Tele-ABR using a satellite connection in a mobile van for newborn hearing testing

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Summary
We assessed the feasibility of conducting Auditory Brainstem Response (ABR) testing in a mobile van with satellite connectivity, with the help of trained health workers. ABR recordings in newborn babies made by telemedicine were compared with recordings made face to face. The auditory evoked response equipment was controlled by an audiologist at a nearby hospital. Videoconferencing was used during the testing process to monitor patient preparation by the village health worker. A total of 24 newborns (13 male and 11 female) aged 8–30 days underwent ABR in face-to-face and tele-mode. There was no significant difference between peak V latency measured at three intensity levels in the two modes. Agreement between the two methods of measurement was examined with a Bland-Altman plot. Almost all points were within the limits of agreement, suggesting no bias in the telemedicine measurements. Real-time tele-ABR testing as a component of newborn hearing screening is feasible in a mobile van using satellite link with the assistance of village health workers.

Introduction
Newborn hearing-screening programmes have been established in many countries in the world to provide early identification and intervention of hearing loss. In India, newborn hearing screening programmes first began in the 1970s. Most were research programmes,1–3 although some were implemented at nursing homes and tertiary care hospitals.4,5

Poor follow-up for re-screening and diagnostic testing is frequently reported in newborn hearing screening programmes. In a newborn hearing-screening programme at a tertiary care hospital in Chennai, the follow up rate for diagnostic assessment was only 12%.6 Poor parental interest, lack of perception of the child’s hearing problem and the need to travel long distances for diagnostic testing6,7 have been reported as reasons for poor follow-up in India. Because diagnostic testing facilities are only available in major towns and cities, parents often have to travel considerable distances. Furthermore, the cost of travel and loss of wages due to absence from work are major deterrents for parents to bring their children for follow-up testing. The success of any early hearing detection and identification programme lies in the follow up rate for diagnostic testing. Telemedicine may therefore be useful.

Audiologists have provided basic hearing testing using remote computing technology in adults8 and hearing screening via telehealth in rural elementary schools.9 Tele-diagnostic tests such as audiometry, video-otoscopy, oto-acoustic emissions, and auditory brainstem response (ABR), are clinically equivalent to conventional face-to-face versions.10 Some studies have attempted interventions such as hearing aid benefit in adults and Internet based treatment for tinnitus.11–13 Tele-practice has been applied in newborn or infant hearing screening programmes to conduct real-time ABR.14,15 Identical results have been obtained face to face and in tele-mode when using Automated Auditory Brainstem Response (AABR) and Distortion Product Oto Acoustic Emissions (DPOAE) for hearing screening.14,16 Reliable click-evoked and frequency-specific ABRs have been obtained from local and distant test sites.17

Connectivity and the availability of personnel at the remote site are important factors for successful tele-audiology. Most tele-audiology testing has used the Internet. However, Internet penetration in rural areas of India is very limited and alternate means such as IP over satellite should be explored.
In terms of assistance at the remote site personnel with various levels of training have been used in tele-audiology, including trained hearing assistants,\textsuperscript{13} audiologists,\textsuperscript{14} physicians\textsuperscript{15} and surgeons.\textsuperscript{19} For real-time tele-ABR assessments, audiologists\textsuperscript{13} and ECG/EEG technicians have been involved.\textsuperscript{15} Using less skilled personnel will be important if tele-ABR is to be used in rural areas. As far as we are aware, real-time tele-ABR has not been conducted before with the assistance of health workers. We have therefore assessed the feasibility of conducting real-time tele-ABR in a mobile van using satellite connectivity, with the help of trained health workers.

Methods

The study was approved by the appropriate ethics committee. Participants were included after obtaining informed consent from their mothers.

For tele testing, the audiologist at the hospital (telemedicine centre) used a laptop computer. This laptop was connected to the Internet via satellite at a bandwidth of 512 kbit/s. The laptop could be used for remote control of the auditory evoked response equipment (GSI Audera) in the mobile van. The hospital audiologist used a videoconferencing system (Huawei View point 8033B) with a camera resolution of 1280 \times 1024 pixels.

Mobile van

The telemedicine van was equipped with a bed, air-conditioner and a generator power supply. A laptop was used in the van with the auditory evoked response software. There was a videoconferencing system (Aethra Theseus) with an omni directional microphone and a camera with resolution of 542 \times 586 pixels. The videoconferencing system was connected via a satellite. The environment was controlled to comply with the recommended standard for ABR testing.\textsuperscript{20} The noise in the van was approximately 40–50 dBA. The van was air conditioned, see Figure 1.

For tele-ABR, the van was stationed approximately 1 km from the hospital. The location was chosen for the convenience of the participants who were attending the hospital outpatient clinic. A technician and health workers were present in the van. The ABRs were recorded in the van by an audiologist at the telemedicine centre in the tertiary care hospital through remote control.

For face to face ABR, the testing was conducted in the van by a second audiologist.

The laptop at the hospital and the laptop in the van were configured with Virtual Network Computing (VNC) software for remote access.

Participants

To recruit babies for the study, mothers at the post-natal ward were informed about the purpose of study and provided with information by the neonatologist and ward nurses. Mothers who consented to participate were asked to bring their babies for testing in the van during their first follow-up appointment at the hospital. Mothers were instructed not to apply Indian dye/oil to the baby's forehead on the day of testing.

Procedure

ABRs were elicited with click stimuli of 0.1 ms duration presented at a repetition rate of 33.1/sec. Stimuli were presented monaurally at intensity levels of 70, 50 and 30 dBnHL. Acquisition settings included a bandpass filter of 100–3000 Hz and an analysis time window of 12 ms. A non-inverting electrode was placed at high forehead level (Fz). The inverting electrode was located on the mastoid (M1, M2) of the stimulus ear and a ground electrode was located on the lower forehead (Fpz).

The order of ABR recordings obtained in face-to-face and tele-mode was randomized to avoid an order effect. An audiologist at the telemedicine centre conducted the remote testing and an audiologist in the van conducted the face to face testing. A trained village health worker prepared the skin, placed electrodes and inserted earphones on the
babies for ABR measurement. The electrodes were retained until both modes of testing had been completed. Testing was conducted when babies were asleep.

An audiologist who was not involved in obtaining ABRs and was blind to the test condition under which ABR was obtained, analysed the ABR waveforms by marking peak V latency at each intensity. ABR latency was compared between the two acquisition modes.

**Results**

**ABR in the van**

Videoconferencing was used during the testing process in order to monitor patient preparation by the village health worker. Skin preparation, electrode placement and the baby’s movements while testing could be observed and guided through videoconferencing.

ABR waveforms were predominantly obtained without contamination of electrical activity. Electrical contamination was controlled by parking the van in an open space where there was no other electrical wiring or equipment. If electrical activity was found to contaminate the ABR waveforms, the air conditioner was switched off until testing was completed. Everyone in the van was instructed to switch off their mobile phones to minimize electrical interference.

**Face to face versus tele-ABR**

Thirty newborns were included in the study. All babies except two had a normal birth history and no high risk factors associated with hearing loss were reported. One baby had low birth weight and another bab had hyperbilirubinaemia. Out of the 30 newborns, testing could only be completed in one mode for 6 babies. Data from these babies were not included. Of the remaining 24 babies, testing could only be completed in one ear in some, and in some babies testing could not be completed at all three intensity levels. A total of 24 newborns (13 male and 11 female) aged 8–30 days underwent ABR in face-to-face and tele-mode. Latency analysis was carried out for 33 ears at 30 dBnHL, 34 ears at 50 dBnHL and 38 ears at 70 dBnHL to compare ABR data recorded in the two modes. An example ABR obtained in the two modes is shown in Figure 2.

There was no significant difference between latency in tele-mode and in face-to-face mode, see Table 1. The mean difference between the two modes at 30 dBnHL was 0.021 s, at 50 dBnHL it was 0.057 and at 70 dBnHL it was 0.007.

Normality of distribution was determined using the Shapiro Wilk test, which suggested that the data followed
Table 1 Measures of central tendency and normality of data

<table>
<thead>
<tr>
<th></th>
<th>30 dB</th>
<th>50 dB</th>
<th>70 dB</th>
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<tbody>
<tr>
<td></td>
<td>Face to</td>
<td>Tele</td>
<td>Face to</td>
</tr>
<tr>
<td>Number of ears</td>
<td>33</td>
<td>34</td>
<td>38</td>
</tr>
<tr>
<td>Mean latency, ms</td>
<td>8.5</td>
<td>8.5</td>
<td>7.7</td>
</tr>
<tr>
<td>SD</td>
<td>0.6</td>
<td>0.6</td>
<td>0.5</td>
</tr>
<tr>
<td>Shapiro-Wilk (W)</td>
<td>0.98</td>
<td>0.97</td>
<td>0.94</td>
</tr>
<tr>
<td>P-value</td>
<td>0.87</td>
<td>0.54</td>
<td>0.38</td>
</tr>
</tbody>
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a normal distribution in both modes at all intensities.
The Pearson product moment correlation was calculated for ABR latencies obtained in the two modes. There was a strong correlation between the two methods ($r = 0.94$ at 70 dBnHL, 0.98 at 50 dBnHL, 0.98 at 30 dBnHL), significant at $P < 0.0001$.

The agreement between the two methods was examined by the Bland Altman technique.21 The difference plot (Figure 3) showed points scattered above and below the zero line for all three intensities. Almost all points were within the limits of agreement, suggesting no bias in the tele-measurements.

**Discussion**

The present study demonstrated the feasibility of tele-ABR for follow-up assessment of babies by village health workers. Audiology telepractice services to remote areas normally utilize the store and forward method.22 The present study demonstrates the feasibility of conducting real-time ABR testing.

Previous real-time ABR studies have employed EEG/ECG technicians23 or audiologists/trained hearing assistants.14 Our study shows that ABRs obtained with the assistance of trained village health workers were similar to standard ABR recordings.

The environment in the tele-van was adapted to conform as far as possible to a standard test environment. The permitted noise levels for ABR testing are 25–45 dBSPL at 500 Hz to 4 kHz,20 and the noise levels obtained in the van were about 40–50 dBA, which is close to the recommended limits. The recommended operating temperature for the GSI Audera equipment is 10–40°C,24 and the temperatures in the mobile van were within this limit. Other than temperature and ambient noise levels, electrical isolation is critical for ABR testing, in order to avoid contamination of recordings. To restrict electrical contamination, it was ensured that there was no other equipment or heavy power lines inside or outside the van.

The correlation between latency of peak V obtained in the two modes was similar to the correlation obtained in a study that compared latency of wave V between distant and near location for clicks and tone bursts.17 In clinical practice, when an ABR is repeated to check for consistency of responses, a latency shift of 0.2–0.5 ms is considered an acceptable difference.24 The mean difference in latency obtained in the present study between the two modes was less than 0.08 ms at all intensities suggesting that the difference was no more than that obtained on repeating an ABR. Similar results have been reported in a study on 15 normal hearing adults, where latencies within clinical limits were obtained. The variation obtained due to different testing sites was reported to be not significant.17
Most studies have reported tele-audiology applications in a standard clinical environment. The only published study using a mobile van for tele-audiology practice employed the store and forward method for providing ear and hearing screening services to aboriginal people in Central Queensland.⁵ The present study demonstrates the feasibility and validity of conducting real-time tele-ABR in a mobile van.

Limitations
The present study was carried out in a mobile van located on a hospital campus using a reliable power supply. Problems in connectivity and conduct of real-time ABR due to an unreliable electrical supply have been reported.¹⁰ The environment in a rural location may pose additional challenges which were not encountered in our study. In the present study, tele-ABR was compared with face-to-face ABR conducted in a mobile van. However, a comparison with ABR conducted in a standard clinical environment would be valuable.

Conclusion
We recorded real-time ABRs via a satellite connection from a mobile van using health workers. The results suggest that conducting tele-ABR in a mobile van is feasible and produces similar recordings to those obtained in face-to-face mode.

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Providing Tele ABR in Rural India

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Abstract

This paper discusses the challenges in conducting real time diagnostic Tele-Auditory Brainstem Response (ABR) testing in remote rural locations, based on our experience with testing over 100 infants and young children in a community based hearing screening program. Two methods of tele-ABR, one using satellite connectivity in a mobile tele-van and other using broadband internet connectivity in a non-government organization at the remote location is used in the program. Advantages and disadvantages related to the two methods, challenges with respect to training technicians for telepractice, training village health workers for remote assistance, and other practical and logistic considerations in conducting tele-ABR in remote site is detailed.

Telepractice offers potential benefits in a country as vast as India, where the majority of the population lives in remote areas with no access to even the most basic healthcare. The Indian Space Research Organization (ISRO) started their telemedicine projects in 2001 with the aim of introducing telemedicine facilities to rural populations. ISRO provided satellite connectivity between remote district hospitals/health centres which provide only basic medical care, with super specialty hospitals which in Indian cities provide expert consultation, training of doctors and paramedics, and continuing medical education. Also, mobile tele-van units were utilized to provide basic eye testing and community health for medical consultations and dispensing (ISRO, n.d.). Sri Ramachandra University and hospital located in Chennai, India is one of the ISRO supported hospitals engaged in telemedicine practices since 1997, providing super specialty consultations with smaller hospitals and consultations in rural areas with mobile tele-van facilities. Telemedicine activity was expanded to audiology in 2011, thereby becoming the earliest adopter of teleaudiology in India.
The teleaudiology program was conceived to address the universal challenge of lack of follow up for diagnostic testing in hearing screening programs. In India, audiological testing facilities are only available in major urban areas. Therefore, cost of travel and wage lose due to absence from work are common deterrents for compliance with follow-up. A rate of follow-up, as low as 12%, is reported in some programs in India (John, Balraj, & Kurien, 2009; Nagarajan, Janet, Bala, & Binu, 2008). In an attempt to reach rural areas and overcome the challenge of loss to follow-up for diagnostic assessment, we explored the combination of a community based hearing screening program for infants and young children in remote rural villages with tele-ABR recording for diagnostic testing.

**Brief Description of the Teleaudiology Program**

Two levels of Distortion Product Otoacoustic Emission screenings were conducted on a door to door basis, covering 50 rural villages in a district of Tamil Nadu, South India. If a child obtains a refer in two out of three frequencies in both screenings, they are seen for diagnostic testing via real time tele-ABR. We recruited village health workers (VHW) from a local non-governmental organization (NGO), which is a not for non-profit organization that works independently of the government on women’s education, health, and social problems. VHW were trained in conducting otoacoustic emissions (OAE) screenings and assisting in tele-ABR. ABR testing using the GSI Audera (GrasonStadler, 2012a) is conducted by an audiologist from the telemedicine centre of the Sri Ramachandra University and hospital.

The portable GSI Audioscreener+ device (GrasonStadler, 2012b) is used on the “noisy” setting to complete the OAE testing at 2, 3, and 4 KHz. ABR recordings are obtained at 70, 50, and 30 dBNHL. Hearing was considered normal if wave V was obtained at 30 dBNHL. Those with abnormal ABRs were referred to the hospital where an ABR is conducted again to confirm prior results.

Two methods explored to establish tele-ABR testing included: (a) the use of satellite connectivity in a mobile tele-van, and (b) broad band internet connectivity at an NGO in one the villages. Tele-ABR was validated with face to face ABR prior to project commencement (Ramkumar, Hall, Nagarajan, Shankarnarayan, & Kumaravelu, 2013). The mobile tele-van was equipped with a bed, air conditioner, and a power generator. A laptop connected to the Internet via satellite at a stable bandwidth of 512 Kbps was used for remote control of the ABR equipment (connected to a laptop) in the mobile van using Virtual Network Computing (VNC) software. The mobile van was stationed at a location in the rural site suitable for patient access. A technician trained in satellite deployment and establishing connectivity was available in the mobile van along with the VHW for assisting in ABR. Figure 1a and Figure 1b show the tele-ABR arrangement in the mobile tele-van.
For the broadband Internet arrangement, three laptop computers with broadband Internet data cards were used. Two of the laptops, equipped with TeamViewer software for desktop sharing, were used for tele-ABR. One laptop was located at the testing site and the other laptop was located at the hospital. The third laptop equipped with video conferencing software was used at the remote end along with speakers, microphones, and a built-in web camera for videoconferencing. A trained technician connected the laptops, broadband Internet data card, and hardware. To date, 100 tele-ABRs have been conducted using one of the methods described above. Since trained VH/W were conducting OAE screening, infants and young children with both “refer” and “pass” results were included for tele-ABRs to validate the OAE screening results obtained.
Challenges in Conducting Tele-ABR in Remote Rural Areas of India

At the start of our project we determined that effective implementation of telepractice required good program planning, staff with adequate training, suitable connectivity, and appropriate space in remote site and instrumentation. The American Speech and Hearing Association (ASHA, 2005) has identified that challenges with reference to telepractice are often associated with these very same components. In our three years of experience with conducting tele-ABRs since program initiation in rural locations in India, we have certainly encountered challenges with training, connectivity, instrumentation, and suitable workspace. While our experience is from rural areas of a state in South India, many of these lessons may be applicable across the world.

**Personnel and Training**

Telepractice requires trained personnel at the remote end to assist in establishing tele-connectivity, handling clinical equipment and computers, and preparing patients for the testing process. There is a dearth of qualified technicians trained in telemedicine and there are too few formal training programs in India. As a result, technicians are often trained on the job and by way of trial and error. In our experience this results in a longer period of training and frequent repairs and troubleshooting.

For our project we trained two different types of assistants. The first set of assistants were the tele-technicians. The tele-technicians had a background in electronics and basic computer science. They were trained to establish satellite connectivity from mobile tele-van to tertiary hospital, connect the laptop with broadband Internet, and enable desktop sharing software for Internet ABR. The technicians were also trained to connect ABR hardware, preamplifier, and electrode wires.

In conducting tele-ABR, remote assistance has been provided by audiologists (Krumm, Ribera, & Schmiedge, 2005) and ECG/EEG technicians (Smaka & Simon, 2012). However, for our project with diagnostic ABR testing at remote rural locations with no infrastructure, using less skilled personnel was inevitable. The second set of assistants were the VHW who were trained to provide remote assistance in ABR. VHW were trained to prepare the skin, place electrodes, and insert earphones on the child for ABR measurement. Training was conducted by the audiologist (first author) by spacing five sessions, six hours each, across two weeks. A rigorous program including a PowerPoint presentation in the local language, live demonstration, hands-on training on adults and children, and frequent evaluations of skills in ABR assistance was conducted. Additional responsibilities included mobilizing the community for ABR follow-up and helping mothers in putting their babies to sleep as all ABRs are conducted in natural sleep. Such intensive training involves dedicated personnel to develop training modules and run frequent training programs and monitor skills in providing assistance at remote end. It also demands dedicating time and money for focused training. Our experience with staff recruitment and training was similar to results reported in England by Joseph, West, Shickleen, Keen, and Clamp (2011) that staff training in telehealth and issues in initial adjustment of staff to machines are some of the key challenges in any telemedicine program.

**Technology and Instrumentation**

**Real-Time Versus Store and Forward.** Audiology telepractice can incorporate store and forward or real-time methods. In the store and forward (asynchronous) model, patient data is obtained and sent to an audiologist or consultant for interpretation. In real time (synchronous) methods, the practitioner either conducts live video conferencing with the patient and/or takes remote control of clinical equipment at site to conduct live testing from the hospital/tertiary care centre.

Store and forward is a better option for tests that require minimal or no judgments in obtaining the clinical information at the remote end. However, test procedures often used in telepractice include automated audiometry, acoustic immittance, otoacoustic emissions, and
automated ABRs which require immediate audiological judgments (Choi, Lee, Park, Oh, & Park, 2007; Givens et al., 2003; Krumm, Huffman, Dick, & Klich, 2008; Krumm et al., 2005). For example, in acoustic immittance, the personnel at the remote end must place a probe within the external ear canal, obtain an airtight seal, record clinical data, and send the data via email. Results are analyzed at a later time by an audiologist. In our program, the synchronous method was the only option available as OAE and ABR testing for diagnostic purposes requires active judgments of the presence/absence of responses to be made by an audiologist. Also, to improve follow-up compliance, we found it was important to provide clinical judgments in real-time rather than wait for an audiologist’s decision on ABR at a later time. However, the disadvantage to real-time tele-ABR requires an audiologist to be available throughout the testing.

**Satellite versus Broadband.** Tele-audiology applications around the world often use broadband Internet for connectivity, as the average broadband Internet speed available in developed countries like the UK, USA, and Australia is 4–5 Mbps. India is ranked 114th in the world on the basis of average internet speed (0.8Mbps) and Internet penetration in rural areas is very limited. Such problems exist in many African and Middle Eastern regions as well (Belson, Leighton, & Rinklin, 2012).

For our program, use of Integrated Service Digital Network (ISDN) lines were explored as they are suitable for telemedicine due to the guaranteed bandwidth. This type of connectivity requires point-to-point connectivity between the remote site and the tertiary care hospital resulting in very high cost. For a stand-alone tele-audiology program such as ours, this option was not suitable. After surveying several locations in the villages, an NGO in the village was chosen for conducting tele-ABRs using Digital Subscriber Line (DSL) broadband Internet. With DSL, the bandwidth is shared and strength and stability of connectivity depends on distance from service provider. Due to bandwidth limitations, using video and remote computing audiology testing, and frequent problems maintaining an Internet connection, time lags in testing and lowered video quality were encountered.

Using broadband Internet at the local NGO for tele-ABR posed challenges that are associated with performing tests in spaces that are not designed for audiological testing. Stability of power supply, reduction of electrical interference, and maintenance of the noise floor (limited to less than 40dBA for ABR) are some of the challenges in rural areas. Power shutdowns of 12—14 hours are common in these rural locations, and conducting ABRs using broadband Internet was impractical during these periods. In addition, laptop batteries could not maintain a charge until all babies were tested in an 8 hour period. Finally, a lack of air conditioning or fans posed serious difficulties in facilitating the child to remain asleep.

In contrast, the advantage of using a mobile tele-van for tele-ABR was the availability of a stable IP over satellite connection even in remote rural areas with minimum bandwidth of 256Kbps. The mobile tele-van was equipped with a bed, air conditioner, chairs, power back-up, and a building video conferencing system. These amenities allowed us to conduct ABR at locations that were accessible to patients without building permanent infrastructure or identifying suitable permanent spaces with internet and power supply. A stable connection along with a dedicated videoconferencing system in tele-van provides better quality of videoconferencing.

Despite these advantages, the initial cost of the tele-van can make it cost prohibitive. While the tele-van had the advantage of stable connectivity and power supply, control of artifacts associated with electrical interference from the air conditioner and power generator were a challenge. Furthermore, the power generators emit a low frequency “hum” noise that interfered with the ABR threshold measurement at low stimulus intensity levels (30 dBNHL). In general, the dearth of availability of trained tele-technicians for establishing satellite link and the high cost of maintenance of the tele-van makes it a less chosen option for telemedicine practice.
**Logistic Factors.** Several other logistic challenges were encountered in obtaining tele-ABRs in remote villages. One of the major challenges was recording ABRs in natural sleep. Testing newborns was not difficult because the infants were often sleeping. However, testing infants and young children up to 3 years of age in natural sleep was challenging. Sedation was not given as there were no medical personnel to prescribe dosage and monitor infant status in the remote locations. ABR conducted during natural sleep resulted in a long waiting time that further restricted the number of children tested per visit.

Tele-ABR was conducted by undertaking day trips to the remote sites due to lack of safe storage for equipment and lack of parking space for the tele-van in the remote locations. Travel time to the field and time limitations in returning equipment to the tertiary care hospital restricted the duration and number of children who could be tested per visit. From a program planning perspective, these logistical challenges raised the question of the cost effectiveness of using such alternate methods.

**Conclusion**

Real-time tele-ABR in rural locations is challenging, especially in rural locations where there is no infrastructure for audiological testing. In our project we evaluated the use of a mobile tele-van with satellite connectivity and broadband internet connectivity utilizing available infrastructure. The advantages and disadvantages of these alternate methods were reviewed. By implementing systematic planning, meticulous problem solving, and intensive training, we were able to successfully test 100 babies in rural locations in India during a 15 month period.

Pearce, Ching, and Dillon (2009), suggest that working with other healthcare programs may assist in providing insights into the best practices for tele-audiology. We are using a mobile tele-van exclusively for audiological testing, but based on our preliminary results we recommend it to explore the option of providing hearing testing along with other disciplines such as physiotherapy, optometry, clinical psychology, and other allied health professionals for better cost effectiveness. Patient satisfaction and acceptance of tele-practice is another important factor for successful implementation of such projects. Parent’s perception and acceptance of tele-ABR is being studied and findings from this study will be reported in a future publication.

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Perception of ‘mothers of beneficiaries’ regarding a rural community based hearing screening service

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ABSTRACT

A rural community-based hearing screening project was established in villages in a rural district of Tamil Nadu in South India. The goal of this project was to address early detection of hearing loss among infants and young children. Village health workers (VHW) were trained to conduct hearing screenings using an Oto Acoustic Emissions (OAE) equipment. They were also trained to provide information about ear and hearing health, and to facilitate follow up visits for diagnostic testing when required.

Objectives: The purpose of this study was to review the project by examining the caregiver perception from the mothers of children who have undergone hearing screening regarding the service provided.

Methods: Focus group discussions (FGDs), were conducted in nine villages of the district to obtain information and perceptions from mothers. In all, 70 mothers with children less than 2 years of age, and 13 mothers with children greater than 2 years of age, participated in the FGDs.

Results: Responses obtained from mothers indicated that door to door health services are rare and are primarily related to sensitizing the community regarding health camps and preventive measures for widespread diseases (like dengue fever). Door to door screening for hearing among children is unique in these villages. Mothers were familiar with the NGO which coordinated the hearing screening program. Local pre-school (Balwadi) teachers were informed about the hearing screening program and its significance. From the responses of the participants it was clear that the sensitization carried out through them in all villages was successful. It was noteworthy that mothers mentioned the result of screening as “pass/refer” as instead of “pass/fail”. This outcome suggests that health workers have used appropriate terminology to convey screening results. Mothers reported test conditions to be present and therefore confirmed that valid testing was conducted by VHWs.

Conclusions: Mothers in the community accepted hearing screening services delivered by health workers. The health workers were effective in delivering the services. Pre-school teachers seemed to have played a pivotal role in communicating about the hearing screening program to the mothers. Ultimately, collaborating with local NGO facilitated acceptance and compliance due to the NGOs strong presence in the community.

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1. Introduction

Identification of congenital hearing loss is commonly conducted through an early hearing detection and identification (EHD1) program or Universal New Born Hearing Screening (UNHS) services guided by governing bodies such as Joint Committee on Infant Hearing (JCHI) and World Health Organization (WHO). UNHS has been adapted in several countries around the world. International Association of Logopedics and Phoniatrics (IALP) Audiology Committee [1] reported on worldwide status of UNHS. According to the report, UNHS is mandatory in Germany and Philippines, while in countries such as Russia, China, India, Brazil and Oman it has been incorporated in the National Plan and is due for nationwide implementation [1]. UNHS has been implemented in a hospital based model, in several countries including the U.S.A, U.K., Canada, Germany, Russia, Korea, China, Philippines, India, Brazil, Oman and Indonesia. In order to improve coverage, few countries such as U.K, Russia, China, India, Bangladesh and Nigeria, have attempted community based models of UNHS [1].
In India, 63 million people (6.3%) are reported to have significant hearing loss. Hearing loss in 2% of this group is congenital in nature or acquired in childhood. Healthcare systems in India have not been effective in all parts of the country and this inequity could also affect the effectiveness of UNHIS program. The Government of India now emphasizes district management of health programs, community participation and ownership through the National Rural Health Mission [2]. Additionally, India has developed its own protocol for secondary prevention of hearing loss and launched the National Programme for Prevention and Control of Deafness (NPPCD), in approximately 65 districts which represents 10% of India’s districts.

Consistent with NPPCD, a rural community based hearing screening project was initiated at Sri Ramachandra University in November 2011. The goal of this project was to address early detection of hearing loss in local underserved villages. In order to implement this program, village health workers were trained to conduct hearing screenings using Oto Acoustic Emissions (OAE) equipment. They were also trained to provide information about ear and hearing health, and to facilitate follow up visits for diagnostic testing when required. When children failed in OAE, telehealth technology with Auditory Brainstem Response (ABR) was used to conduct diagnostic testing in the village. This project was administered in 94 villages in Kancheepuram district of Tamilnadu, located in South India. The program was supported locally by a Non Government Organization (NGO) with more than 25 years of experience in community health and social empowerment. Local pre-school (Balwadi) teachers and Self Help Group Members (village based financial intermediary) were also involved in information dissemination about the project. Information regarding new births in the village was obtained from the Balwadi teachers. Fig. 1 shows the project model.

Training of village health workers (VHW) was for the program and was conducted over a period of two weeks. Training modules consisted of (a) an introduction to ear and hearing, (b) the need for hearing screening and (c) methods for screening hearing. All trainings were conducted by the audiologist involved in the project, in local language (Tamil), VHWs were trained to assess the appropriateness of the screening location (including acceptable noise levels) infant test preparation and step by step procedures for OAE administration and results. Additionally, VHW’s were trained to collect demographic data, identify high-risk factors for hearing loss, and provide appropriate counselling to the caregiver.

The success of a community based program is influenced by the community structure, norms and constraints. In primary health care and development, community participation, perception and opinion is important which results in enhanced program success [5]. Before the commencement of the project, FGDs were conducted in six villages to study the knowledge and beliefs on the ear and hearing health among mothers of young children in these villages [4]. Findings suggested that mothers in these villages were knowledgeable about ways to identify hearing ability and consequences of hearing loss. However, superstitions beliefs and misconceptions also existed in the community which suggested gaps in knowledge. The lessons learned from the community focus groups were used in planning the rural community based hearing screening program which was implemented in November 2011.

By March 2013, 1988 infants and young children had been screened. Care givers (mothers) had received information from village health workers (VHW) regarding ear and hearing health and misconceptions were addressed. However, little is known about how perceptions of caregivers may change over time. Consequently, the purpose of this study was to review the project by examining the caregiver perception from the mothers of infants and young children who have undergone hearing screening since November 2011.

2. Method

The Institutional Ethics Committee approved this study. Informed consent was obtained from all participants of this study.

Fig. 1. Model of community based newborn hearing screening in the villages.
2.1. Sampling

Community based hearing screening services were provided in villages of two sub-districts (an administrative sub-division) of a district in Tamil Nadu in south-east India. Four VHWs oversaw 94 villages. A sampling frame of mothers of infants and children under 2 years of age who received hearing screening in all the villages was obtained. Random sampling was conducted to select participants from two villages serviced by each VHW.

2.2. Procedure

2.2.1. Developing focus group guides

Guides were developed to conduct FGD, under the broad domains of (a) general information about community based services, (b) hearing screening process and follow up, (c) ear and hearing health information received and (d) willingness to pay. Guides were developed based on specific objectives and with input from local NGO involved in local co-ordination of the hearing screening program in the village.

2.2.2. Pilot study

An FGD manual developed by Tropical Health Program, Queensland Institute of Medical Research and Training in Tropical Disease (TDW), (WHO, 1993) served as a guideline. Pilot FGDs were carried out in two villages and comprised of 9 and 11 mothers in each group. Each FGD was supervised by two audiologists and two VHWs with prior experience in conducting FGD. The pilot was conducted to fine tune and finalize FGD guides used for data collection.

2.2.3. Conducting focus group discussion

Once pilot FGDs were revised, the next phase of the study was initiated. Specifically, VHWs informed mothers regarding the date and venue of focus group discussion. The venue selected was either balwadi or well-known households, which were easily accessible to all the participants.

The FGD team consisted of (a) a moderator (principal investigator) to initiate and guide the discussion, (b) a facilitator (audiologist) to assist the moderator in the discussion, (c) an observer intern in Bachelors in Audiology and Speech, Language Pathology) to take notes on the discussion and (d) participants to involve in the focus group discussion.

FGDs were conducted within a times frame of one week in all the sampled villages, to avoid contamination of information to other villages. Initially eight FGDs were planned (two villages from among the villages served by each the four VHWs). However, due to a limited number of participants in FGD 3, an additional FGD was conducted in the same village (FGD 9). Table 1 shows the number of participants in each FGD.

Prior to the commencement of FGD, number cards were placed in a circular fashion, to identify each participant. Two digital voice recorders (Sony recorder ICD- UX523 and Cenix VR-P2340 voice recorder) were placed in the center to ensure quality of voice recording. Each session lasted from 45 min to 1 h.

Focus group discussions started by the moderator welcoming participants, and mothers were then asked to introduce themselves giving information about their age, educational qualification, occupation and age of children. The study purpose and significance of participant’s contribution was explained. Equal opportunity was given for all participants to express their views. In order to avoid bias in responses, VHWs were not present in the FGD sessions.

2.2.4. Data analysis

The recorded sample was transcribed and typed in Tamil using Bamini word font. The observer notes were used as a reference to clarify translation questions about the recorded sample. Tamil transcriptions were verified by another audiologist, to ensure that there was no loss of information. Thematic analysis was done using grid tables. In addition, verbatim transcripts of few participants were extracted in each theme for better understanding of the response.

3. Results

Operational definition: The term ‘hearing test’ has been used to refer to OAE screening as mothers used this term in Tamil during FGD.

Findings from the focus groups conducted in nine villages are reported in descriptive summary method under the broad domains stated in the method section. Though mothers of children less than 2 years were invited to participate in the discussions, a few mothers having older children in the same neighbourhood presented interest in participating, and these mothers were also included. All mothers, however, fulfilled the remaining inclusion criteria. The responses from these mothers were included in the data.

In all, 70 mothers of children less than 2 years of age and 13 mothers of children greater than 2 years of age participated in the FGD. Table 2 summarizes the background information of participants.

Eighty five percentage of mothers were under the age of 30 years, 98% were house wives. All mothers had some level of education with 56% having completed at least 5th grade.

3.1. General information about community services

Information about health care programs in the community was obtained to understand current programs, government and NGO

<p>| Table 1 | Distribution of FGDs and number of participants. |
|---|---|---|</p>
<table>
<thead>
<tr>
<th>FGDs</th>
<th>Village</th>
<th>No. of participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Vellipuram</td>
<td>Thirukkalukundram</td>
</tr>
<tr>
<td>2</td>
<td>Pandur</td>
<td>Thirukkalukundram</td>
</tr>
<tr>
<td>3</td>
<td>Mulikolathur</td>
<td>Thirukkalukundram</td>
</tr>
<tr>
<td>4</td>
<td>Karumarapakkam</td>
<td>Thirukkalukundram</td>
</tr>
<tr>
<td>5</td>
<td>Poondur</td>
<td>Madhuranthangam</td>
</tr>
<tr>
<td>6</td>
<td>Padalam</td>
<td>Madhuranthangam</td>
</tr>
<tr>
<td>7</td>
<td>Kallapiapuram</td>
<td>Madhuranthangam</td>
</tr>
<tr>
<td>8</td>
<td>Keechavalam</td>
<td>Madhuranthangam</td>
</tr>
<tr>
<td>9</td>
<td>Padalam-1</td>
<td>Madhuranthangam</td>
</tr>
<tr>
<td>Total</td>
<td>9</td>
<td>2</td>
</tr>
</tbody>
</table>

| Table 2 | Characteristics of the participants of the study. |
|---|---|---|
| Characteristics | No. of participants |
| Age of mothers |  |
| 18-30 years | 71 |
| 31-40 years | 12 |
| Age of children |  |
| <2 years | 70 |
| >2 years | 13 |
| Education |  |
| >1st grade and ≤5th grade | 45 |
| ≤10th grade | 28 |
| ≤12th grade | 08 |
| Under graduate | 02 |
| Occupation |  |
| House wife | 81 |
| Self employed | 02 |
presence in the community and penetration of such programs including the hearing screening program.

3.1.1. Health care programs in the community

When asked, if there were any health care programs conducted in their village, 20 mothers mentioned about availability of testing for diabetes, blood pressure, blood test, urine test, midwifery services in the village. Nine mothers mentioned that such testing is available through village nurses at the Primary Health Center. Eleven mothers reported (and 72 mothers agreed) that counseling regarding hygiene, nutrition and health related issues of children were provided through village nurses at primary health center.

When asked specifically about community based programs or door to door programs at their villages, 11 mothers reported that cancer awareness programs were conducted by college students from Chennai (nearby metro city). Eight mothers mentioned that they received counseling regarding prevention of dengue fever from village nurses at their homes. Five mothers informed that breast and uterine cancer screening was conducted by the local NGO for married women between 18 and 40 years of age.

More than 10 mothers reported that free eye checkup for older individuals was conducted and, eyeglasses were distributed through camps by private trusts and hospitals. Those who required surgery were referred to hospital for further treatment. Information about such camps was announced through mobile vans or autos with public address systems.

Three mothers acknowledged that a recent hearing “checkup” was conducted by VHWs from Sri Ramachandra Hospital for the first time.

3.1.2. Information about community based hearing screening

All participants, except those from FGD 6, reported that they had been informed about the hearing testing services through Balwadi teachers. These teachers had organized a meeting with the mothers at Balwadi (pre-school) center, where the VHW briefed them about the program. One mother reported that any program or event in the village is known to them primarily through balwadi teachers.

In one FGD (No. 6), mothers (two reported and eight agreed) informed that they knew about the hearing testing through VHW, and who self-introduced themselves, by coming from their village.

3.2. Hearing screening process and follow up

Information about OAE screening conducted by VHW was obtained. This was to assess if screening was appropriately conducted and if adequate information was provided as per protocol.

3.2.1. Procedure of hearing screening

Twenty two mothers reported that a “machine” (OAE Screener) was used for testing. One mother mentioned that she was informed by VHW that the “machine” will assess the external ear, middle ear and inner ear. Three mothers had made specific observations about the test, such as: “there is an arrow in the machine that moves up and down”, “there were numbers 2000, 3000, 4000”, “Pass and refer was shown in the machine”. Participants also added information about some of the factors that could affect testing. Mothers (15 reported and 68 agreed) mentioned that if there is background noise, test results will get affected. The other pre-requisite mentioned by seven mothers (25 reported and 58 agreed) was that, the child had to be asleep before testing.

Diagnostic follow up was conducted using real-time tele-ABR testing with the assistance of technicians and VHW. This method is described in a separate paper title [5]. Specific instance showed apprehension of a mother, whose child was referred for diagnostic ABR testing. She was worried that the ABR test may involve “electric shock”, however, she was comfortable after “madam” (audiologist on video conferencing) counseled her about the testing and confirmed that there was no electric shock involved.

One mother who had concerns regarding her child’s hearing even prior to hearing screening by VHW, explained that for her child, the result was “pass” in right and “refer” in left ear in both 1st and 2nd screening. She reported that she was counseled to bring her child for detailed testing (tele-ABR) to a nearby village, where a “madam” (audiologist) tested the child and counseled through television (video conferencing) that the child’s hearing was normal. She was also explained that the “refer” was possibly due to wax in the ear, which was noted by the audiologist through videoconferencing when the insert tips were clogged with ear wax.

3.2.2. Time taken for screening

Thirteen mothers having children greater than 2 years of age reported that it took 1 h 30 min for the hearing test. Eleven mothers having children less than 2 years of age reported testing time to be 30 min. Mothers agreed that on average, the test time varied between 30 min and 2 h. According to the mothers (30 reported and 53 agreed), one or two visits were needed to complete testing. They reported that testing was repeated due to the presence of background noise (environmental sounds such as a nearby outdoor loudspeaker, crow crowing and dogs barking) in the village. All participants reported that the VHW returned on another day if the child was awake and crying.

When asked if they were able to spend time for the hearing test, mothers (37 reported and 46 agreed) informed that they were able to spend time for the testing as they considered hearing testing to be very important for the child. One mother suggested that if prior information is given regarding date and time of testing, it would have been useful to prepare and spend time for the testing.

3.2.3. VHW conducting hearing screening

Fifty one participants welcomed the hearing testing facility provided through VHW as they felt it was something (in their own words) ‘new’, ‘available at no cost’ and ‘is very important for the child’. When asked if they had any reluctance in allowing an unknown person (VHW) to enter their homes and allow their babies to be tested, 22 mothers reported that they were “comfortable” as they were familiar with VHW who had conducted other programs for the local NGO. One mother reported that she asked the details of VHW before allowing her to enter the house. One mother reported that the VHW provided adequate information about the testing process and therefore, they could trust them and comply for testing. Two mothers reported that they had initial hesitation and did not comply for the test, but after observing VHW performing the test for other children they allowed their children to be tested.

3.3. Ear and hearing health information received

3.3.1. Information obtained from mothers during hearing screening by village health workers

Thirty two mothers mentioned that questions were asked regarding the child’s weight at the time of birth, normal or caesarean delivery, preterm or full term, family history of hearing loss, consanguinity, ICU admission, presence of jaundice, dirt in ear, ear injury and infection to mother (during pregnancy), history of foreign body in the ear and exposure of loud noise.

3.3.2. Information given by VHW after hearing testing

Of the 83 mothers, 76 mothers reported that this was the first time they received information about ear and hearing care and hygiene. Nineteen mothers mentioned that information was provided about ear hygiene. Specifically they had been advised
to avoid the use of instruments such as stick, safety pin, hair pin, to clean ears and pouring water and hot oil in the ear. Knowledge about the consequences of childhood hearing loss, (such as delay in development of speech, education and social life) was reported by two mothers. One mother had suspected hearing loss in her child and had taken the child to the local doctor, and the other mother’s son had confirmed hearing loss.

All mothers reported that VHW explained the results after completion of the testing. One mother elaborated that if ‘pass’ appears it is “normal”, but if ‘refer’ appears then the testing should be repeated.

3.4. Willingness to pay

Since most of the services provided at the village were at no cost, mothers were asked if they would be willing to pay for hearing testing. They were explained that the hearing test would cost them Rupees 400 – 500. Seventy three participants expressed their willingness to spend money for hearing testing. When asked to specify the charges that they would readily pay for this service, 32 mothers reported that salary in the rural area is very minimum and there are no jobs. Twenty two mothers opined that if the test is conducted at half the price of hospital charge it will be affordable to them. Twenty mothers reported that they can spend around Rs.500, five mothers reported they can spend only less than Rs. 100.

4. Discussion

4.1. General information about community services

Door side services are rare and are primarily related to sensitizing the community regarding health camps and preventative measures for widespread diseases (like dengue fever). Screening for vision (cataract) and cancer were mentioned at the community, however these are also delivered at the local health center or hospital. Door to door screening for hearing among children is evidently unique in these villages.

The National Population Policy (NPP, 2000), National Health policy (NHP, 2002), and National Rural Health Mission (NRHM, 2005) have all indicated that there should be greater involvement of NGOs in the implementation of different health and family welfare programs in the country. Specifically, NRHM promotes coordinating with local NGOs to improve health service in blocks as a part of program monitoring and planning [6]. NGO collaborated for this program, being involved in the community for over 25 years in the area of women and childcare programs, was familiar to people of the village. Therefore, the decision to liaison with this NGO seems appropriate.

During program planning, it was decided that VHWs will conduct meetings with balwadi teachers,1 and Self Help Groups (SHG)2 to sensitize the community about the hearing screening program. This was planned in order to familiarize the community prior to screening, for better compliance and coverage. From the responses of the participants it is clear that the sensitization carried out through balwadi teachers had been successful. All mothers acknowledged the balwadi teacher to be an important source of information dissemination to the community. While SHG groups were also tapped for information dissemination about the hearing screening program, this group does not seem to have played a role in reaching the message to the community, as no mother reported knowing about the program through members of SHG. There are two possibilities, either the VHW did not conduct effective meetings with SHG, or SHG being a more finance oriented group may not be enthusiastic participant in health related programs.

4.2. Hearing screening process and follow-up

Many parents were observant about testing and gathered significant details about the test such as, frequencies tested, results of screening and validated the training conducted for VHW. It is noteworthy that mothers mentioned result of screening as “pass/ refer” (in contrast to “pass/fail”) as this terminology is meant to reduce caretaker anxiety. The use of appropriate terminology for screening result was emphasized during VHW training and this information had been appropriately conveyed. A mother’s report of OAE “machine” testing external, middle and inner ear, raises concern about information given by VHW regarding OAE testing. However, this was not reported by any other mother in any FGD and therefore, was not probed further. The mothers report of pre-requisites for effective testing such as ‘less noisy environment’ and ‘sleep state of child’ indicates that VHW had followed the guidelines for OAE screening in the community.

Mothes reported that testing time varied from 30 min to 2 h. This is a very broad range and is relatively longer, to the time taken for OAE screening in the hospital by an audiologist. In a community based UNHS program carried out by health visitors in UK on a door to door basis and in community clinics, the median time taken by health visitors to test the baby is reported to be only 12.2 min, however the mean age of babies tested was less than 1½ months of age [8]. It is noteworthy that shorter time (30 min) was reported by mothers having children less than 2 years of age and more time (1½ h) was reported by mothers having children greater than 2 years of age. In a community based NHS conducted in primary health care centers only infants aged less than three months were included in the test to avoid increased difficulty of testing in older children [9]. In another community based screening effort in Bangladesh, researchers reported that physiological testing is feasible with children aged between 0 and 5 years, however, it was not effective in many children due to the presence of excessive wax [10]. While ear wax was not reported as a common deterrent to testing, the increase in time taken for testing can be attributed to, older age group of children who are non-compliant for testing and younger children who were not sleeping. It also appears that noise in the community extends testing time. This is predictable as it is an inherent shortcoming in conducting OAE screening door to door. While the testing time seems to be long, it can be inferred that VHW attempted several times to complete test by giving breaks and repeating and ensuring good testing environment.

In general, mothers in the community seemed to accept hearing screening delivered by VHW. This compliance could be attributed to the familiarity of VHW through NGO, testing at no cost and the convenience of testing in caregiver’s homes. It should also be noted that 98% of the mothers, were home makers and were possibly available all day. Further, community involvement also seems to have influenced compliance.

4.3. Ear and hearing health information received

Accredited Social Health Activist (ASHA) instituted by the Government of India, through NRHM, have been trained in rural

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1 A pre-school teacher in an early education center run by government or not for profit organizations, is referred to as a “Balwadi teacher” in India. The role of a rural Balwadi teacher is different from the role of a teacher in urban setting. The Balwadi teacher constitutes an important source of information to the rural community and can play a role in transforming values at this level [7].

2 A Self Help Group (SHG) is a village-based financial intermediary usually composed of a small group of local women or men. Each member of the group contributes funds to a common pool. Once a capital is built they begin to lend money for local business in the village. SHG's are linked to banks for the delivery of micro-finance (small loans for people with no credit history typically in rural areas), once they build credibility in fund management as a group.
communities to provide information to the community on determinants of health such as nutrition, basic sanitation and hygienic practices, healthy living conditions and information on existing health services in order to promote better utilization of services available in the community. In line with such efforts, in this community based hearing screening program, VHWs were trained to provide ear care related information in the community.

Since several mothers were able to recollect information regarding high risk factors, ear hygiene, that had been disseminated, it may be speculated that the program has had some success in sensitizing these mothers. While health talks in the community, using media, use of billboards and posters, pamphlets have been recommended for creating awareness regarding ear and hearing care [11], communities may be effectively sensitized by information provided by health workers during hearing screening.

4.4. Willingness to pay

The findings of a community-based program in Tainan city of Taiwan suggest that the newborn hearing screening program with a pay-for-test model is feasible and was supported by parents. Therefore, UNHF programs may be operated without the government’s financial support [12]. However, Tainan study was conducted in the city at community hospitals.

The present community based hearing screening program was delivered at no cost. In order to assess the likelihood of sustaining the program using “pay for test” model, mothers were asked about their willingness to pay. While there is no guarantee, when a “pay-for-test” model is implemented in these villages, it appears to be acceptable to mothers, who reported the willingness to pay between Rs. 100and 500. However, it is notable that several mothers did not comment on payment and indicated that there are no jobs in their village.

5. Conclusions

In essence, the community based hearing screening model has worked and has implications for other emerging countries where healthcare is not easily accessible. Furthermore, the model demonstrates the value of providing hearing health care in a culturally appropriate manner. In this project, trusted leaders of the community, the VHW and Balwadi teachers played an important role for better coverage. Acceptance of hearing testing program through VHW also seems to be influenced by the role of a credible NGO in the project.

This study also brings out some of the challenges of a door-to-door hearing screening, such as prolonged testing time. Noisy environment and children not sleeping during OAE screening (as they are older) interfered with time taken for OAE screening considerably. It maybe worthwhile to device strategies to overcome such challenges. In addition, through this project, hearing screening was conducted at no cost, however, for a program to be self sustaining, a pay-for-test model should be considered. Information obtained from these FGDs may be valuable in identifying barriers and strengths of the program. This could be further used to modify approaches/strategies to improve service delivery and facilitate greater compliance from the community in achieving the goals of early identification and early intervention of hearing loss.

6. Limitations of the study

Measures such as random selection of village, ensuring non-participation of VHW in FGD, were taken to avoid bias in responses. However, information about the venue and date of FGD was informed to the mothers by the VHW and on the day of FGD, VHW intimated mothers to assemble at the venue. Since there was some contact between the VHW and the participants of FGD, some influence of VHW on the mother’s responses cannot be ruled out. The overall positive feedback may have also been influenced by the availability of hearing screening services at the door step at no cost to the beneficiary.

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Conflict of interest

The authors declare no conflict of interest

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References

Knowledge and Beliefs about Ear and Hearing Health Among Mothers of Young Children in a Rural Community in South India

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ABSTRACT

Purpose: To study the knowledge and beliefs about ear and hearing healthcare among mothers from a rural community.

Method: In 1 week, 6 focus group discussions were conducted across 6 villages of a district in Tamil Nadu in southern India. The participants were 60 mothers who had children below 5 years of age.

Results: Mothers in this rural community had information about some aspects of ear and hearing healthcare. They were aware that use of hairpins and safety-pins to clean ears was harmful; they were knowledgeable about ways to identify hearing ability (child responds to name call, verbal instructions, and startles at loud sounds); and, conditions like consanguinity and malnutrition of expectant mothers were recognised as risk factors for hearing loss. However, misconceptions also existed. The practice of pouring herbal juices to remove insects in the ear continued; there was the perception that all children with a hearing problem were “deaf”, and a lack of awareness about the possibility of partial/unilateral hearing loss. Regarding the age of identification, mothers believed that a child’s ability to speak and the ability to hear was pertinent to assess hearing. None of the mothers related normal speech development to normal hearing.

Conclusion: For the success of a community-based hearing screening programme, it is important to utilise the existing knowledge of the mothers, and simultaneously attempt to fill in gaps in knowledge and clarify misconceptions. These measures will facilitate greater compliance from the community in

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achieving the goals of early identification and early intervention for problems of hearing loss.

**Key words:** rural community, knowledge and belief, ear and hearing

**INTRODUCTION**

Poverty, ignorance, poor hygiene, inadequate medical guidance, and customs and beliefs based on tradition and culture are reported to be reasons for poor health awareness (Kumar, 1997). Having appropriate health-related information ensures that people are better equipped to access services (WHO, 2010). Hence, lack of health awareness results in poor primary and secondary prevention of diseases or health conditions. This lack of awareness also extends to the area of ear and hearing healthcare. Attempts have been made to create awareness about hearing loss and ear care through information, education and communication strategies using health personnel and grassroot workers using local, culture-specific innovative strategies (Garg et al, 2009).

With the aim of preventing avoidable hearing loss (primary prevention), early identification and treatment of ear problems, and rehabilitation of persons with hearing impairment, the Government of India initiated the National Programme for Prevention and Control of Deafness (NPPCD) and integrated it with National Rural Health Mission (NRHM) at the state and district levels. In line with such efforts, the Department of Speech, Language and Hearing Sciences at Sri Ramachandra University proposed a rural community-based hearing screening programme for infants and young children, with the focus on newborns, in Thirukazhukunram and Madhurantagam blocks of Kancheepuram district in Tamil Nadu in southern India. During this programme, trained Village Health Workers (VHWs) conducted hearing screening using Oto Acoustic Emission equipment on a door-to-door basis in the villages. For those children advised to be ‘referred’ after screening, telehealth technology with Auditory Brainstem Responses was used to conduct diagnostic testing.

The key to the success of a community-based programme lies in the developmental spirit of ‘fact-finding’ and ‘learning lessons for improvement’ from the grass root (Garg & Laskar, 2010). Although measures have been initiated to improve ear and hearing care at the community level, the goals will be achieved only when programmes implemented at the grassroot level relate to the region, community, or even the family. For example, Scheppers et al (2006) who reviewed studies on
ethnic minorities conducted in different countries, reported low use of screening health services among them due to lack of awareness. Strong local beliefs and traditional health practices in the community, such as “health problems are caused by natural and supernatural causes” or “a result of the act of God”, deter people from availing healthcare services (Scheppers et al, 2006). Studies in South Africa by various researchers such as Olusanya (2000), de Andrade and Ross (2005) and Swanepoel and Almec (2008), note that poor public awareness regarding childhood disabilities is often aggravated by superstitious customs and beliefs. Lack of knowledge among programme planners about these local customs and beliefs can impact the use of healthcare services in the community.

The purpose of the present study was to gain insight into the knowledge and beliefs of the community regarding ear and hearing. Specifically, the researchers wanted to find out whether the community was aware that hearing could be tested/screened as early as at birth; when they first suspected hearing loss and whether they knew the consequences of unidentified and untreated hearing loss; also, whether there were any culture-based beliefs that deterred the community from availing screening services.

It was considered necessary to obtain this information prior to the initiation of the rural community-based hearing screening programme in order to incorporate appropriate messages for the VHWs to convey: a) during sensitisation programmes carried out before screening, and b) after screening, as a part of the counselling for parents /caregivers. Such measures are expected to improve compliance for availing of the hearing screening service in the village. The mothers were the target group to obtain this information, as they represent the specific population for whom the screening programme is designed. Compliance for hearing screening has been reported to increase when the mothers were educated on infant hearing loss and its consequences (Francozo et al, 2007).

This study was approved by the Institutional Ethics Committee. Participants were included after obtaining their informed consent.

**METHOD**

**Location**

The study was conducted in 6 randomly sampled villages from Thirukazhukunram and Madurantagam, 2 blocks of Kancheepuram district in Tamil
Nadu, India. Kancheepuram district is located on the northern East Coast of Tamil Nadu. The population of Thirukazhukunram and Madurantagam is approximately 39,000 and 41,000 respectively.

Participants
The 60 women participants included mothers of children between 0-5 years of age who were residents of the rural area under study. None of them had family members with congenital hearing loss. The average age of the mothers was 28.73 years (SD= 5.12) and 73% had children under 2 years of age. All the mothers were fluent in Tamil, the local language. All of them had some level of education, but only 4% had completed an undergraduate Degree. The annual income of 93% of these mothers was less than Rs. 20,000.

Developing Focus Group Guides
To facilitate the focus group sessions and lead the discussions, the investigator developed guides in Tamil. Literature reviews were conducted, using databases such as Medline, Pubmed, and EBSCO, employing the key words ‘parent and caregiver’, ‘knowledge and belief’, and ‘ear and hearing healthcare’. Literature search was conducted in the areas of: i) ear care, ii) assessment of hearing ability, iii) risk factors for hearing loss, iv) consequences of hearing loss, and v) professionals and services for persons with hearing loss. Expert opinions of people working in the area of hearing healthcare and the inputs of VHWs working in the area of community health were also included while developing the guides. Two pilot studies were conducted to assess appropriateness of the guides in promoting participation and discussion.

Based on the pilot studies, minor changes were incorporated and a final set of guides to lead the FGDs was developed. Guides used under each heading are provided in Appendix I. They have been translated from Tamil to English for the purpose of this publication.

Execution of Focus Group Sessions
FGDs were conducted with the assistance of the VHWs, who identified the venue for the sessions and communicated information about the time and place to the participants. FGDs were conducted at a residence accessible to all the participants. Each FGD included: 1) participants, 2) principal moderator (audiologist) to
initiate and guide the discussion, 3) facilitator (VHW) to assist the moderator in the discussion, and 4) observer (VHW) to take notes. Each session was audio-recorded using 2 digital voice recorders (Sony IC recorder ICD-UX70 and Cenix VR-P2340 voice recorder). The duration of each session ranged from 45 minutes to one hour.

Data Analysis
The recorded data was analysed and written transcriptions were developed. The observer’s notes were referred to for clarifications. The transcriptions were verified by another audiologist (co-investigator). The transcribed data was reviewed to identify 3 themes: correct knowledge, gaps in knowledge and misconceptions. Themes were analysed under the broad areas of: 1) ear care, 2) identification of hearing status in children, 3) age at which hearing can be assessed, 4) risk factors for hearing loss, 5) consequences of hearing loss, and 6) professionals and services available for children with hearing impairment. Both word coding and thematic analysis were done. Thematic analysis carried out by the principal investigator was verified by both co-investigators. The responses are reported using the descriptive summary method. To understand the responses better, verbatim transcripts of a few participants are quoted as examples.

RESULTS
Results are reported according to the broad areas under which FGDs were conducted. Quantifiers used to describe the results are: ‘All’ for 100%, ‘Majority’ for more than 50%, ‘Many’ for more than 20% but less than or equal to 50%, ‘Some’ for more than 10% but less than or equal to 20%, and ‘Few’ for less than or equal to 10%.

1. Ear Care
All the mothers believed that ears should be kept clean. Many used either ear buds or cloth to clean ears. They were aware that foreign objects (insects, sticks, grains) could enter the child’s ear and had approached medical professionals for help in such cases. Some reported that insects were removed using traditional home remedies such as pouring warm water, saline water, and herbal juice into the ear.
“If there is any dirt inside the ears, we don’t put anything else because it might damage the ears. So we take it out using ear buds” (FGD 5 - participant 8).

“Sometimes we pour salt water inside the ear. If there is any insect gone inside, that is how we take it. Otherwise we take the child to the doctor” (FGD 4 - participant 6).

2. Identification of Hearing Status of Children

The majority reported that they were certain that the child could hear when he/she responds to name call. A few mothers stated that if a child demonstrates comprehension when spoken to, or if the child is startled or responds to loud sounds, then it is certain that the child can hear. One mother reported that the child’s ability to localise sound is an indication that the child hears. On further probing regarding levels of hearing loss and its manifestation, the general consensus of the groups was that all children with hearing problems are “deaf” or have “no hearing”. The possibility of children having partial and/or unilateral hearing loss was not recognised.

“If the child turns towards us when we call, then we understand that the child can hear” (FGD1- participant 2).

“If any vessel is dropped, when we switch on the television or radio, or if there is a loud noise, then the child cries. With that we can understand that the child hears well” (FGD1- participant 7).

“The child comes to you on hearing your call. Likewise, if somebody else calls they will move towards them” (FGD 6- participant 3).

3. Age at which Hearing can be Assessed

Mothers had varying opinions regarding the age at which hearing could be assessed. The majority believed that since babies sleep a lot in the first 3 months of life, it is not possible to ascertain whether they can hear. Some believed that only at 1 year of age would it be possible to ascertain that the child could hear, since there would be response to commands and soft sounds. A few mothers reported that hearing ability could be identified at birth using informal methods, and they offered their observations with their own children as evidence.

“As soon as the child is born, the child is not able to see around. It takes about 1 to 1.5 months for the child to look at you and smile and to turn for even soft sounds. I
just wanted to say that we do not know anything about its hearing ability as soon as the child is born. In fact, the child is able to hear even when it is in the womb of the mother before birth. It cannot open its eyes to see whether we talk or not. It is difficult to even lift the child as soon as it is born. We do not know whether the child is hearing at that time or not. It takes a month or two, for the child to turn or cry on hearing even soft sounds” (FGD 4 - participant 3).

“We can perceive the child’s (hearing) ability only after he /she starts growing At birth, the child has the ability (to hear) but we do not get to know it” (FGD4 - participant 6).

“I got to know (about child’s hearing) at birth itself. The child will stop crying on listening to voice. When the nurses come and go inside the room, the child starts crying on hearing the sound of the doors when shut. With that I could confirm the hearing ability” (FGD 5- participant 8).

4. Prenatal, Perinatal and Postnatal risk factors for Hearing Loss

To gain insight into the mothers’ knowledge about risk factors for hearing loss, “word coding” of the transcribed conversation was carried out. Most common risk factors reported were consanguinity (which was mentioned 7 times) followed by malnutrition of expectant mothers (which was mentioned 6 times).

“If we marry within blood relations, such things (hearing loss) occur” (FGD 2-participant 5).

A few mothers reported that they were not aware of the risk factors leading to hearing loss. Figure 1 shows the risk factors for hearing loss as reported. Knowledge about consanguinity and maternal malnutrition during pregnancy was high and it was thought that these could cause even other types of disability.

Beliefs such as expectant mothers doing work during the solar eclipse, leading to congenital malformation of the ear, lip or face, were reported. In order to prevent disability such as hearing loss in unborn children, participants reported that pregnant women were not allowed to strain boiled rice or go out of the house during the solar eclipse.

“If a child is born on an eclipse day, it might be born with its head and ear tilted. Even lips will be raised (referring to cleft lip and palate)” (FGD 6 - participant 1).
"When you filter the boiled water when cooking rice, (pregnant women) should not cover it with lid. If you do that, you will get children born with closed ears or mouth" (FGD 4- participant 10).

Other prenatal risk factors for hearing loss such as maternal infections and iodine deficiency were not reported. Perinatal risk factors such as low birthweight, hypoxia, jaundice, infections, and ototoxicity of hearing loss, and postnatal factors such as otitis media, measles and mumps, were not mentioned. A few mothers believed that ear discharge when treated with ear drops resolved the condition and therefore was not a risk factor for hearing loss.

Figure 1: Reported Causes of Hearing Loss by Mothers

5. Consequences of Hearing Loss

Majority of the mothers were aware of the consequences of hearing loss for a child. They reported that the child with hearing loss would have difficulty in learning, understanding verbal instructions, and leading an independent life. A few mothers reported problems with verbal expression, and psychological problems such as being aloof, low confidence levels and frustration.

"Even if you try to teach the child, the child is not going to hear" (FGD1- participant 8).
“It is a matter of great difficulty when you take the child out. The child is not going to hear when the bus conductor is asking for something while issuing the ticket. One must touch the child” (FGD 3 - participant 8).

“The child’s mental health will be very much impaired. The child will find it very difficult to play with other children” (FGD 4 - participant 6).

“The child will feel inferior when compared with other children” (FGD 5 - participant 2).

6. Professionals and Services for Children with Hearing Impairment

The general opinion among mothers was that a paediatrician should be approached for any medical problem concerning children, including ailments related to hearing. However, few were aware that Ear, Nose and Throat (ENT) specialists were medical professionals for ear treatment. None were aware of audiologists and their role in ear and hearing healthcare.

It was evident that the majority of mothers were aware that hearing aids could be fitted for children with hearing impairment. Consensus of the group was that hearing aids were fitted only after 1 year of age. They believed that once a child was equipped with a hearing aid, he/she could hear normally and therefore could go to regular school. No mother reported the need for rehabilitation or intervention after fitting the hearing aid.

Only a few of the mothers were aware of the availability of special schools. One mother reported surgery or cochlear implantation as a treatment option for hearing impairment. However, another mother contradicted her and said that surgeries were meant for adults and not for children. A few mothers reported the availability of government allowances for children with hearing impairment. One mother reported that there are facilities and allowances for people with disabilities but none were available for individuals with hearing impairment.

“There are allowances for people with disability but none of them are bothered about people with hearing impairment” (FGD 3 - participant 8).

Table 1 summarises the participants’ correct knowledge, inferred gaps in knowledge and misconceptions about ear and hearing healthcare.
### Table 1: Summary of Mothers’ Knowledge and Beliefs regarding Ear and Hearing Healthcare

<table>
<thead>
<tr>
<th>Area</th>
<th>Correct knowledge</th>
<th>Inferred gaps in knowledge</th>
<th>Misconceptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ear care</td>
<td>Use of instruments (such as hairpin, safety pin, key, stick, etc) will harm the child’s ear.</td>
<td>Ear buds should be avoided for cleaning ears.</td>
<td>Practices like pouring herbal juices for removal of insects in ear.</td>
</tr>
<tr>
<td>Methods to identify normal hearing in children</td>
<td>Response to name call, understanding verbal instructions, startles at loud sounds.</td>
<td>Normal speech development in children is an indicator for normal hearing.</td>
<td>–</td>
</tr>
<tr>
<td>Age of identification of hearing ability</td>
<td>–</td>
<td>Hearing ability can be ascertained at birth.</td>
<td>–</td>
</tr>
<tr>
<td>Causes of hearing loss</td>
<td>Following conditions lead to hearing loss: Consanguinity, malnutrition of expectant mothers, ear wax, and ear trauma.</td>
<td>Causes of hearing loss such as <strong>Prenatal causes:</strong> Infections to expectant mothers. <strong>Perinatal causes:</strong> Low birthweight, hypoxia, jaundice, infections, ototoxicity. <strong>Postnatal causes:</strong> Otitis externa, chronic otitis media, measles, mumps, ototoxicity, noise exposure</td>
<td>Ear discharge is a condition to be treated but not a cause of hearing loss. Pregnant women doing work at home or outside during pregnancy can cause malformations of the ear.</td>
</tr>
<tr>
<td>Consequences of hearing loss</td>
<td>Children with hearing loss have difficulty in understanding verbal instructions, in pursuing education and leading an independent life.</td>
<td>Hearing loss could affect speech development.</td>
<td>–</td>
</tr>
<tr>
<td>Area</td>
<td>Correct knowledge</td>
<td>Inferred gaps in knowledge</td>
<td>Misconceptions</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>-----------------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Procedures for hearing testing</td>
<td>–</td>
<td>Hearing can be tested at birth.</td>
<td>Hearing can be tested only when the child starts speaking.</td>
</tr>
<tr>
<td></td>
<td>Test procedures are available for hearing testing.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ear and hearing healthcare</td>
<td>E.N.T specialists as professionals for ear and hearing healthcare.</td>
<td>There are professionals (Audiologists) who are involved in hearing evaluation and rehabilitation.</td>
<td></td>
</tr>
<tr>
<td>professionals</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Services for persons with hearing loss</td>
<td>Appliances such as hearing aids can be used for hearing loss.</td>
<td>Allowances/concessions are available for children with hearing impairment.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Special schools are education options for children with hearing impairment.</td>
<td>Child with hearing loss needs training in hearing.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hearing aids can be fitted at less than one year of age.</td>
<td></td>
</tr>
</tbody>
</table>

**DISCUSSION**

From the discussion on ear care, it is inferred that mothers were aware that cleaning a child’s ear with instruments (such as a safety pin, key or stick) would cause damage. However, the use of herbal juice and oil to remove insects from the ear seems to be a common practice. Practices like pouring mother’s milk, neem or garlic oil into the ear, and going to tantric and faith healers for ear diseases have been reported even in an urban community in North India (Gupta et al,
In a rural South Indian community, high prevalence of otitis media was attributed to earache being disregarded (26.4%) or treated with home remedies (67.2%) by most caregivers, while a doctor's opinion was often sought for ear discharge (50%) (Srikanth et al, 2009). Such misconceptions seem to exist in both rural and urban areas, emphasising the need for health education regarding ear care in general.

Regarding identification of hearing status, majority of the mothers mentioned “response to name call” as an indication of normal hearing; however, none directly reported the achievement of normal speech milestones as being related to normal hearing. Similar findings were reported in a questionnaire-based study conducted in rural West Bengal. The authors reported that suspicion of hearing loss was aroused mostly by “no response to name call” (65.6%), followed by “no response to clap” (13.4%), and only 10% reported “lack of speech development” (Rout & Singh, 2010). This would suggest that since delay in a child’s speech development may not arouse suspicion, it could lead to delayed identification of hearing loss. Hearing loss in children was associated with “deafness” and it is possible that mothers therefore missed the subtle symptoms of partial or unilateral hearing loss in speech. This may have also influenced their beliefs regarding the consequences of hearing loss, as difficulty in leading independent lives, psychological problems and educational difficulties were reported. Studies have shown that parental concern was low regarding detection of minimal or mild hearing loss in their child (Cone et al, 2010). It is imperative that hearing screening programmes for infants and young children focus on identification of mild to moderate hearing loss. Information, education and communication to parents and caregivers should reinforce the possibility of partial and / or unilateral hearing loss in children, and highlight milestones of hearing and speech development.

In this study, the responses of mothers regarding age of hearing testing suggests that there is a misconception that normal hearing ability can be ascertained only when the child can voluntarily respond (e.g. localisation, saying “I can hear”, or by comprehending verbal instructions). The belief that hearing ability can be ascertained only when the child is older, could be detrimental to early identification and intervention. It is important to educate the community about objective hearing testing methods that can be carried out even at birth, so that there is a change in attitude. In a study done in rural West Bengal in India, Rout et al (2010) reported that though children’s caregivers first suspected hearing loss
at the mean age of 1.5 years, the first visit to the doctor was at a mean age of 2.4 years and consultation with an audiologist was at a mean age of 9.3 years. Hence, information about early diagnosis and early intervention should be provided to the community.

Majority of the mothers acknowledged consanguinity as a prenatal risk factor for hearing loss; however, awareness about peri- and postnatal factors was limited. A study in a tertiary care hospital in an urban city of South India, shows a similar high rate of awareness regarding consanguinity (64.1%) as a risk factor for hearing loss, followed by noise exposure (61.2%), ear discharge (57.3%), and family history (53.4%) (Revathy et al, 2014). Among Nigerian and South African mothers, poor awareness regarding medications, asphyxia, jaundice, measles and preterm/low birthweight as a risk factor for hearing loss has been reported (Olusanya et al, 2006). The findings of this study and review of literature suggests that this lack of knowledge exists in developing countries, and therefore should be addressed in all public awareness programmes on ear and hearing health.

In a study among residents of an urban locality in New Delhi, awareness about preventable causes of deafness such as ear infections, trauma and any infection during pregnancy has been reported (Gupta et al, 2010). However, they were unaware that being hit on the ears, excessive use of headphones to listen to loud music and indiscriminate use of ear buds could be harmful. In contrast, among mothers in this rural community there was a lack of awareness regarding preventable causes. The difference could be attributed to better health-related awareness in cities. Also, superstitious beliefs did exist about risk factors for hearing loss and other disabilities, such as the ill effect of solar eclipses and pregnant women carrying out certain household chores. Similar superstitious beliefs were also reported in South Africa (Swanepoel et al, 2008). Misconceptions regarding risk factors should be corrected through culture-specific strategies and the community should be sensitised to prenatal, perinatal and postnatal factors responsible for hearing loss.

While it is encouraging to note that some mothers were aware of ENT specialists, in general there was limited awareness about professionals and services available for individuals with hearing impairment. It is not surprising that mothers from rural areas were unaware of the ear and hearing healthcare professionals, as specialists are almost non-existent in rural areas. The majority believed that fitting a hearing aid solved the hearing loss. The need for intervention after identification should be emphasised in the community. As the paediatrician is
the first medical professional that a mother may interact with, it is important that this group of professionals be sensitised to early identification and intervention for hearing loss.

CONCLUSION

This study was carried out to gain insights into the knowledge and beliefs about ear and hearing health in a rural community where it was proposed to have a hearing screening programme for infants and young children. The objective was to use the information obtained to incorporate appropriate messages into the sensitisation and counselling of the community by village health workers.

The results of the study suggest that while mothers in this rural community were knowledgeable regarding some aspects of ear and hearing healthcare, lack of information and misconceptions were also prevalent. For greater compliance with the community-based programme aimed at identification of hearing loss in children, it is important to use the existing knowledge of these mothers. Simultaneously, attempts should be made to fill in the gaps in knowledge and work towards dispelling prevalent myths.

In the proposed hearing screening programme, screening in the villages will be conducted by VHWs who will be in close and constant contact with the community. They will be trained to provide the following information on ear and hearing healthcare:

1. Prior to hearing screening, meetings will be conducted in every village at the Balwadi (pre-school) to sensitise parents about:
   a. Risk factors for hearing loss, such as low birthweight, hypoxia, jaundice, maternal infections, and hearing loss due to untreated ear infections.
   b. Speech and language development as an indicator of hearing ability.
   c. Possibility of partial and unilateral hearing loss other than ‘Total’ deafness.

2. In order to dispel the misconception that hearing can be tested only when the child is old enough to respond verbally, the VHWs will inform the community about the availability of hearing testing methods that are objective and suitable for newborns. This is expected to improve participation in the screening.
3. Before the screening, in order to capitalise on the mothers’ knowledge about informal assessment of hearing, questions on behavioural response to sounds will be incorporated in the case history.

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REFERENCES


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APPENDIX I

Focus Group questions (Translated from Tamil)

A. Ear care
   1. How do you keep your child’s ears clean?
   2. What do you all do when any object or insect goes inside the ear?

B. Causes & prevention of hearing loss, specific to early childhood hearing loss
   3. What according to you are the reasons for a child to have hearing loss?
   4. How do you think hearing loss can be prevented?

C. Hearing assessment
   5. How will you ascertain that the child is able to hear?
   6. At what age can hearing ability of a child be assessed?
   7. People may have complete loss of sight or some can see partially; are you aware of any such thing for hearing loss? How will you come to know about it?
   8. What will you do if your child has any problem in hearing?
      1) Do you know anything about hearing testing?
      2) At what age can a child’s hearing be tested?
      3) Are you aware of any specialist or professionals for ear and hearing?

D. Consequences/ Signs of hearing loss
   9. What do you feel are the consequences of hearing loss?

E. Hearing rehabilitation (Hearing aid/ surgery/ education)
   10. What can be done for children with hearing loss?
   11. Are you aware of any schemes for persons with hearing loss?