



Screening a newborn baby for hearing loss using ABR technology.
SOUTH AFRICA
TERISA DE KOCK

Early detection of hearing loss in newborn and preschool children



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Undiagnosed or late-diagnosed hearing loss in young children can have substantial negative consequences: not only in terms of its impact on a child's language and communication development, but also on social and emotional development and mental health, family relationships, educational opportunity and achievement and later economic contribution to society.

Many high-income countries have implemented early hearing detection and intervention.¹ There is now compelling evidence from established

programmes that when hearing screening in early life is followed up by appropriate assessment, management and support for both child and family, the developmental outcomes for a child with hearing impairment can be radically improved.

Around 90% of the world's hearing-impaired children live in countries where limited resources are likely to present a significant challenge to the implementation of newborn hearing screening. However, novel pilot or emerging programmes in some low- and middle-income countries have already demonstrated that it is feasible to implement hearing screening whilst taking into account not only the societal, cultural and economic conditions but also existing health structures and

patterns of care. One of the lessons from such programmes is that even where follow-up services are under-developed, parents benefit from knowing early the status of their child's hearing and can modify their communication style to facilitate essential effective parent-child interactions. The opportunity to develop language through a positive approach rather than focusing on a deficit not only enhances the child's social development, but enables proper access to education and increases life chances.

The development of competent and fluent language and communication is central to children achieving their full potential. Considerations of the cost-effectiveness of newborn hearing screening have tended to focus on numbers of cases detected rather than on the long-term impact of hearing screening on the health, quality of life and productivity of children

“Early intervention can radically improve outcomes for children with hearing impairment”

identified as having a hearing impairment. However, the cost of lifelong disability to society is substantial, and failure to identify hearing loss early when there is a possibility to do so may be deemed not only a failure to address the economic issue but also a denial of the rights of the child. It is in this context that any reservations about the ethics, appropriateness or cost-effectiveness of implementing early hearing screening should be challenged.

¹The US Joint Committee on Infant Hearing (JCIH) 2007 Position Statement and its 2013 supplement are widely recognised as authoritative guidance in respect of the principles and practice of early hearing detection and intervention.

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Early detection of hearing loss: overcoming challenges in resource-poor settings



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Approximately 32 million children in the world have a disabling hearing loss (40dB or greater) and approximately 1 out of every 1,000 babies are born with congenital hearing loss.

Most deaf children develop language at a slower rate than their

hearing peers and are at higher risk of mental health problems. However, if hearing loss is detected early and these children are then given appropriate support, this need not necessarily be the case. Deafness is not a learning disability and there is no reason why they should achieve any less than their hearing peers.

Detecting hearing loss early and supporting identified newborn and preschool children has been shown to be extremely beneficial. Many high-income countries have implemented universal newborn hearing screening together with services for intervention. However, in low- and middle-income countries (where the prevalence of preventable hearing loss is substantially higher than in high-income countries), most children who have a hearing loss are not identified until they enter primary school or at a later stage. For example, a study looking into the histories of children who were born profoundly deaf in Trinidad-Beni, Bolivia, showed that just under 8% were diagnosed before two years of age and that the average age of diagnosis was eight years for girls and ten years for boys.¹

Obstacles to early detection in developing countries

Why is hearing loss not identified and managed as early as it could be? The reasons differ from country to country, but common obstacles can be identified:

1 Hearing loss is a low priority

The World Health Organization considers disabling hearing loss to be a 'public health emergency' because its global prevalence (5.3%) is higher than 4%. However, decision-makers mostly consider hearing loss a low priority because it is not a cause of mortality and they are unaware of its huge impact on peoples' lives and its massive economic impact on society.

2 Lack of resources

- Limited financial resources to equip neonatal and paediatric services for hearing testing.
- Lack of ear and hearing care personnel and lack of professional training amongst health workers already involved in screening newborn babies and preschool children for other conditions.

3 Lack of awareness

- Health workers caring for newborn and preschool children are not aware of the benefits of ear and hearing screening and of early intervention.
- Parents and the community are not aware that early detection and early intervention can make a difference to the whole of a child's life.
- Parents are not aware of the rights of children with hearing loss, and they are generally not empowered to advocate for them. Civil society tends to wait for health services to take action, when it could be a powerful force for societal change.

4 Lack of supporting services

- Lack of ear and hearing care personnel to support identified children: an audiology team needs to confirm and assess the hearing loss, and the child's development needs to be supported by specialist medical and education services.
- Lack of preschool education services for children who have a hearing impairment: most developing countries do not offer special education until primary school.
- Lack of efficient referral and counter-referral network systems: a functional health network is as important as the service provision itself.



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- Lack of supporting services to facilitate universal access and reach all the population, not just high-risk groups.

What are the solutions?

We – those working in low- and middle-income countries – have been focusing on replicating the public health examples implemented in high-income countries for early identification and intervention in ear and hearing care. This, unfortunately, will only be possible when each country has a national strategy and an approved annual plan budget, which considers the practical implications derived from the implementation of the plan itself, and is designed to cover and fund them all.

In the meantime, it is important to look for solutions to implement programmes for early detection and management of hearing loss, even if these efforts are on a smaller scale. Existing personnel, regardless of their number, can take the lead to make this a reality. Here are a few actions worth considering:

Training primary ear and hearing care personnel to go into the community to raise awareness and detect possible hearing loss: this is generally perceived as the best solution, but on its own it is not sufficient to address the lack of early detection.

Training those who are already in the community. It would be a productive exercise to widen our thinking and consider which people are available for training. Because health services do not go into the community frequently enough, it seems necessary to train and equip those persons who are already in the community, such as maternal and infant care workers and other professionals (see Table 1 for suggestions).

Increasing awareness amongst parents and community members. Parents and relatives should play a crucial role in observing the child and how his/her language is evolving. They, and members

of the community, also need to be made aware of the importance of early detection and intervention (see Table 1). They can also advocate for services.

Advocating for alternative strategies when universal screening is not possible.

It is important to advocate that it is always possible to do something, rather than wait for a large-scale government-led programme to be implemented, even though this approach remains the ideal strategy for long-term sustainability.

Examples of alternative strategies, include: screening at local level (choosing specific maternity hospitals), screening babies in the high-risk group for congenital hearing loss, screening all babies and children who attend immunisation clinics during their first year of life, etc. (see also articles on pages 8 and 10 of this issue).

These small-scale activities will not only serve as a pilot screening programme and demonstrate existing need, but will also raise awareness for early detection. They may also help to advocate for policy change at national level and be the first step towards universal screening.



ANDREW SMITH

Young child undergoing a hearing test during a hearing survey.

MADAGASCAR

¹ Diego J Santana-Hernández. 'Hear Bolivia' Programme for Ear Care and Prevention of Hearing Impairment. ENT News vol. 17 (2008) n°4: 52-54.

TABLE 1 TRAINING FOR EARLY DETECTION OF HEARING LOSS AND INCREASING AWARENESS: WHO CAN BE TARGETED?

Who can be targeted?	What can they be taught?
Parents	<ul style="list-style-type: none"> • Importance of early detection and referral • Effectiveness of early intervention and consequences of not doing it
Community members who are in contact with mothers and infants	<ul style="list-style-type: none"> • How to observe a child for signs of hearing loss • Rights of persons with disabilities and how to advocate for them
Maternal and infant care (MIC) workers (e.g. midwives)	<ul style="list-style-type: none"> • Importance of early detection and referral • Effectiveness of early intervention and consequences of not doing it
Community health workers, community-based rehabilitation (CBR) workers and other community helpers	<ul style="list-style-type: none"> • How mother and child health influences hearing • How to screen for ear problems and hearing loss • How to raise awareness among parents and the community
Primary health care workers	<ul style="list-style-type: none"> • Importance of early detection and referral • Effectiveness of early intervention and consequences of not doing it • How mother and child health influences hearing • How to screen for ear problems and hearing loss • How to raise awareness among parents and the community • Selected personnel can be trained in primary ear and hearing care
Educators (formal and informal)	<ul style="list-style-type: none"> • Importance of early detection and referral • Effectiveness of early intervention and consequences of not doing it • How to screen for ear problems and hearing loss • How to raise awareness among parents and the community • Methods for early intervention in education

Early detection of hearing loss: an overview of methods and resources



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Benefits of early detection and intervention

Hearing, particularly in the first four to five years of life, is extremely important for the development of speech and oral language in children. Significant hearing loss, if undetected early, can lead to speech and language delay. Early detection of hearing loss and appropriate management leads to better speech and language and educational outcomes for the child, allowing the child to achieve his or her best. The main benefits of early detection and intervention are listed in the Box on page 5.

Identification of hearing loss in a newborn baby relies heavily on technology as the tests are objective rather than behavioural. Such technology is expensive and may not be readily available in a developing country. It may not be realistic to expect every country to be able to screen all newborn babies for hearing loss at birth or soon after. However, the aim should be to detect hearing loss very early, preferably in the first year of life, with identification at birth as the eventual aim. Habilitation can begin in the first six months of life and should be implemented as soon as possible after the hearing loss is confirmed.

If the above cannot be established because of financial limitations or other reasons, a simple questionnaire might lead to identifying those children with at least severe to profound hearing loss.

This article lists the methods for detecting hearing loss in newborn and preschool children, and the personnel, training and equipment required to perform those. Some of these methods may be more suitable than others in your current set-up, depending on the levels of resources and training they require.¹ You can also refer to the article on pages 8–9 for what to consider when planning a systematic hearing screening programme.

Screening an infant for hearing loss using OAE technology. INDIA



SHELLY CHADHA

Before you start: essential points

1 Make sure support is available for children who fail the test

You should only screen for hearing loss when there are personnel in the country to confirm hearing loss and manage babies or children who have a hearing loss. The essential components of early intervention are:

- **An audiologist or audiology team** who can test babies referred from the hearing screen: this includes confirming the hearing loss, assessing the middle ear status using tympanometry and establishing ear-specific hearing thresholds.
- **Hearing aid fitting and earmould facilities:** these should be available for children who may benefit from them.
- **A medical support team** to check whether anything else is associated with the hearing loss (as it can be part of a syndrome) and to manage those other problems.

The following are also important, but may not exist in some low- and middle-income countries:

- Speech and language therapy (when the child starts speaking).
- Early intervention education services (preschool): to show parents how to use hearing aids, stimulate their child, etc.
- Specialised schools or provisions for inclusive education.
- Social welfare system to support the family.
- A consumer organisation to support parents.

You should identify the components of early intervention in your region and contact relevant services, so that screeners know exactly where to send those babies and children who fail the screen.

2 Set up a protocol

It is very important to establish protocols for performing the screen (even if it is a simple questionnaire) and further diagnostic tests, so that there is uniformity across the your health centre, district, region or country.

All screeners should receive initial training and periodic re-training to maintain their skills.

There should be regular checks in place to determine that the screen and tests are being performed correctly.

3 Always assess hearing when a problem is suspected

Bear in mind that some children suffer from a progressive hearing loss, so it is important to carry out hearing assessments whenever a problem is suspected, irrespective of the child's age.

4 Remember: a screening test is a pass/refer procedure only

Only subsequent assessment will confirm and determine the degree and nature of hearing loss.



OAE screening at a community centre. NIGERIA

Screening for hearing loss at birth or soon after

Automated otoacoustic emissions (AOAE) and automated auditory brain-stem response (AABR) are used to screen for hearing loss in newborn babies and infants.

1 AOAE screen

Two types of otoacoustic emissions can be used to screen for hearing loss: transient evoked otoacoustic emissions (TEOAE) and distortion product otoacoustic emissions (DPOAE). Both are equally suitable for screening newborns to preschool children.

An AOAE screen measures the integrity of the outer hair cells within the cochlea, which generate low intensity sounds in response to clicks or tone bursts presented to the ear.

This screen is carried out by recording the outer hair cell response to a sound presented at the ear canal via an earphone. The equipment gives a 'pass' or 'refer' result using a pre-programmed algorithm. Those who are referred are given an audiological assessment, which leads to confirmation of hearing level.

The result of the screen is kept in the machine's memory for periodic uploading to a computer.

Material needed by the screener: a portable, hand-held automated OAE screening machine.

2 AABR screen

This is an electro-physiological screen of the function of the auditory pathway from the auditory nerve through to the brainstem.

A sound (usually a click sound) is presented into the child's ear canal and the resulting response is recorded by electrodes placed on the child's head. The child should be quiet, preferably sleeping. This test takes longer than the AOAE screen. The equipment will provide a pass/fail result.

Material needed by the tester: a portable, hand-held automated ABR machine. This instrument may cost twice as much as an OAE machine.

3 AOAE or AABR screen?

Both can be used for screening, but the AOAE cannot detect auditory neuropathy spectrum disorder (ANS), a neural hearing loss, contrary to the AABR method.

However, an AOAE screen has the advantage of being much cheaper and quicker than an AABR screen. For this reason, in some countries, automated

OAE is used to screen all well babies whereas babies needing intensive neonatal care are screened with both AOAE and AABR.

Some AOAE devices incorporate both OAE and ABR screens (but they are expensive).

4 At what age should babies be screened?

In the first day of life, the presence of vernix and amniotic fluid in the ear canal can lead to too many children not passing the screen. The ideal time to screen using AOAE and AABR screens is 48 to 72 hours after birth.

5 Where can children be screened?

This depends on how postnatal care is delivered in your area. When births tend to take place at home, newborn babies can be screened in the community. In low- and middle-income countries, mothers tend to stay longer in the hospital for a screen to be performed before they return home.

If screening is done in the community, e.g. in remote villages, the screener would either need a laptop to empty the machine's memory, or they could go back to a base for this. Someone could also go around communities to collect the results from screeners by uploading them on to a laptop.

6 Who can administer these screens?

A number of staff can fulfil this role, as the level of education needed to perform the AOAE or AABR screen is very basic.

Training people to perform these screens takes about two days, but refresher courses every year are important. The training needs to include what you tell parents, how to deal with their anxieties, and where to refer babies if they do not pass the screen.

It is a good idea to have a coordinator who is a more trained person, whom screeners can contact if they have issues with the equipment or need more information.

7 Communicating with parents

If the AOAE or AABR equipment detects a baby with a potential hearing loss, the parents need to be told the importance of following up. Importantly, they should be also told that a great number of children who fail the test do not have a hearing loss.

8 When physiological screening is not possible: questionnaires

Screening questionnaires can be used if physiological

Continues overleaf ➤

“Early detection of hearing loss and appropriate management allows children to achieve their best”

BENEFITS OF EARLY DETECTION OF HEARING LOSS AND APPROPRIATE HABILITATION

- The child can undergo habilitation before the age of six months.
- The child will achieve better speech and language and educational success.
- The cause of hearing loss can be identified early and managed appropriately.
- Associated medical conditions can be identified and managed early.
- The child's auditory system will develop better.
- The burden of stress within the family will be reduced.
- Parents can be offered genetic counselling (if relevant), especially if they are planning for more children.
- The child will continue reaping benefits in the long term: social, psychological, educational and professional.

screening cannot be implemented because of financial reasons. Questions can be simple, asking parents whether they think there is a hearing loss: e.g. 'Do you think your child can hear?'



Screening for hearing loss using a distraction test. UK

Important note: although this article mentions the age at which each test can be used, please be aware that the ages indicated are guidelines only.

From 7 to 9 months: distraction test and visual reinforcement audiometry

From this age, children start making sounds and turning to sounds. They are able to localise a sound in a horizontal plane and their hearing can be tested using a distraction test or using visual reinforcement audiometry.²

1 Distraction test

This test can also be used as a screen when sounds are presented at an agreed intensity level.

Two people are needed to perform this test. A 'distractor' controls the infant's attention using toys (see picture above), whilst the tester makes a sound from behind the child, outside the child's visual field, by using various sound makers, a hand-held warbler or by making the sound themselves. The child's reaction (or lack of reaction) to sound is then observed. The sounds that are presented should cover the speech frequency range (500Hz to 6KHz).

Play audiometry using a box of toys. SRI LANKA



Testers need to be trained for this test and understand the sounds they can use: there should be a protocol in place so that the same sounds are used every time and performed in an identical manner. If a hand-held warbler is used, it should be calibrated and checked at regular intervals.

Testers need to be aware of the child's developmental age and behaviour as older children could inhibit the response that might affect the outcome of the test (they may not be interested). Distraction tests can be valuable if carried out correctly, but at the same time a poorly-conducted distraction test can miss children with significant hearing loss.

Material needed by the tester: the tester's own voice, to make specific sounds such as 'ba ba ba', 'moo moo moo' (low frequency) and 'ss ss ss' (high frequency). Noisemakers (toys, rattles, cup and spoon) or a hand-held warbler (FM sound) can also be used. This last option is more costly.

2 Visual reinforcement audiometry (VRA)

This test uses the same principle as the distraction test, but with the addition of a visual reward. The tester, positioned outside the child's visual field, makes a sound through a speaker or headphone, and the child is rewarded visually for turning round (e.g. the child is shown a toy with flashing lights).

VRA can also be used as a screening tool, e.g. by using a handheld warbler with flashing lights at a predetermined intensity level.

Material needed by the tester: VRA equipment (reward boxes, speakers and an audiometer) or a handheld warbler with visual rewards (e.g. flashing lights).

3 At what age can these tests be performed?

The ideal age to perform either of those tests is 7 to 9 months.

They can be used from the age of 6 months if the child can sit unsupported (though they may not respond to quieter sounds) up to, with caution, 24 months. There are two reasons for this. Firstly, as children get older, they inhibit their responses and may not turn round twice, because they already know there is someone behind them (this is why VRA can be used more reliably than the distraction test in older children, because the child is rewarded for turning when they hear the sound). Secondly, older deaf children have learnt to use their other senses to compensate for their hearing loss.

This means distraction tests and VRA should be used with caution after 18 months.

4 Where can these two tests be administered?

Both tests can be performed in the home or at the health centre during routine visits, as long as the room is very quiet: ideally, ambient noise levels should be 30dBA or less.

5 Who can administer these tests?

Health visitors and nurses can be trained to administer these tests. Training takes about two weeks, assuming there are children to test for demonstrations and practice sessions. In addition to learning the theory behind the test, trainees should receive practical training by someone who knows how

to administer the test. The trainee needs to practise producing the right level of sound with their voice or with an object when learning to perform a distraction test (as sound levels can change depending how you manipulate the object): to this end, during training, an observer should check the intensity and the frequency of the sounds the trainee is producing.

From 18 months to 30 months: questionnaires for parents

You can find out whether a baby can hear properly by asking parents about their child's behaviour.

Questions can be asked by a tester in the parents' home, at a health centre or in a community hall, using a simple paper questionnaire. Although this material costs very little, it needs to have been designed specifically to detect hearing loss.

There are many questionnaires of this type already in use. Questions relate to observations the parents may have made concerning their child's response to sound and their speech and language development (see Table 1 for milestones), such as:

- 'Does your child answer when you call his/her name?'
- 'Does your child startle to loud sounds?'
- 'Can your child hear you when you whisper?'

When can a questionnaire be used? From 18 months (when VRA and distraction tests become more difficult to perform), until the child can be reliably conditioned to a sound, usually from about 30 months of age.

However, when other tests are not available, you can ask parents questions about their child's response to sounds and speech development, when he/she reaches 12 months of age.

Who can administer the questionnaire? Anyone with minimal training; personnel can be trained in a day. For example, this could be included in the curriculum for training health visitors. The questionnaire should come with an answer grid that gives a pass or fail, so the tester need not make any decisions. If questionnaire answers indicate a suspicion of hearing loss, the parents will be sent to an audiology team.

From two and a half to three years of age: play audiometry

At this stage, children can be tested using what is known as 'play audiometry'.

In play audiometry, the child is conditioned to do something in response to sound presented through a speaker and headphones, e.g. to drop a brick in a basket or put a figurine in a toy boat. As with the distraction test, when using objects such as rattles to produce a sound, the tester needs to know how to produce the right frequency range. Tone sounds can be presented through the headphones.

At what age can the child be tested? From the age of 24 months.

Where can the test be performed? In the parents' home, in a health centre, or in a community hall.

Who can administer the test? Usually, audiologists. Indeed, the training for this kind of test needs to be extensive: it can take from 3 to 6 months full time. The tester needs to know the theory behind the test, as well as practise with someone who knows how to perform it. Testers should know the frequency of each object they use to make sounds and should also know how to handle the object to always produce the right frequency range.

Conclusion

Babies and children who have not passed a hearing screen should be referred for a full audiological assessment and subsequently supported by appropriate interventions. If carried out in a timely manner, this process will lead to much better outcomes for babies and children from the point of view of speech and language development and educational achievement.

It is important to remember that identifying and subsequently managing hearing loss is essential, irrespective of the age of the child, as the child will always benefit in some way.

¹ The next issue of this journal will be entitled 'Testing hearing with little or no equipment' and will offer step-by-step instructions.

² You will find simple step-by-step instructions for performing these tests in: World Health Organization, Primary Ear and Hearing Care Training: Advanced Manual (WHO: Geneva, 2006): 32–39. This resource is part of a collection of four manuals aimed at primary level health workers and communities in low- and middle-income countries. They can be ordered by emailing WHOPBD@who.int or downloaded from www.who.int/pbd/deafness/activities/hearing_care

TABLE 1 SPEECH AND LANGUAGE MILESTONES IN EARLY CHILDHOOD*

0–6 months: Sound recognition
<p>0 to 3 months</p> <ul style="list-style-type: none"> • Recognises and quiets to parent's voice • Startles to loud sounds • Laughs, gurgles and coos
<p>3 to 6 months</p> <ul style="list-style-type: none"> • Awakens to sounds or speech • Turns towards interesting sounds • Makes a variety of sounds and enjoys interesting sounds
6–18 months: Speech understanding
<p>6 to 12 months</p> <ul style="list-style-type: none"> • Understands first words such as: 'Da-Da', 'Stop it', 'Go', 'Come' • Responds to his or her name • Enjoys sounds from rattles and similar toys • Coos to music and imitates speech
<p>12 to 18 months</p> <ul style="list-style-type: none"> • Says first words such as: 'Da-Da', 'Ma-Ma', 'Bye-Bye' • Identifies body parts and favourite toys by pointing to them • Responds to sounds coming from far away in all directions
18–36 months: Verbal communication
<p>18 to 24 months</p> <ul style="list-style-type: none"> • Has a vocabulary of few words • Speaks two-word phrases • Understands simple 'Yes' and 'No' questions • Refers to self by name
<p>24 to 36 months</p> <ul style="list-style-type: none"> • Has a vocabulary of many words by the age of three • Speaks to communicate wants and experiences • Speaks simple sentences • Recognises different sounds • Understands most of what is said to him or her

*This table is intended as a guide that can be adapted to fit different contexts.

Planning for a hearing screening programme in neonates and infants



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Providing early and optimal interventions is crucial to ensuring that children with hearing loss can enjoy equal opportunities in life alongside other children. Newborn and infant hearing screening – i.e. the routine and systematic testing of neonates and infants for hearing loss – is an important tool for early detection and management of hearing loss in young children.

This article outlines the key practical issues that need to be addressed when planning a programme for hearing screening in neonates and young children¹:

Whom to screen?

In order to identify all neonates and infants with hearing loss, all children in the population should be screened. However, where this is not feasible, the programme may instead focus on a subset of the population:

- **Geographical subset:** a particular area may be chosen for the screening programme based on availability and accessibility of equipment and personnel.
- **Babies in neonatal intensive care units:** the incidence of hearing loss is significantly higher in babies who require intensive medical care, especially in the first few days of life.
- **Babies who have a recognised high risk factor (e.g. family history, antenatal rubella, birth asphyxia and low birth weight):** these babies have a much higher rate of hearing loss compared to those who do not exhibit such a risk factor.

Screening an identified subset can be the first step towards a future universal neonatal or infant hearing screening programme. It is an option for initial implementation of the programme, especially in areas with limited technical and human resources.

When to screen?

- Programmes should aim to screen all babies in the programme within the **first month** of life.
- Babies who fail the initial screening should undergo diagnostic tests to establish or rule out hearing loss before the age of **three months**.
- When a child is identified with hearing loss,

audiological, medical and educational habilitation should be initiated as soon as possible and no later than by **six months** of age.

What to screen for?

At the outset, it is essential to define the scope of the screening programme and agree on the 'case definition.' The population to be screened and the resources available for screening, diagnosis and re/habilitation need to be considered while making such a decision.

Most existing programmes target permanent sensory or conductive hearing loss above 30–40dB in the speech frequencies. However, milder losses are also important and can have a negative impact on the development of linguistic skills and cognition. Some programmes may focus only on bilateral hearing loss, even though there is strong evidence supporting the importance of early intervention for children with unilateral hearing loss.²

Ideally, a programme should identify and habilitate all children with hearing loss, including those with unilateral hearing loss and those with mild hearing loss. However, where the capacity for screening and re/habilitation is limited, programmes may start with identifying children with bilateral moderate to profound hearing loss (excluding milder degrees). As the programme evolves, it should expand its scope to include the other cases.

What screening tools should be used?

A variety of tools are available for screening neonates and infants for hearing loss, including:

Physiological measures:

- **Otoacoustic emissions (OAE):** these measure the status of the peripheral auditory system extending to the cochlear outer hair cells.
- **Auditory brainstem response (ABR) testing:** this is usually automated and reflects the status of the peripheral auditory system, the auditory nerve and brainstem auditory pathway.

High-risk register: the identification of babies who have one or more risk factors for hearing loss can be the first step in identifying children with hearing loss. However, it is important to remember that nearly half of those babies who have a hearing loss do not exhibit any risk factors. Hence, if a high-risk register is the only screening tool used, it is possible that many children who have hearing loss will go undetected.

Family questionnaires: parents or caregivers may be asked directed questions regarding the infant's response to sounds and acquisition of language. When a baby is found to be performing poorly with respect to language development, further audiological evaluation must be undertaken. The questionnaires used for this should be validated prior to widespread use.

Behavioural response: the responses of babies to loud sounds can be recorded with devices ranging from simple noisemakers (e.g. a rattle) to more sophisticated and standardised audiological equipment. Observations based on the baby's response can help to determine if the child requires further evaluation. However, such methods may be unable to identify babies with unilateral hearing loss or bilateral mild/moderate degrees of hearing loss. In addition, high levels of false positives and false negative responses are possible in babies younger

Screening a neonate for hearing loss at the hospital. NIGERIA



BOJAJOKO OLUSANYA



Training session for hearing screening at a midwife obstetric unit. SOUTH AFRICA

than 12 months. Nevertheless, the technique may provide a useful alternative in communities where access to physiological testing is not available.

It is widely accepted that physiological screening, with use of OAE or ABR testing, is the best approach to infant hearing screening. However, in settings where this is not possible, behavioural measures or a combination of behavioural and physiological tools can be used to identify a significant number of babies with hearing loss. These methods should be used only where the standardised physiological tests are not available, and must be followed up by detailed audiological testing in those suspected to have hearing loss.

In all cases, it would be useful to work towards eventually implementing universal physiological screening.

Who should undertake screening?

This will depend on the screening tools used and human resources available. It is important to ensure that the persons responsible for screening are properly trained in the techniques of screening and communication. The following personnel could be considered for training⁴:

- Audiological or audiometric technicians
- Neonatal intensive care nurse/maternity room nurse/obstetric nurse/health workers
- Junior doctors/residents

After screening, what next?

- Children who fail screening must receive follow up and a detailed audiological evaluation to confirm or rule out hearing loss.
- Once a hearing loss has been confirmed, thorough assessment must be undertaken to establish its cause, where possible.
- Children with hearing loss must be provided with suitable interventions to ensure timely re/habilitation and development of communication.
- Parents of children identified with hearing loss should be directed towards family-support programmes and parent associations.

Raising awareness

It is important to guide and support families throughout the process of screening. Providing relevant, credible

and culturally appropriate information can contribute to the success of the screening programme.

- Prior to screening, inform parents about the justification for screening and how it will be done.
- Parents of babies who fail screening must be counselled about the interpretation of these results, follow-up actions and available resources. Their concerns must be suitably addressed.
- Parents of children who pass the initial hearing screening should be counselled regarding language development and its milestones. They should be informed about possible causes of hearing loss in early childhood and the importance of early identification and management.
- Suitable awareness materials should be developed as part of the programme and provided to families.

Besides relatives of children undergoing hearing screening, it is also relevant to raise awareness about hearing loss and its early identification among other parents, physicians, health workers, policy-makers, educators and other stakeholders.

IMPORTANT POINTS FOR PROGRAMME IMPLEMENTATION

The approach to the actual implementation of hearing screening programmes may vary depending upon countries' health care systems, availability of resources and personnel. However, certain common principles need to be kept in mind for proper planning, implementation and monitoring:

Screening protocol

- It should be developed based on local circumstances, community practices, available resources and after a study of other established screening programmes.
- It should be field-tested prior to full implementation and made available to all stakeholders.
- It should define record-keeping and reporting procedures, paying due attention to patient/parent consent, privacy and confidentiality of information.

Human resources and equipment

- Programmes need to have clearly stated goals with well-specified roles and responsibilities for everyone involved.
- The person(s) responsible for the programme should be clearly designated.
- Staff involved in the conduct of screening should be trained in the chosen methods.
- Training should include the communication skills required to inform parents of test results and their interpretation.
- Equipment for physiological screening and diagnostic evaluation should be properly maintained and checked periodically.

Recording and monitoring

- A mechanism for follow-up and tracking of patients should be established. All children who fail the initial screening must be tracked and any failure of follow-up procedures needs to be documented.
- Quality assurance procedures should be implemented to document results and show when they are not consistent with expectations.
- The screening programme should document and regularly report its procedures, outcomes and costs.
- Regular monitoring of screening programmes and outcomes is important to ensure the required efficacy. Where possible, certification processes should be developed.

Links with infant health programmes

- The screening programme must be linked to early intervention and family support programmes.
- Where infant health records exist, efforts should be made to make hearing screening results, follow-up and services, a part of this official record.

¹ Newborn and infant hearing screening: current issues and guiding principles for action, World Health Organization 2010: http://www.who.int/blindness/publications/Newborn_and_Infant_Hearing_Screening_Report.pdf, last accessed on 8 October 2014

² Lieu JEC, Tye-Murray N, Karzon RK, Piccirillo JF: Unilateral hearing loss is associated with worse speech-language scores in children: a case control study, *Pediatrics* 2010;1348-1355.

³ Society for Sound Hearing: Guiding principles for infant hearing screening. <http://www.soundhearing2030.org/guidelines.php>, last accessed 3 November 2014.

Developing community-based infant hearing screening in the Western Cape



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Newborn hearing screening has not been legislated or mandated in South Africa, although awareness of early detection and intervention has increased.

National surveys in the private and public healthcare sectors revealed that approximately 90% of newborns in South Africa have no prospect of having their hearing screened.¹ Only 7.5% of hospitals in the public sector offer some form of screening, with universal newborn hearing screening being offered by less than 1% of units.² The reported age of initial diagnosis ranges from 23 to 42 months in different studies.

Our NGO

The Carel du Toit Centre is a Cape Town-based nongovernmental organisation (NGO) that supports and provides services to children with hearing loss and their families, through an early intervention programme and a school for learners aged three to 10 years.

Having witnessed on numerous occasions the consequences of late diagnosis of hearing loss, the Centre initiated a community outreach infant screening programme in 2001, by providing daily screening services at the Nolungile clinic in Khayelitsha, one of Cape Town's biggest townships. To this day, the team screens on average 100 infants per month.

Following this project, the Centre felt compelled to reach more infants and initiated a pilot programme on a larger scale.

Combining hearing screening with infant immunisations

Why this pilot programme?

As a significant number of births in South Africa take place outside of hospitals, either at home or at birthing clinics, and those born in public hospitals are often discharged on the same day, a community-based approach to infant hearing screening is necessary.

Immunisation clinics seemed suitable as a platform for screening because they are well attended and the first immunisation visit take place at 6 weeks of age.

Mothers wait for their newborns to be tested.

SOUTH AFRICA



TERSIA DE KOCK

Partnership

A proposal was brought forward to perform the hearing screening and a partnership was formed with the City of Cape Town's Health Department (municipal health system) that manages the immunisation clinics. Eight primary healthcare (PHC) clinics were selected for piloting hearing screening in 2007.

The City of Cape Town committed to purchase and maintain the eight otoacoustic emissions (OAE) devices whilst our NGO provided the managing audiologist and covered operational expenses.

This was the first systematic government-supported infant hearing screening programme.

Protocol

Fully automated handheld DPOAE (distortion product OAE) devices were selected for screening, as they are easy to use by non-specialists and require no interpretation.

The managing audiologist trained existing nursing personnel to perform the hearing screening in conjunction with their immunisation duties. They provided theoretical as well as practical in-service training to nursing staff and visited each site on a bi-weekly basis to provide ongoing support and mentoring.

Referral and follow-up

A two-stage screening protocol was implemented. The first hearing screening was performed during the immunisation visit scheduled at six weeks of age. Infants who failed the screen were scheduled for a follow-up screen within four weeks (coinciding with their next planned immunisation visit).

For the sake of cost-effectiveness, children were referred only when they failed the OAE screen in both ears. Although we do not disregard the impact of unilateral hearing loss, we made this decision due to resource constraints in terms of follow-up at both clinic and tertiary hospital level.

Infants who failed both the initial and the follow-up screen were referred to the tertiary hospital for a diagnosis. In an attempt to speed up the diagnostic process, we negotiated one fixed appointment per week with the audiology department, for babies referred through the programme. Unfortunately, even with this in place, waiting time for an appointment often ranged between three and six months.

Assessing results

The screening programme was introduced in three phases (two to three clinics per six-month period) and the programme was closely monitored. Results and feedback from each phase informed the roll-out of the next phase. For example, we found that training needed to be repeated whenever staff rotations or changes took place, which could be as often as every three months.

Research evaluating the efficacy of the screening programme reported low coverage rates: only around 30% of immunised infants were screened for hearing

loss. This was mainly attributed to the use of already burdened nursing staff as screeners.³ In total the programme reaches between 2,000 and 2,500 infants per annum.

With the aim to optimise screening coverage and cost-effectiveness, we developed a new model for community-based infant hearing screening.

Combining hearing screening with postnatal visits at birthing units

Why this pilot programme?

Midwife obstetric units (MOUs) are birthing units run by midwives in the community for primary healthcare patients. Although mother and baby are usually discharged six hours after birth if they are in good health, they return to the MOU for postnatal follow-ups focussing on navel care and feeding advice. These postnatal visits take place every second day until the umbilical cord falls off. They seemed an ideal platform for hearing screening as the babies would be younger and there would be two to five screening opportunities before the infant reached the age of two weeks.

Partnership

The MOUs fall under the management of the Western Cape Government: Health (WCGH), so a new partnership had to be established. A pilot programme was initiated in 2012 in all three MOUs within the Klipfontein/ Mitchell's Plain sub-structure.

Protocol

Two different models of service delivery were used:

- **Training existing personnel:** at the two medium-sized MOUs, the personnel involved in the postnatal visits were trained to perform OAE hearing screening as part of the standard visit.
- **Using a dedicated screener:** in the third facility, which was the largest MOU with double the amount of births and postnatal visits, a dedicated screener was appointed. Infants were seen for their postnatal visit and then sent over to the screener who performed the hearing test.

Prior to initiating hearing screening at each MOU, staff information sessions were held to introduce the concept of early hearing loss detection and to explain the implementation plan. A mother and child with hearing loss, from the area, were invited to share their story. This greatly influenced staff attitudes.

After a few weeks the screener reported that some mothers treated her with disrespect and we realised that she needed a uniform. Once she was in uniform, the mothers viewed the screener and the service as official and a change in attitudes was experienced.

Referral and follow-up

A two-stage screening protocol was used at all the MOUs: infants failing the initial screen were re-screened at their next postnatal visit, usually two days later. Those who failed the second screen were sent to the tertiary hospital.

A research study was also launched at the third MOU, comparing the outcomes of DPOAE and AABR screening, to see if the latter could be used in a community-based setting (AABR produces fewer

false positives, and therefore fewer referrals, which is important when services are overburdened).

Results

This new model rendered excellent results, yielding high coverage and follow-up rates.

At the two medium-sized MOUs, staff managed to integrate the hearing screening and felt that it added value to the postnatal visits.

At the large MOU, the dedicated screener was essential to run the service and could cope with the added administrative tasks of follow-up management and electronic data capturing.

The research showcased the viability of AABR screening in community-based contexts with the benefits of reduced disposable costs (due to the technology's built-in fixed electrodes) and lower hospital referral rates (1%).

The three MOU facilities now screen between 10,000 and 11,000 infants per annum.

The way forward

Although the MOU pilot project was a success, long waiting lists at tertiary level highlighted the dire need for better access to hearing and speech services to support infants with hearing loss.

To this end, the Child Speech and Hearing Project was formed: this three-way partnership between the WCGH, the Children's Hospital Trust and the Carel du Toit Centre offers children (and their families) access to hearing and speech services within the District Health System.

Newly developed speech and hearing packages of care (including newborn hearing screening), for children aged 0–6 years, will be demonstrated over a two-and-a-half-year period in the pilot sub-district.



TERSIA DE KOCK

Performing a hearing test at a midwife obstetric unit.

SOUTH AFRICA

¹ ME Meyer, D Swanepoel, T Le Roux, M Van der Linde. Early detection of infant hearing loss in the private health sector of South Africa. *Int. J. Pediatr. Otorhinolaryngol.* 76 (2012) 698–703.

² M Theunissen, D Swanepoel. Early hearing detection and intervention services in the public health sector of South Africa. *Int. J. Audiol.* 47 (2008) S23–S29.

³ N Friderichs, D Swanepoel, JW Hall. Efficacy of a community-based infant hearing screening program utilizing existing clinic personnel in Western Cape, South Africa. *Int. J. Pediatr. Otorhinolaryngol.* 76 (2012) 552–559.

KEY LESSONS

- Pilot programmes are crucial in developing efficient and contextually appropriate models for infant hearing screening.
- Using evidence-based research strengthens programme credibility and helps to advocate for further roll-out.
- Building relationships and trust takes time: persevere.
- If an NGO is taking the lead, it is essential to get buy-in from all partners and for government to take some form of responsibility. This greatly impacts on sustainability.
- Follow a phased approach in the roll-out of new services: plan, implement, evaluate, optimise, and learn from the experience. Then move on to the next phase.
- Appoint a programme manager who will monitor quality and provide ongoing support and training.
- Implementation and training are not to be seen as one-off occurrences.
- Embed your early hearing detection and intervention programme within the existing healthcare system: this ensures greater sustainability and cost-effectiveness.

Hearing loss should be identified as early as possible in children



Early detection enables early management of hearing loss



Better speech, language and communication skills

Better learning

Children are better equipped to reach their full potential

Never ignore signs of possible hearing loss in a baby or child