International Journal of
Neonatal Screening

MDPI

Communication

Setting up a Newborn Hearing Screening Programme in a Low-Income Country: Initial Findings from Malawi

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Received: 31 October 2017; Accepted: 29 November 2017; Published: 4 December 2017

Abstract: Establishing a newborn hearing screening programme in a low-income country with poor communication infrastructure has unique challenges. Data from 195 infants in three different patient populations in Malawi who underwent hearing screening using transient evoked otoacoustic emissions (TEOAE) testing were analysed to investigate the feasibility of a long-term screening programme. There were 65 infants in each group: infants from Group A were born in a private maternity unit, Group B attended a free community vaccination clinic, and Group C were receiving special care at a government hospital. 75% of infants requiring follow-up from the special-care baby unit were uncontactable following hospital discharge, and screening was discontinued there. Lost to follow-up rates after the first screen were lower from the private maternity unit (14%) and the community vaccination clinic (36%), and these screening programmes continue. A successful hearing screening programme requires extensive support services to manage infants requiring further testing and habilitation, this is not currently possible on a large scale in Malawi due to the small number of Audiology departments and trained staff.

Keywords: newborn hearing screening; loss to follow up; audiology

1. Introduction

The estimated prevalence of disabling hearing loss in sub-Saharan African children is over three times that of high-income countries [1]. Without early identification and access to appropriate support, hearing-impaired children in Malawi are at risk of failing to develop speech and language, and may not be able to access education.

The World Health Assembly recently adopted a resolution on the prevention of deafness and hearing loss, which recommends the implementation of screening programmes for the early identification of high-risk groups, including infants [2]. Hearing screening offers the possibility of identifying infants with hearing loss in the first weeks of life and, if linked with early intervention services, has been found to improve speech and language outcomes [3]. A pilot project was carried out in three different patient populations in Lilongwe, Malawi, with the aim of determining whether a long-term screening programme was sustainable in a low-income country.

2. Materials and Methods

Transient evoked otoacoustic emissions (TEOAE) testing (Madsen Accuscreen) was used to assess the hearing of each infant. A clear TEOAE response bilaterally resulted in the infant being discharged from the project. When a clear TEOAE response was not obtained for one or both ears after three attempts, the family were invited to bring their infant to the African Bible College (ABC) Hearing Clinic for a repeat screen on another day at their convenience. Failure to establish a clear response in one or both ears at second screening resulted in a referral for diagnostic testing, consisting of

otoscopy, tympanometry, and auditory brainstem response (ABR) testing. Screening was carried out by audiology assistants; diagnostic testing was carried out using the Newborn Hearing Screening Programme protocols of the United Kingdom National Health Service, and was overseen by an experienced audiologist.

If an infant requiring a second screen was not brought for repeat screening within eight days, the family received a follow-up phone call to remind them. If the family did not answer the phone, a further three attempts were made to contact them. After four unsuccessful phone attempts, an infant was considered 'lost to follow-up', and no further efforts were made to contact the family. If it was possible to contact the family, yet they failed to attend for the repeat screen, then a further three attempts were made to contact them by phone before listing the baby as 'lost to follow-up'.

The hearing screening pilot project was started using a convenience sample of infants from the ABC maternity and community clinics, and the nearest local government hospital.

Group A: Bedside testing was carried out for infants born in the private maternity wing of ABC Clinic, Lilongwe (January—March 2017), infants were aged 12 h–4 days at the time of first screen. It was not always possible to obtain results due to background noise on days when the nearby generator was running; in those cases, the family was asked to bring their infant for screening at the ABC Hearing Clinic following discharge from the maternity unit. The average socio-economic status of mothers giving birth in this facility is likely to be higher than those in groups B and C.

Group B: Families with infants aged $\leq$84 days who attended the free vaccination service held twice weekly at the ABC Community Clinic were given information about the hearing screen and invited to opt into it if they chose. Families brought their infants to ABC Hearing Clinic for screening in a quiet room.

Group C: Screeners made six visits to assess premature infants in kangaroo care/special care units at Bwaila government hospital in January/February 2017. Infants were aged $\leq$50 days at the time of first screen. Usually, not all infants in the ward were tested on any given visit because of the large numbers and fluctuating background noise.

All services were offered free of charge for infants in groups B and C. The bill for the private maternity services included a small charge for hearing screening for infants in Group A; if diagnostic testing was required, then no further charge was made.

This study is a clinical audit, all families gave consent for anonymized data about their infant(s) to be collected and used for audit purposes. Permission to publish data was given by the directors of ABC Clinic, ABC Hearing Clinic and Bwaila Hospital.

3. Results

Data from the first 65 infants tested in each of the three different groups were analysed. Table 1 shows the outcomes for infants in the three different groups.

Significant time and effort was required to follow up infants requiring a second screen; very few families brought their infants for a second screen without prompting. 25% of families whose infants needed a second screen could not provide a valid phone number. Of those needing second screens who could provide phone numbers, multiple phone calls were required to contact most families, and it was not possible to reach 20%, despite repeated attempts. Contact via post was not an option, because few people have addresses, and there is no regular postal system.

It was not possible to determine how many families came for a second screen without prompting, because those in Group A routinely returned for a 7-day health check with a clinical officer who was asked to remind families to go to the Hearing Clinic for follow-up if required. Families with infants in groups B and C did not receive this face-to-face reminder, and contact was made by phone calls alone.

No infants were identified with permanent hearing loss from this small dataset (see Table S1 for further details); this is not unexpected given that the prevalence of neonatal hearing loss in developing countries has been estimated to be 6 per 1000 live births [4]. It should also be noted that of the seven

infants referred for diagnostic testing, two failed to attend their appointments, and two families declined further testing.

Table 1. Outcomes for infants going through the hearing screening programme.

		Group A n = 65	Group B n = 65	Group C n = 65
Discharged following 1st screen		35	54	29
Parents declined screen		1	0	0
Required 2nd screen		29	11	36
Discharged following 2nd screen		23	5	6
Required 2nd screen but lost to follow up	unable to provide a valid phone number	1	3	15
	contact not possible using phone number provided	3	1	11
	unable to afford journey to the clinic	0	0	1
Total lost to follow up after 1st screen		4	4	27
Referred for further testing		2	2	3
Diagnostic test results	satisfactory hearing bilaterally	0	0	1
	conductive hearing loss indicative of middle ear effusion	0	2	0
Did not attend for diagnostic testing/Declined further testing		2	0	2
Total lost to follow up before diagnostic pathway was complete		6	4	29

4. Discussion

TEOAE testing is an assessment of outer hair cell (OHC) function in the inner ear; it is widely accepted to be a rapid indicator of hearing status, and is routinely used for newborn hearing screening. No clear response on TEOAE testing indicates moderate hearing loss or greater; it is not sensitive enough to reliably identify mild hearing loss [5]. TEOAE testing will not identify infants with auditory neuropathy spectrum disorder (ANSD), a condition affecting the inner hair cells (IHCs) and/or synapses between IHCs and the acoustic nerve [6]. Infants with ANSD may have anything up to a profound hearing loss, but would give a clear response on TEOAE testing because OHCs function satisfactorily [7]. The equipment required to screen for ANSD, an automated auditory brainstem response (AABR) testing device, was not available for this project.

A TEOAE screening device is costly, but easy to use; the initial TEOAE screen was therefore quick and straightforward. There was a low uptake for repeat screening without the family receiving a reminder. The reason for this may be due to the screening project being new, and families not understanding why it is important. It would be helpful to have a public awareness campaign running in conjunction with the screening programme.

It was unfeasible to continue screening in Group C, because 75% of those requiring a second screen were lost to follow-up; yet this population is likely to have a significantly greater incidence of hearing loss than the well-baby population [8]. There are many possible reasons for the large number of infants from Group C who were lost to follow-up, in addition to the difficulties with maintaining contact. Families travel long distances to access the special care services of Bwaila hospital, and may not manage to travel that distance again for repeat hearing screening; whereas infants in groups A and B tend to live locally. Premature infants are more likely than those in the other groups to have other, possibly more obvious health concerns, and assessing the baby's hearing may not be considered a priority.

Before any screening project is started, a process should be in place for follow-up of those requiring further testing. The electrophysiological testing required to definitively diagnose hearing loss in an infant involves expensive equipment, extensive staff training, and a quiet environment with

a reliable source of electricity and low levels of electrical interference. Diagnostic testing can take a number of hours to complete, and multiple tests may be needed to establish all of the information required. A programme should be in place for supporting infants who are diagnosed with hearing loss, as well as their families. Staff should be competent in taking ear impressions and fitting hearing aids appropriately and safely for infants, and there should be an early intervention programme available to accept referrals [9]. The equipment and specialist skills required for the long-term management of early-identified children with permanent hearing loss should not be under-estimated. Staff currently capable of carrying out high-quality diagnostic hearing testing on infants in Malawi are thought to number fewer than ten, and there are only two Audiology departments in the country with suitable facilities. Currently, the ABC Hearing Clinic is the only audiology department in Malawi offering a comprehensive early intervention programme.

The financial implications of continuing a hearing screening programme require consideration. For this pilot project, the costs to the families were minimized to encourage participation. The equipment required was already available at the hearing clinic; however, the staff time needed to carry out the screening, diagnostic testing, and accompanying administration must be paid for. Screening in groups A and B continues, with the small charge made for screening infants in group A helping to offset the costs of the overall programme.

To widen the scope of infant hearing screening in Malawi, it would be helpful for other clinics in the area to purchase OAE screening devices and carry out the first and second screens, then refer infants who require diagnostic testing to the ABC Hearing Clinic. To increase effectiveness, targeting screening to prioritise those with risk factors for hearing loss would be beneficial.

Many cases of childhood hearing loss in Africa are thought to be related to preventable or treatable infections [10], which often occur after the age at which infant hearing screening would be carried out. It is possible that, having been told that their child's hearing is considered satisfactory, following the infant screen, families may not take hearing loss that develops later seriously. Alternatively, the hearing screening programme may raise awareness of audiology services, which could increase the likelihood of families seeking appropriate and timely support when they suspect a hearing loss in their child.

5. Conclusions

A screening programme is possible in a low-income setting; however, great thought and creativity needs to be invested into considering how best to limit the number of infants lost to follow up. A publicity campaign running in conjunction with a screening programme may increase awareness of hearing issues and improve rates of follow up. Screening should only be carried out where there is a sustainable paediatric audiology service to diagnose infants with hearing loss and offer appropriate long-term support. An increase in the capacity of high-quality tertiary paediatric audiology referral centres is required in Malawi before infant hearing screening services can be significantly expanded. The long-term effects of the screening programme remain to be seen.

Supplementary Materials: The following are available online at www.mdpi.com/2409-515X/3/4/33/s1, Table S1: Anonymised data from the 195 infants in the pilot project.

Acknowledgments: The author would like to thank the staff of ABC hearing clinic for support in data collection and critical appraisal of this work.

Conflicts of Interest: The author declares no conflict of interest.

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