's speech and language acquisition, academic performance as well as social and emotional wellbeing [1]; and so the cost-effectiveness of such campaigns is positive.

3.2 Audiological Evaluation

In addressing the second aim of establishing the audiological evaluation of children with hearing impairment; current results indicated that 81% of children received appropriate comprehensive audiological evaluations. Results were further analyzed and 88% of the children received an otoscopic examination, 81% middle ear tests such as tympanometry, 68% received subjective testing in the form of visual reinforcement and/or behavioural observation audiometry, 82% received an OAE measure and 78% of the children underwent an auditory brainstem response (ABR) assessment. From the current findings, it was clear that the majority of participants (approximately 81%) underwent appropriate and comprehensive audiologic evaluations that included both behavioural and objective measures. These findings are consistent with the JCIH recommended test batteries for infants. These positive findings are in the context where research has shown that audiology services within the South African context are significantly influenced by equipment constraints. In the public healthcare sector, progress has been hampered by limited availability of equipment, use of outdated equipment; and constant challenge with funding to repair and/or calibrate equipment.

3.3 Amplification

The third aim of the current study was to identify whether children diagnosed with hearing impairment were provided with amplification. From the data collected, 60 out of 70 (85.71%) children were fitted with amplification. Of the 10 that were not fitted, 8 had not returned to the audiology clinics for follow up after they had been diagnosed with a hearing loss, 1 was awaiting results from an ABR and 1 was booked for a recheck as a clear and consistent diagnosis had not yet been made. Considering the costs associated with amplification and limited resources under which state hospitals function, the fact that a large majority of the participants were aided is a significantly positive finding. Evidence suggests that provision of amplification as soon as possible after a child is identified with a hearing loss is of crucial importance as lack of auditory stimulation has an effect on the development of the child's speech and language skills [18]. Evidence further illustrates that if children with hearing loss are provided with amplification between 6- 12 months of age, their spoken language and cognitive skills become comparable to those of their normally hearing peers[18].Current findings are very positive for the South African context specifically within the government healthcare sector, indicating that once identified with a hearing loss, at least 85% of children receive amplification; and this figure would be higher if challenges such as follow-up; and parental awareness of hearing impairment and its effects were addressed. It is believed that this finding might be different if UNHS was being implemented and there were possibly greater numbers of children identified (including those with mild and/or moderate hearing loss); as this would require greater budgetary consideration.

3.4 Type of Amplification

The next aim of this study was to examine the type of amplification being provided to children who are diagnosed with hearing loss in the Gauteng state hospitals.

Table 3. Types of Amplification Provided in the Current Sample

Type of amplification	Number of participants	Percent
Behind-the ear Hearing Aids	52	86.66%
Bone Anchored Hearing aids	3	5%
Cochlear Implants	3	5%
Referrals not in district *	2	3.33%

The results showed that 86.66% of the sample received behind-the-ear hearing aids, 5% received Bone Anchored Hearing Aids (BAHA), 5% received cochlear implants, and 3.33 % were referred elsewhere because they were not from within the diagnosing hospital district. Published evidence indicates that the public health care system in South Africa provides behind-the ear hearing aids free of charge to children under the age of 6 years[14]. This practice therefore explains the current findings as to why behind-the ear hearing aids were the most popular type of amplification in the current sample. Bone Anchored Hearing Aids (BAHA) were supplied to those children with additional outer and middle ear pathologies. Five percent of participants in the current study were fitted with cochlear implants. The fact that only 5% of the sample were fitted with cochlear implants was not a surprising finding for this context when one considers the costs involved with cochlear implantation. The expense of cochlear implants and the high costs associated with the follow up and therapy are possible factors which contributed to the low percentage of children fitted with cochlear implants in Gauteng state hospitals [14]. The current authors postulate that the numbers of cochlear implantees is not likely to increase in the near future if UNHS is universally implemented in the country. This is based on the belief that if more children are identified; ethical practice would dictate that they receive amplification; and budgetary constraints would not allow for as wide a coverage should cochlear implants be standard. This of course would not be true if an increased and dedicated budget is allocated to EHDI programmes in the country.

3.5 Timing of Amplification

In addressing the specific aim of the time lapse between identification and amplification, it was found that the period ranged from 2 weeks to 3 years with a mean of 7.11 months.

These findings are inconsistent with the study conducted by Swanepoel [10] in urban South Africa, which revealed that the average amount of time between diagnosis and fitting was 5 months; although this study was also in urban South Africa. The results of the current study indicated that the average age of identification of a hearing loss is 23 months, and the average waiting period to be fitted with a hearing aid is approximately 8months. Children only received amplification around 30 months of age and therefore missed out on the critical periods of accessing residual hearing for language acquisition. The age of amplification in the current study is significantly delayed when compared to the recommended guidelines of amplification between 6 to 12 months of age. This therefore puts the South African hearing impaired child at a significant disadvantage when it comes to them developing spoken language and cognitive skills comparable to their normal hearing peers [18].

There may be different reasons for the long waiting period for amplification found in the current study. In the public health care system, administrative measures are reported to often be a major factor delaying the availability and accessibility of hearing aids to the

hearing impaired. Time delays linked to procurement processes result in the late fitting of amplification. The procurement process often dictates that companies supplying hearing aids be paid before hearing aids are delivered; and this process often takes considerable time – time which adversely affects efficiency in provision of hearing aids timeously. .Furthermore, between the public and the private health care sectors, audiologists are unequally distributed; with an insufficient number of audiologists in the public sector [17]; which has a direct impact on caseloads. Busy therapist schedules in the public sector due to the long waiting lists are another contributing factor to this delayed amplification [17] as therapists have to attend to a much higher patient load and their bookings are usually exceptionally high.

These findings highlight the urgency for careful administrative planning that includes appropriate human resource allocation as well as more efficient procurement systems in the public sector.

3.6 Unilateral Versus Bilateral Fitting

In addressing the specific aim of establishing whether bilateral or unilateral amplification was provided, results indicated that all the children identified with a bilateral hearing loss were bilaterally aided and all those identified with a unilateral hearing loss were unilaterally aided. This is another positive finding from the current sample; in that financial constraints do not seem to be compromising the clinical service for the identified children.

Enough evidence has demonstrated that children with a bilateral hearing loss will benefit more from bilateral amplification than those who are monaurally fitted. Binaural hearing aids provide benefit such as clarity of speech as well as hearing in noisy conditions. Binaural fitting is said to remove the need for strategic positioning; and it is reported to support higher order functionalities through improvement in binaural processing [20]. In light of this, the findings of the current study indicate a better prognosis for the children in terms of acquisition of speech and language skills during the aural habilitation process. These findings would be even more positive had the age of identification and the age at amplification was lower in the current sample.

3.7 Age at Introduction into Aural Rehabilitation

In addressing the specific aim of establishing the age at introduction into aural rehabilitation, the following results were found: the children's ages ranged from 3 months to 5 years 3 months, with an average age of 2 years 5 months.

These findings, although consistent with previous findings by Swanepoel [10], where the average age of initial enrolment into an early intervention programme was 31 months; are disappointing and concerning. These findings indicate a significantly delayed point of entry to aural rehabilitation. The HPCSA position paper states that children must be enrolled in an early intervention programme before the age of 6 months [2].Of course; delayed point of entry to rehabilitation is consistent with delayed identification found in the current study; and this yet again just highlights the importance of UNHS and/or targeted screening at neonatal period to ensure early identification.

3.8 Modes of Communication

In addressing the specific aim of establishing the mode of communication being adopted in therapy with the hearing impaired children in the public hospitals in Gauteng, results are depicted in Table 4.

Table 4. Modes of communication of Children Identified with a Hearing Loss in Gauteng State Hospitals

Mode of Communication	Percentage
Auditory Verbal Therapy (AVT)	48.57%
Sign Language	18.57%
Total Communication	11.43%
No Aural Rehabilitation	14.29%
Referrals to elsewhere as child's residence not in district	1.43%

Results revealed that 48.57% of children who receive aural rehabilitation were utilizing an AVT approach which allowed them to effectively communicate through speech [21]; while 18.57% were using sign language as a mode of communication and this gave them access into the deaf community [12]. A further 11.43% were using the total communication approach; while14.29% of the current sample did not receive aural rehabilitation. Those that did not receive aural rehabilitation were again affected by failure to follow up; which has been reported to limit the effectiveness of early identification efforts. Follow-up aural rehabilitation appointments are also crucial because of the possible progressive nature of paediatric hearing loss [17].

4. CONCLUSIONS AND RECOMMENDATIONS

This study investigated the audiological management of children who were identified with a hearing loss in the Gauteng state hospitals; in South Africa. Although current findings should be interpreted within the identified limitations in the design such as the small sample size; these findings still have relevance and value for EHDI efforts within a developing country context. The results of this study indicated that early identification and intervention as internationally recognized has not yet been achieved. There is a significant delay in the time when children are diagnosed with hearing loss; notable lag in the period between identification and provision of amplification; with a serious delay in enrolment into aural rehabilitation programmes. On average children are identified with a hearing loss at 23.65 months and they receive amplification. This delay is not only against internationally recommended norms; but also when compared to the Health Professions' Council of South Africa's guidelines of children being identified by 3 months and amplification being provided by 6 months of age. These results may be due to lack of parental knowledge regarding hearing loss, poor audiologist to patient ratio in the government sector as well as burden of disease priorities for both patients and healthcare providers. Although identification and intervention is delayed; once identified, the results indicate that appropriate audio logical intervention is provided; and this includes individualized aural rehabilitation programs that include collaboration with caregivers and families, schools and communities; as well as comprehensive medical team management.

Current findings highlight the importance of mandated structured and systematic new born hearing screening programs in Gauteng hospitals which could lead to earlier identification. If the age of identification is reduced; consequent early intervention will be achieved. Success of such programs will be achieved if challenges such as poor follow up; where many children are lost to the system and not benefiting from the services provided, are also addressed at the same time. Current evidence highlights the need to put in place appropriate follow up services to ensure that children, once identified with a hearing loss, are being fitted with amplification timeously and continue to receive appropriate intervention. Audiologist need to advocate for early hearing detection and intervention to mitigate for the well documented effects of unidentified hearing loss.

This research study adds to the body of literature, regarding the audiological management of children identified with a hearing loss, as well as early hearing detection and intervention services available in South Africa. Although appropriate management strategies are in place, timing is of major concern with regards to early identification, hearing aid fittings as well as introduction into aural rehabilitation. It is hoped that this project will be motivation to provide early identification services in Gauteng hospitals; as well as to provide a stepping stone on further research into the long term management and follow up of children identified with a hearing loss in South Africa. Future research could also include longitudinal efficacy studies where cultural and linguistic diversity aspects of the country and their possible influence on EHDI are explored.

CONSENT

Authors declare that 'written informed consent was obtained from the relevant hospital authorities for publication of this research.

ETHICAL APPROVAL

Authors hereby declare that all experiments have been examined and approved by the appropriate ethics committee and have therefore been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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