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.


BOLAJOKO OLUSANYA

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 (ANSD), 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.

> **"Early detection of hearing loss and appropriate management allows children to achieve their best"**

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 ➤

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?'

CHIME

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

TONY SIRIMANNA

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? From18 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

0 to 3 months
- Recognises and quiets to parent's voice
- Startles to loud sounds
- Laughs, gurgles and coos

3 to 6 months
- Awakens to sounds or speech
- Turns towards interesting sounds
- Makes a variety of sounds and enjoys interesting sounds

6–18 months: Speech understanding

6 to 12 months
- 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

12 to 18 months
- 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

18 to 24 months
- Has a vocabulary of few words
- Speaks two-word phrases
- Understands simple 'Yes' and 'No' questions
- Refers to self by name

24 to 36 months
- 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.