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Diagnostic hearing testing of infants aged 0–36 months in 3 South African provinces – Comparison of audiology records to HPCSA guidelines

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ABSTRACT

Introduction: Within the Early Hearing Detection and Intervention (EHDI) pathway, which includes the processes of screening, diagnosis and intervention for paediatric hearing loss, paediatric diagnostic audiology involves a battery of specific tests and procedures. International studies have highlighted a golden standard for diagnosis of paediatric hearing loss as based on the Joint Committee of Infant Hearing (2007) diagnostic guidelines, closely resembling the HPCSA diagnostic guidelines. There are limited South African studies on the processes and protocols followed in diagnostic paediatric audiology.
Objectives: This study aims to provide a comparison for how the tests used for diagnosis of paediatric hearing loss in South Africa (within both the public and private healthcare sectors) compare to the HPCSA recommended diagnostic guidelines.
Methods: A retrospective record review of paediatric clients with hearing loss (recruited through non-probability convenience sampling) was conducted. This study is part of a longitudinal study of 711 deaf or hard of hearing children referred to the HI HOPES early intervention programme from September 2006 to December 2011. Diagnostic data from audiology reports of 117 children between 0 and 36 months were coded and analysed.
Results: Large variation was found in the tests included in the diagnostic audiology reports. For 22 children (19%) a comprehensive test battery was used. Health Professions Council of South Africa (HPCSA) recommended guidelines for diagnostic testing were not followed in any of the records analysed. Components of the HPCSA recommended test battery most frequently omitted was bone conduction testing. For both electrophysiology and behavioural testing, there was limited frequency specificity information. This exclusion of information is evidence of deficiencies in data recording and management, as well as having an effect on accuracy of classification of degree and type of hearing loss.
Conclusion: There are gaps in age-appropriate assessment protocols, which will have an effect on accurate differential diagnosis of paediatric hearing loss. Reasons for not including all testing components of the HPCSA recommended guidelines, as well as the possibility of developing guidelines more relevant to a developing world context, should be explored. There might be a need for. The impact of South African specific factors that have an effect on provision of accurate paediatric diagnostic audiology services should be determined.

1. Introduction

Within the field of paediatric audiology, the Early Hearing Detection and Intervention (EHDI) pathway includes a battery of specific tests and procedures used in the process of screening, identification and diagnosis of paediatric hearing loss, followed by the provision of the required early intervention services. Once children are screened (using quick and efficient techniques such as Automated Auditory Brainstem Response (AABR) and/or otoacoustic emission (OAE) screening) and referred for further testing, diagnosis is the next step in the EHDI pathway. The diagnostic process is more technical, requiring specialised equipment and the services of a qualified audiologist to conduct and interpret results

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from diagnostic testing procedures. An accurate and timely diagnosis is necessary for appropriate amplification, planning of early intervention services and future education options [1].

The importance of ensuring accurate diagnosis and subsequent early intervention as a follow on from birth screening, to ensure equal opportunities for development for children with hearing loss, led to the development of the American and British diagnostic guidelines.

The British guidelines for the audiological assessment of babies referred from the newborn screening programme (Guidelines for the Early Audiological Assessment and Management of Babies Referred from the Newborn Hearing Screening Programme Version 3.1) [4] include a comprehensive guide on the order of testing, technical aspects of ABR testing as well as selected case studies of testing situations. The American guidelines (Joint Committee on Infant Hearing Year 2007 Position Statement: Principles and guidelines for early hearing detection and intervention) [5] includes a summary of comprehensive assessments that should be completed on infants birth to 6 months of age, as well as infants and toddlers from 6 to 36 months of age.

In South Africa, the HPCSA (2007) [6] Early Hearing Detection and Intervention Position Statement was closely modelled on the JCIH (2000) [7] position statement and includes a section on recommended tests to be used for diagnosis of paediatric hearing loss in the 0–6 months and 6–36 months age ranges (Table 1).

Different diagnostic tests in the recommended test battery assess different components of the auditory system. Each test contributes a component to understanding the process of hearing for each individual, and where there is a breakdown in the auditory system (outer/middle/inner ear and cochlear/retrocochlear). The results of each test complement each other, provide a means of cross-check of results and a means of differential diagnosis of type and degree of hearing loss.

Development of and adherence to recommended practice guidelines (including the NHSP (2013), JCIH (2007) and HPCSA (2007) diagnostic guidelines) is aimed, among other things, at improving quality of care, and enhancing service provider accountability [8], as well as ensuring diagnostic accuracy. While clinical guidelines for diagnosis are in place internationally, the reality in terms of actual practice and procedures for diagnosis of paediatric hearing loss is that the guidelines are not always adhered to [9].

A recent review of EHDI services in South Africa [15] highlighted the limited studies related to diagnostic practice and data management in South Africa. The procedures and tests used in paediatric diagnostic audiology practice in South Africa have not been determined, as to date there have been isolated small-scale region specific studies [10–14]. A study on audiological practice post HPCSA position statement [16], based on diagnostic data of a small sample (four children), found that there were gaps in age appropriate assessment protocols.

2. Objective

Due to the limited research on paediatric audiology diagnostic testing in South Africa, this study was conducted to determine firstly the current practice for the diagnosis of paediatric hearing loss, and secondly to determine how the practice of diagnostic audiology across the public and private healthcare sectors in three provinces compares to HPCSA recommended guidelines.

The objectives of the study were to:

1) Outline the comprehensiveness of paediatric diagnostic audiology testing across the public and private healthcare sectors and determine any differences.
2) Document the age of and frequency specificity of electrophysiology testing across the public and private healthcare sectors
3) Document the age and frequency specificity of behavioural testing across the public and private healthcare sectors

3. Methods

3.1. Research design

A retrospective record review of 711 deaf and hard of hearing infants was conducted. The sample (recruited through non-probability convenience sampling) was from the longitudinal

Table 1
Recommended tests for diagnosis of paediatric hearing loss [Based on HPCSA (2007) [6] EHDI Position Statement].

0–6months		6–36 months	
Evaluation	Tests	Evaluation	Tests
Child and family history Electrophysiology testing- (used for obtaining thresholds in this age group)	Case history information - ABR/ASSR using frequency specific stimuli - Diagnostic OAEs	Child and family history Physiologic measures at initial evaluation and subsequent evaluations as necessary (for conformation of thresholds from behavioural testing)	Case history information - OAE - ABR - ASSR
Middle ear functioning	- Tympanometry with high frequency probe tones of 660 or 1000 Hz (preferably 1000 Hz, - Bone conduction ABR/ASSR, and/or pneumatic otoscopy - Acoustic Reflex Thresholds		
Behavioural (for confirmation of thresholds obtained from electrophysiology)	Observation of the infants behavioural response to sound Parental report of emerging communication and auditory behaviours	Behavioural evaluation (used for obtaining thresholds in this age group).	Behavioural response audiometry according to child's developmental age: visual reinforcement or conditioned play audiometry - Speech detection and recognition measures
		Screening of communication and language milestones	- Parental report of auditory and visual behaviours. Appropriate communication and language screening tools

Abbreviations - ABR- Auditory Brainstem Response, ASSR – Auditory Steady State Response, OAE- Otoacoustic Emissions.

dataset of children referred to the HI HOPES early intervention programme from September 2006 to December 2011.

3.2. Sample characteristics

Diagnostic audiology information was available for 32% (n = 230) of the 711 children ranging in age from 1 to 142 months. This study focused only on diagnosis of hearing loss for children between 0 and 36 months of age, yielding a sample size of 117 of the 230 children. Of the 117 children, 5% (n = 6) were in the 0–6 month age range and 95% (n = 111) were between 7 and 36 months.

The geographic spread of the research sample includes three of the nine provinces, namely Gauteng, Kwazulu Natal (KZN) and the Western Cape (WC), where HI HOPES services were available during the period of the study. These three provinces make up more than 50% of the South African population and are representative of the population demographics in terms of public and private healthcare sectors [17]. Provincial breakdown of the sample showed that 63% (n = 74) were from Gauteng, 19% (n = 22) from KZN and 18% (n = 21) from WC. The ethnicity breakdown includes 68% Black (n = 80), 12% Coloured (n = 14), 8% Indian (n = 9) and 12% White (n = 14) children. The gender breakdown of the sample is 48% female (n = 56) and 52% male (n = 61).

17% (n = 20) had audiology testing conducted in the private healthcare sector, whereas 74% (n = 87) were from the public healthcare sector, and 9% (n = 10) were tested at University Audiology departments.

3.3. Procedures

Each child's file was examined to obtain audiology reports that included diagnostic testing information which was then logged onto an excel sheet. Variables logged included all diagnostic audiology tests completed for each child, age of testing, as well as province and healthcare sector.

Based on the tests completed for each individual child, the data were categorised into one of four groups. The groups were based on four categories (partial, incomplete, comprehensive and JCIH recommended) used in a USA study on diagnostic testing [9]. However, this grouping as used by Munoz, Nelson, Goldgewicht & Odell [9] was amended to account for the possibility that frequency specificity of electrophysiology testing might not be included in reports and rather looked at whether components of testing were included. The South African HPCSA guidelines as opposed to the JCIH guidelines were used. The grouping for this study is shown in Table 2, together with the implications of inclusion and exclusion of specific components of the test battery.

3.4. Data analysis

Initial data analysis involved an overview of diagnostic audiology tests completed. Data were initially analysed according to whether electrophysiology testing was completed, to determine the regularity of use of electrophysiology testing methods. Data were then further analysed to indicate frequency specificity of the electrophysiology testing and behavioural testing.

Data analysis included basic descriptive statistics indicating frequencies and percentages. Data were grouped and analysed according to the variables of private vs. public practice and the province in which the practice is located to determine the variation in diagnostic practice with respect to these variables.

3.5. Ethical considerations

This study is part of a larger, longitudinal study on audiology as well as demographic information on a dataset of children with hearing loss enrolled in an early intervention programme in South Africa. Parents have signed consent forms providing permission to access all data, including paediatric audiology records, to be used for research purposes. To ensure privacy and confidentiality of data, all identifying information from the audiology records were replaced with a coding system for tracking and storage of information.

Table 2
Categories of testing (adapted from Munoz, Nelson, Goldgewicht & Odell, 2011).

Category	Tests included	Tests omitted	Implications
Partial testing	Air conduction -behavioural OR Air conduction -electrophysiology	• Bone conduction • 2 or more of ○ Tympanometry ○ Reflexes ○ Speech testing	Omitting bone conduction as well as tympanometry or reflexes means there is no indication of middle ear status. The possible impact of a conductive component on thresholds is not determined
Incomplete testing	• Air conduction -behavioural • Tympanometry	• Bone conduction • No more than 2 of ○ Reflexes ○ Electrophysiology ○ Speech testing	Behavioural air conduction and tympanometry will indicate the level of loss as well as middle ear status. Omission of bone conduction means there is no verification of type of hearing loss. Omission of electrophysiology and speech testing means there is no cross check of behavioural results
Comprehensive testing	Tests recommended in HPCSA position statement (with exception of tests omitted)	• Bone conduction OR electrophysiology • Reflexes OR speech testing	Omission of bone conduction but inclusion of electrophysiology provides a means of classification of type of hearing loss as does omission of electrophysiology but inclusion of bone conduction. Omission of electrophysiology as well as acoustic reflexes takes away the means for differential diagnosis of auditory neuropathy. Omission of electrophysiology and speech testing means there is no verification of behavioural testing results
Testing recommended by HPCSA	• Air and bone conduction -behavioural • Air and bone conduction -electrophysiology • Tympanometry • Reflexes • Speech testing		Accurate differential diagnosis of degree and type of hearing loss, with cross-check and verification of results

The University of the Witwatersrand Ethical Clearance Board provided permission for the study of all data and records relating to the early intervention programme.

4. Results

Results from this study will highlight the key issues of diagnosis based on inclusion of tests for accurate classification of the degree and type of hearing loss, as per HPCSA recommended diagnostic guidelines. In addition, the results will focus on the frequency specificity for electrophysiology and behavioural testing, as well as the ages at which electrophysiology and behavioural testing were conducted.

4.1. Comprehensiveness of testing

The audiology testing information provided for the 117 children included in this study were assessed for comprehensiveness of the test battery used for diagnosis. The completeness of testing based on the four categories, as indicated in the section on procedures, is outlined in Table 3. This initial analysis does not include the criteria of frequency specific information, but only assesses the inclusion of tests in the battery for diagnosis of hearing loss.

While 19% (n = 22) of diagnostic audiology testing in this sample included a comprehensive test battery, HPCSA recommended guidelines were not followed in any of the 117 infants' diagnostic testing. Components of the HPCSA recommended test battery most frequently omitted was bone conduction testing (n = 114). Within the three provinces and two healthcare sectors "partial testing" was the most frequent category.

4.2. a) Age of electrophysiology testing

Ninety four of the 117 children (80%) had air conduction electrophysiology testing included as part of the diagnostic battery. The age of air conduction electrophysiology testing is included in Table 4.

The KZN public and WC public sectors start conducting electrophysiology testing at a younger age than the private healthcare sectors in their respective provinces. The Gauteng public and private sectors conducts the majority of testing in the 25–36 month age range.

Three children (two with atresia) had bone conduction electrophysiology testing. All three children were from Gauteng, two from the public healthcare sector and one from the private healthcare sector. Average age of BC testing was 18 months (±8.9).

4.3. b) Frequency specificity of electrophysiology testing

The frequency specificity of electrophysiology testing is outlined in Table 5.

Only 3 (3%) children had all frequencies from 250 Hz to 8000 Hz completed. Nine children had only 1 frequency completed (10%) with the large majority being 39 (41%) where two and three frequencies were used. 26 children (28%) had electrophysiology testing based on tone burst information. There were no details of frequency specificity for 13 children (14%) who had electrophysiology testing.

Bone conduction frequency specificity included a click ABR for two children and frequencies of 500 Hz and 8000 Hz tone burst information included for one child.

4.4. a) Age of behavioural testing

Air conduction behavioural testing was included in the diagnostic test battery of 60 children (51%) in this sample. The age and provincial breakdown of behavioural testing is outlined in Table 6.

For twelve children (20%) the age of behavioural testing was not provided. The statistics on behavioural testing are thus limited to the 48 children where this information is available.

Behavioural testing was used for one child in the birth to 4 month age range, indicating very limited use of behavioural observation audiometry in this sample.

The Gauteng private sector has the lowest average age of behavioural testing, with the KZN public sector conducting behavioural testing in the 5–24 month age range. However, KZN public sector also has the largest percentage (73%; n = 8) of children where the age of behavioural testing was not provided. Behavioural testing was included in the test battery of only one child each in the KZN private sector and KZN university sector. The WC public sector conducts behavioural testing most frequently in the 25–36 month age range.

Table 3
Comprehensiveness of testing.

Diagnostic testing categories	Public (n = 87)			Private (n = 20)			University (n = 10)			Total (n = 117)
	Gauteng (n = 48)	KZN (n = 18)	WC (n = 21)	Gauteng (n = 17)	KZN (n = 3)	WC (n = 0)	Gauteng (n = 9)	KZN (n = 1)	WC (n = 0)	
Partial	31 (64.5%)	12 (67%)	14 (67%)	11 (64.5%)	3 (100%)	–	6 (67%)	1 (100%)	–	78 (66.5%)
Incomplete	9 (19%)	2 (11%)	3 (14%)	2 (12%)	0 (0%)	–	1 (11%)	0 (0%)	–	17 (14.5%)
Comprehensive	8 (16.5%)	4 (22%)	4 (19%)	4 (23.5%)	0 (0%)	–	2 (22%)	0 (0%)	–	22 (19%)
HPCSA recommended	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	–	–	0 (0%)	–	0 (0%)

Table 4
Age of AC electrophysiology testing.

Age of AC electrophysiology	Public			Private			University			Total
	Gauteng (n = 35)	KZN (n- = 15)	WC (n = 16)	Gauteng (n = ?)	KZN (n = 3)	WC	Gauteng (n = 8)	KZN (n = 1)	WC	N=(94)
Birth to 4 months	0 (0%)	2 (13.5%)	1 (6%)	1 (6%)	0 (0%)	–	0 (0%)	0 (0%)	–	4 (4%)
5–24 months	15 (43%)	5 (33%)	9 (56%)	8 (50%)	2 (67%)	–	5 (62.5%)	–0 (0%)	–	44 (47%)
25–36 months	19 (54%)	8 (53.5%)	6 (38%)	7 (44%)	1 (33%)	–	3 (37.5%)	1 (100%)	–	45 (48%)
Unknown	1 (3%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	–	0 (0%)	0 (0%)	–	1 (1%)
Average Age	24.2	22.6	22.5	18.6	22.3	–	20.4	–	–	22.4
Std Dev	8.3	11.1	9.7	9.4	6.7	–	9	–	–	9.3
Range	7–36	1–35	4–36	2–34	18–30	–	5.-31	–	–	1–36

Table 5
Frequency specificity of air conduction electrophysiology testing.

Missing frequency components electrophysiology (Hz)	Public (n = 66)			Private (n = 19)			University (n = 9)			Total (n = 94)
	Gauteng (n = 35)	KZN (n = 15)	WC (n = 16)	Gauteng (n = 16)	KZN (n-3)	WC	Gauteng (n-8)	KZN (n = 1)	WC	
All completed	0 (0%)	3 (20%)	0 (0%)	0 (0%)	0 (0%)	–	0 (0%)	0 (0%)	–	3 (3%)
8000	3 (9%)	3 (20%)	0 (0%)	3 (19%)	0 (0%)	–	–0 (0%)	0 (0%)	–	9 (10%)
250, 8000	2 (5.5%)	5 (33%)	10 (63%)	10 (63%)	3 (100%)	–	0 (0%)	0 (0%)	–	30 (32%)
500, 8000	1 (3%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	–	0 (0%)	0 (0%)	–	1 (1%)
250, 4000	0 (0%)	0 (0%)	0 (0%)	1 (6%)	0 (0%)	–	0 (0%)	0 (0%)	–	1 (1%)
250, 2000, 4000	0 (0%)	0 (0%)	0 (0%)	1 (6%)	0 (0%)	–	1 (12.5%)	0 (0%)	–	2 (2%)
250, 4000, 8000	0 (0%)	1 (7%)	1 (6%)	0 (0%)	0 (0%)	–	1 (12.5%)	0 (0%)	–	3 (3%)
2000, 4000, 8000	2 (5.5%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	–	0 (0%)	0 (0%)	–	2 (2%)
250, 1000, 2000, 4000	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	–	4 (50%)	0 (0%)	–	4 (4%)
No frequency specificity (clicks)	21 (60%)	3 (20%)	1 (6%)	0 (0%)	0 (0%)	–	1 (12.5%)	0 (0%)	–	26 (28%)
No details	6 (17%)	0 (0%)	4 (25%)	1 (6%)	0 (0%)	–	1 (12.5%)	1 (100%)	–	13 (14%)

Table 6
Age of air conduction behavioural testing.

Age of AC behavioural testing	Public (n = 48)			Private (n = 7)			University (n = 5)			Total (n = 60)
	Gauteng (n = 29)	KZN (n = 11)	WC (n = 8)	Gauteng (n = 6)	KZN (n-1)	WC (n = 0	Gauteng (n-4)	KZN (n = 1)	WC (n = 0)	
Birth to 4 months	1 (3.5%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	–	0 (0%)	0 (0%)	–	1 (2%)
5–24 months	9 (31%)	3 (27%)	2 (25%)	4 (67%)	0 (0%)	–	1 (25%)	0 (0%)	–	19 (31.5%)
25–36 months	16 (55%)	–	5 (62.5%)	2 (33%)	1 (100%)	–	3 (75%)	1 (100%)	–	28 (46.5%)
Unknown	3 (10%)	8 (73%)	1 (12.5%)	]0 (0%)	0 (0%)	–	0 (0%)	0 (0%)	–	12 (20%)
Average age	26.2	16.7	27.9	22.5	–	–	27.3	–	–	25.4
Std dev	7.6	5.9	9.3	8.8	–	–	4.5	–	–	7.7
Range	4–35	10.-21	9–36	13–34	–	–	22–33	–	–	4–36

Bone conduction behavioural testing was completed for 3 children, all from the public healthcare sector (with two in the Western Cape and one in Kwazulu Natal). The average age of bone conduction behavioural testing was 22.3 months (±13.1).

4.5. *b) Frequency specificity of behavioural testing*

The frequency specificity of behavioural testing was not included in reports for 48% (n = 29) of this sample (Table 7). As with electrophysiology testing this lack of information is evidence of poor data recording and management as well as having an effect on accuracy of classification of degree and type of hearing loss. All frequencies from 250 Hz to 8000 Hz is completed for only 17% (n = 10) of this sample.

5. Discussion

Diagnostic audiology is the component of the EHDI pathway that provides the link between screening and further management and intervention for the child with a hearing loss. Accurate diagnostic evaluation is necessary for amplification options, programming of hearing aids, and communication methodology options. The test battery for paediatric diagnostic audiology thus has to provide information for accurate differential diagnosis. The challenge is in obtaining accurate diagnostic information for the paediatric population where there is a need for both objective testing (electrophysiology) and subjective confirmation of the child's actual physical response to sound. This has shown to be a challenge internationally, with South African paediatric audiology having its own unique challenges including difficulty conditioning children due to linguistic and cultural differences, data management difficulties, staff and equipment challenges as well as limited comprehensive studies in this specific area.

Diagnostic audiology is composed of a comprehensive system for assessment of each component of the auditory pathway. Each test provides an important part of a cross-check for assessing and evaluating results from each diagnostic procedure employed, as well as providing a means for accurate classification of the degree and type of hearing loss. Standardisation of procedures and tests and inclusion of information in records is important so that other

Table 7
Frequency components not included- Air Conduction- Behavioural testing.

Missing frequency components (Hz) behavioural air conduction	Public (n = 48)			Private (n = 7)			University (n = 5)			Total (n = 60)
	Gauteng (n = 29)	KZN (n = 11)	WC (n-8)	Gauteng (n = 6)	KZN (n = 1)	WC (n = 0)	Gauteng (n = 4)	KZN (n = 1)	WC (n = 0)	
250	1 (3.5%)	-	-	-	-	-	-	-	-	1(2%)
8000	2 (7%)	2 (18%)	1 (12.5%)	–	–	–	–	–	–	2 (8%)
250, 2000.	–	–	–	1 (17%)	–	–	–	–	–	1 (2%)
250, 8000	2 (7%)	–	2 (25%)	1 (17%)	–	–	1 (25%)	–	–	6 (10%)
4000,8000	1 (3.5%)	1 (9%)	1 (12.5%)	–	1 (100%)	–	–	–	–	4 (7%)
500,8000	–	–	–	–	–	–	–	1 (100%)	–	1 (2%)
All completed	7 (24%)	1 (9%)	–	2 (33%)	–	–	–	–	–	10 (17%)
Could not condition	2 (7%)	–	–	–	–	–	1 (25%)	–	–	3 (5%)
No details	14 (48%)	7 (64%)	4 (50%)	2 (33%)	–	–	2 (50%)	–	–	29 (48%)

service providers are able to accurately interpret information and provide comprehensive services [20] (Campbell & Hyde, 2010). The inclusion of behavioural and electrophysiology testing procedures is thus important to provide an objective means of assessment as well as an indication of the actual behavioural response to sound.

The HPCSA guidelines recommend physiologic assessment of younger children. Physiologic assessment requires that a child be very still (asleep or sedated) to reduce movement artefact, access to specific electrophysiology equipment, and setting up and appropriate adjusting of recording parameters. The increased age of electrophysiology testing for this sample indicates the number of children who would require sedation and the medical personnel and medical equipment (such as specialised paediatric resuscitation equipment) necessary to ensure safety during sedation.

With electrophysiology testing, 72% of this sample had missing threshold information for 250 Hz and 4000 Hz. Click stimuli (that applies to 28% of this sample) is based on information that activates a greater portion of the cochlear partition and a larger number of neural components (with larger amplitude for wave detection), but has limited frequency specificity [19]. This poses difficulties with overestimating thresholds with a sloping hearing loss. These children have a classification of degree and type of hearing loss based on incomplete information which might lead to inaccuracies. This could have an effect on aural rehabilitation options as well as communication and language development of the child.

Behavioural testing is dependent on appropriate equipment e.g. visual reinforcement materials for VRA, as well as audiologists skilled in conditioning a child to respond to tones and in accurately detecting response to sound. The age of behavioural testing as well as the cultural diversity of the sample shows the need for audiologists able to condition children who might speak a different language, an audiologist to condition the child and an audiologist to conduct the test, in addition to appropriate visual reinforcement equipment. Adherence to clinical guidelines is thus dependent on resources, equipment and personnel available. Behavioural testing frequencies not included as part of the diagnostic battery for this sample are 250 Hz, 4000 Hz and 8000 Hz. This will have an effect on programming of hearing aids for the low and high frequencies, and thus have an effect on the child's access to the complete speech spectrum.

The programing of aids with partial or incomplete testing (behavioural or electrophysiology) means that amplification programming will be affected and benefit from amplification might not be optimal. In this sample, 81% fell into the category of partial and incomplete testing.

6. Conclusion

Diagnostic audiology is the link between identification of hearing loss and provision of amplification and intervention services, so as to ensure appropriate choices in terms of communication methodology, education options and future development of the child. As found in Kanji and Opperman [16], there are gaps in age-appropriate assessment protocols, which will have an effect on accurate diagnosis of paediatric hearing loss. This will have an effect on amplification options, programming of hearing aids, aural rehabilitation, communication modality options and early intervention. The inclusion of all aspects of the recommended guidelines for diagnosis is thus an important aspect for the accurate differential diagnosis of the degree and type of hearing loss.

Reasons for not including all testing components of the HPCSA recommended guidelines should be explored in order to determine if this is due to lack of resources and equipment, or due to audiologists feeling that the tests excluded are not relevant for accurate diagnosis. This will inform the needs for allocation of additional resources and equipment, additional audiology training or a reworking of the HPCSA recommended guidelines.

The HPCSA recommended guidelines are currently based on the JCIH (2000) guidelines for diagnostic testing in a developed world context. There might be a need for development of guidelines in a developed world context, where children are being tested at older ages, and there is less availability of medical personnel and equipment. Guidelines for a South African specific, developing world context might include a decreased need for electrophysiology testing as older children, who are able to be conditioned for behavioural testing, may not require electrophysiology. If analysed from this ‘ developmental’ perspective, the large number of children that had comprehensive testing completed would then be included in the category of recommended diagnostic testing. However, a focus on behavioural testing for older children would present challenges related to staff resources and conditioning of second language English speakers, as well as further training of audiologists to conduct accurate behavioural testing for the paediatric population. A focus on behavioural testing could be a solution to the challenge of sedating older children (together with the extra resources required for this) for electrophysiology testing.

This study has looked at diagnostic audiology data over a period of five years (2006–2011), in three provinces. Studies on the current status of paediatric diagnostic audiology in a national context will provide an indication of the national status quo of paediatric diagnostic audiology, what progress has been made (in the three provinces studied) and factors that are aiding or hindering progress. Development of task teams related specifically to how challenges related to the field of paediatric diagnostic audiology can be addressed will be an initial step towards making improvements in the field of paediatric diagnostic audiology.

Author contributions

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Competing interests

The authors declare that they have no financial or personal relationships which may have inappropriately influenced them in writing this article.

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