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A REVIEW OF NEONATAL HEARING SCREENING PRACTICES IN INDIA

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Contributions:
A Study design/planning
B Data collection/entry
C Data analysis/statistics
D Data interpretation
E Preparation of manuscript
F Literature analysis/search
G Funds collection

Abstract

Newborn hearing screening (NHS) programs were implemented in India as a part of research studies beginning in the early 1970s. Later, several hospitals established their own hearing screening programs. In 2006, the Government of India initiated efforts towards prevention and control of deafness in which neonatal hearing screening at a grass-roots level was envisioned. Presently, despite the lack of a universal newborn hearing screening program, several hospital-based programs and some community-based programs have evolved. This review on NHS practices in India, both in the public and private sectors, is drawn from an exploration of published work as well as information on newborn hearing screening programs available from authenticated public domains.

Key words: newborn hearing screening • India • government • hospital • community

REVISIÓN DE LA PRÁCTICA DE IMPLEMENTACIÓN DEL CRIBADO NEONATAL EN LA INDIA

Resumen

En la India los programas de cribado neonatal (NHS) han sido introducidos como una parte de la investigación científica, a partir de los principios de la década de los setenta del siglo XX. En el periodo posterior, cierto número de hospitales elaboró sus propios programas de cribado auditivo. En el año 2006 el gobierno indio adoptó las medidas para prevenir la sordera y controlarla – su visión incluyó el cribado auditivo neonatal llevado a cabo a nivel básico. Actualmente, a pesar de faltar un programa único del cribado auditivo neonatal a aplicar, se desarrollaron sucesivamente varios programas hospitalarios y medioambientales de este tipo. La revisión de la práctica de implementación de NHS en la India - tanto en el sector público como también en el privado – se llevó a cabo sobre la base de la literatura pertinente bien profundizada y de la informaciones obtenidas de unas páginas web autorizadas relativas al cribado auditivo en recién nacidos.

Palabras claves: cribado auditivo neonatal • la India • gobierno • hospital • entorno social

ОБЗОР ПРАКТИКИ ПО ВНЕДРЕНИЮ НЕОНАТАЛЬНОГО СКРИНИНГА В ИНДИИ

Изложение

В Индии программы массового обследования новорожденных (NHS) были введены в качестве части научных исследований с начала семидесятых годов XX в. В более поздний период определённое количество больниц разработало собственные программы массового аудилогического скрининга. В 2006 году индийское правительство предприняло действия, имеющие целью предотвращение глухоты и надзор над ней, – в их планы вписывался аудиологический скрининг новорождённых, проводящийся на базовом уровне. В данный момент несмотря на отсутствие одной действующией программы аудиологического скрининга новорождённых постепенно развилось несколько больничных и врачебных программ данного типа. Обзор практики по внедрению NHS в Индии – как в общественном, так и частном секторе – был осуществлён с опорой на глубоко изученную литературу предмета и информацию по аудиологическому скринингу новорождённых, полученную с авторизованных интернет-сайтов.

Ключевые слова: аудиологический скрининг новорождённых • Индия • правительство • больница • социальная среда

PRZEGLĄD PRAKTYKI WDRAŻANIA BADAŃ PRZESIEWOWYCH NOWORODKÓW W INDIACH

Streszczenie

W Indiach programy badań przesiewowych noworodków (NHS) wprowadzono jako część badań naukowych, począwszy od wczesnych lat siedemdziesiątych XX w. W późniejszym okresie, pewna liczba szpitali opracowała własne programy badań przesiewowych słuchu. W roku 2006 rząd indyjski podjął starania mające na celu zapobieganie głuchocie i nadzór nad nią – w ich wizję wpisywały się badania przesiewowe słuchu u noworodków, przeprowadzane na podstawowym szczeblu. Obecnie pomimo braku jednego obowiązującego programu przesiewowych badań słuchu u noworodków, stopniowo rozwinęło się kilka szpitalnych i środowiskowych programów tego typu. Przeglądu praktyki wdrażania NHS w Indiach - tak w sektorze publicznym, jak i prywatnym - dokonano w oparciu o zgłębioną literaturę przedmiotu oraz o informacje pozyskane z autoryzowanych stron internetowych, dotyczących badań przesiewowych słuchu u noworodków.

Słowa kluczowe: badania przesiewowe słuchu u noworodków • Indie • rząd • szpital • środowisko społeczne

Introduction

In India, hearing disability has a higher prevalence in children aged 0–4 years (0.60%) and 5–9 years (0.28%) than all other disabilities (0.32%) [1]. Even though two-thirds of all persons with hearing deficits are from developing countries, newborn hearing screening (NHS) programs are not widely adopted. These countries are often burdened with other life-threatening public health concerns meaning that hearing loss has not received due attention [2].

In rural West Bengal, India, the average age of a "suspicion" for hearing loss is approximately 1 year and 5 months; the first visit to the doctor occurs approximately at 2.5 years; and a consultation with an audiologist at 9 years and 4 months [3]. In a cross-sectional study of 246 children of 5–15 years of age in Surat, Gujarat, India, the average age of suspicion was 2.9±1.7 years; the first consultation was at 3.5±1.5 years; and the average age of intervention for hearing loss was 7.8±3.3 years [4]. These studies suggest that hearing loss identification and intervention are considerably delayed. In a study of the trend in age of identification in India between 1989 and 2008, it was found that the age was reduced by 9.59 months over the period; however, it was far from the 12 month international criterion [5].

The challenge of implementing NHS in India has to face several important facts, foremost being the scarcity of audiologists and the lack of infrastructure able to reach the 72% of the population which resides in rural areas [6]. Of the 350 government-run hospitals with tertiary care facilities, 120 have diagnostic and rehabilitation facilities for early detection of hearing loss. Significant numbers of private centers offer facilities for audiological evaluation; however, they are not uniformly distributed across the country [7]. Additionally, there is a strong contrast in the demand for human resource versus capacity, as the ratio of the combined number of audiologists and audiometricians to population has been reported to be 1: 500,000 [8].

Despite these challenges, NHS programs have been implemented in India as part of research studies since the early 1970s [9–12]. One of the early research attempts to determine the most effective method of screening for hearing loss on a large scale was the study by Yathiraj, Sameer, and Jayaram in 2002 [13] in rural and urban areas of Mysore district of Karnataka in South India. They screened 1000 babies from the high-risk register (HRR) and they assessed the infants with Behavioral Observation Audiometry (BOA) using calibrated noise-makers and pediatric screeners with Otoacoustic Emissions (OAEs). Based on the preliminary cost analysis, the HRR-based screening conducted by grass-root workers was found to be the most effective.

In 2011 a survey was conducted with the objective of evaluating the NHS status in India. Among the 31 institutions that participated in the survey, more speech and hearing centres had implemented NHS compared to hospitals of medical colleges. Predominantly, medical colleges with NHS facilities had audiologists in the planning and execution of screening. Nearly half of the medical colleges used subjective measures of screening such as behavioural observation audiometry, while the speech and hearing centres assessed infants using ABR and OAEs [14].

The main objective of this paper is to present information on NHS practices in India. To collect this information, a detailed review of literature has been conducted. From the published data on NHS, information was collected about the resources used, the protocols followed, and the achieved outcomes.

Method

This review on NHS practices in India is drawn from a comprehensive exploration of published work as well as information in the area of NHS available from authenticated public domains. Information on government initiatives, programs run by private hospitals and birthing centres, and community-based programs were gathered. Literature review was conducted using search engines such as Google Scholar, Mendeley, and Pubmed. Information on programs run by teaching institutions was retrieved from online repositories of research reports and dissertations. If a full-length article was not available, the authors were contacted for the same. Information focused on the service providers, the personnel employed for screening, protocols used (single-step vs. two-step), screening devices used, and outcomes of the program.

The following section describes the results of the review with respect to Government of India initiatives towards

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early identification of hearing loss, hospital-based NHS programs, and community-based hearing screening initiatives.

Results and Discussion

Government initiatives towards early identification of hearing loss

The National Programme for Prevention and Control of Deafness (NPPCD) was launched by the Ministry of Health and Family Welfare, Government of India, in 2006, under the broader program of the National Rural Health Mission (2005–12). Under this program, both institution-based screening and community-based screening were implemented in more than 200 districts. Institution-based screening was modelled after hospital-based programs, and community-based screening was targeted towards babies not born in hospitals. Community-based screening was conducted using a brief questionnaire and behavioural testing by a trained health-care worker during immunization. Any infant who did not pass the screening was to be followed up at the district hospital for OAE and ABR testing, and if required, for rehabilitation. Some of the key issues in the implementation of the program were identified as lack of human resources, inadequate infrastructure, equipment-related shortcomings, and low priority for deafness prevention [15,16]. In addition, a shortage of centers with diagnostic testing facilities and a shortage of audiologists in all district hospitals were reported [8].

In 2013, the Government of India launched the Rashtriya Bal Swasthya Karyakram (RBSK) [17]. This new initiative involved child-health screening and early intervention services for children 0–18 years of age, for defects at birth (including congenital hearing loss), disease, deficiencies, development delays, and disabilities. Under RBSK, children undergo community-level screening by mobile health teams comprising a medical officer, paramedics, and nurses at *Aanganwadis* (government-run pre-school centres). Screening is also conducted at government-aided schools, and at public health facilities like primary/composite health centres and district hospitals, by existing health personnel such as medical officers, nurses, and auxiliary nurses. Children diagnosed with illnesses receive follow-up services at tertiary level at no cost.

NPPCD and RBSK are significant milestones in the implementation of systematic nationwide hearing screening programs. Olusanya (2011) reported that among regions such as in South-East Asia and Africa, where the burden of hearing impairment is highest, only India has established concrete steps towards nationwide hearing screening [18].

Hospital-based neonatal hearing screening programs

Outcomes of hospital-based NHS obtained from published literature are summarised in Table 1.

The summary in Table 1 suggests that since 2002, if not earlier, hospital-based programs have been implemented and documented for outcomes. It may be noted that most programs are from the southern region of the country; there are two programs from the west and two from the northern region. There are no known reports of NHS in the eastern region of India. Based on published evidence, three programs were found to have run for at least 5 to 13 years: Christian Medical College, Vellore, Tamil Nadu; Sri Ramachandra Hospital, Chennai, Tamil Nadu; and a centralised newborn hearing screening program in Cochin, Kerala [19–25]. The program (described by Paul, 2011, 2016), initiated by the Indian Academy of Pediatrics (IAP) in 2003, is one of the largest programs with a unique centralised screening facility. It includes 20 major hospitals in Cochin, Kerala (South India), with maternity units. Human resources and screening equipment are shared between the hospitals in rotation, and the facility is operated by trained technicians employed as screeners.

In Western countries, it is common for nurses to carry out screening in the hospital; however, none of the NHS programs in India has explored this possibility. Generally, audiologists are involved in screening [22,23,26,27]. Three programs used trained screeners/health workers to carry out screening [19,20,24,25,28]. ENT specialists were involved in the screening in one program [29]. Programs involving trained screeners/health workers covered larger cohorts in the screening, suggesting that larger numbers could be covered without involving the professional time of audiologists. Audiologists can be involved in program planning, implementation, and evaluation and in performing diagnostics, counselling, and rehabilitation.

First screening was conducted at birth or before discharge [19,20,22–28] or within 1 month of discharge [19,25,30,31]. Conducting first screening prior to discharge is preferred to ensure better coverage and reduce loss in follow-up. Second screening is scheduled anytime between 1–3 weeks or during the next scheduled visit [19,22,25,28,30], except in one program where the second screening was also scheduled before discharge [27]. In all programs, diagnostic follow-up was scheduled at or before 3 months of age.

Information on referral rate and follow-up rate for rescreen as well as diagnostic testing is not explicitly stated in several studies; therefore, this information was inferred using available data provided in the study. On certain occasions, data of 'at risk' and 'not at risk' have been combined to obtain single values of referral and follow-up rate.

Referral rates reduced from the first to second screening. Predominantly, referral rates for the second screening were well within the JCIH benchmark of 4%. Referral rates were particularly low in the program reported by Sharma et al. (2015), suggesting that trained health workers were skilled at conducting the screening.

The follow-up rate for rescreen ranged from 28% [23] to 100% [20,27,28]. Scheduling re-screening before discharge may have resulted in better follow-up in these programs. It is not known if the health workers involved in the program described by Sharma et al. (2015) had any role in improving follow-up. Follow-up for diagnostics was almost within the JCIH benchmark in most programs.

All programs followed universal screening strategies. Such an approach may have evolved as a result of lessons learnt from established programs in the West regarding

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Table 1. Outcomes of neonatal hearing screening programs in India

Authors	Region in India	Year of program	No. of children screened	Screening personnel	Age at 1st screening	Age at follow-up screening	Age at follow-up for diagnostics
Nagapoornima et al., 2007	South West	2002–2006	1764	Not specified	6 weeks	Within 3 weeks	Not specified
Vaid, Shanbhag, Nikam, 2009	West	2005–2007	2621	Not specified	Within 3 days of birth	After 1 month	At 3 months of age
John and Balraj, 2009	South	2005	500	Trained screeners	At birth	Before discharge	3 months after discharge
Augustine et al., 2014	South	2010	9448	Trained technicians	24–72 hours after birth; NICU babies, before discharge	After 1 week	1–3 months of age
Nagarajan, Bala, Janet, 2010	South	2005–2006	299	Audiologists	Before discharge	Before discharge; Within 1 month of age	Within 6 months of age
Nallamuthu, Selvarajan, Seethapathy, Nagarajan, 2012	South	2011–2012	1135	Audiologists	At birth or within 1 month	After 2 weeks	Within 3 months of age
Paul, 2011	South West	2003–2009	10,165	Trained screener	Before discharge	Next scheduled visit	Not specified
Paul, 2016	South West	2003–2015	101,688	Trained screener	Before discharge (at 6 weeks) at the time of follow-up for immunization	Next scheduled visit	Not specified
Rai and Thakur, 2013	North	2009–2010	500	ENT specialist	Within 1 week of birth	1 month of age	3 to 6 months after birth
Ul et al., 2015	North West	2011	415	Audiologists	At birth	None	At 3 months of age
Vignesh, Jaya, Sasireka, Sarathy, Vanthana, 2015	South	2013–2015	1405	Audiologists	24 hours after birth or before discharge	Before discharge	After 3 months
Sharma, Mishra, Bhatt, Nimbalkar, 2015	West	2012–2015	2534	Trained health worker	At birth	After 10 days	At 3 months of age

Authors	Refer rate, 1st screen	Refer rate, 2nd screen	Follow-up rate for rescreen	Screening protocol	Follow-up rate for diagnostics	Diagnostic protocol
Nagapoornima et al., 2007	5.5%	0.6%	Not specified	Two-step TEOAE–TEOAE	Not	ABR, BOA
Vaid, Shanbhag, Nikam, 2009	19.2%	8.4%	43%	Two-step OAE–OAE	94%	ABR
John and Balraj, 2009	6.4%	1.6%	100%	Three-step DPOAE–DPOAE–AABR	100%	ABR
Augustine et al., 2014	9.13%	1.7%	82%	Two-step AABR–AABR	28%	ASSR, Diagnostic DPOAE
Nagarajan, Bala, Janet, 2010	16%	1.6%	28%; 100%	Three-step DP/TEOAE–DP/TEOAE–DP/TEOAE	100%	ABR

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Authors	Refer rate, 1st screen	Refer rate, 2nd screen	Follow-up rate for rescreen	Screening protocol	Follow-up rate for diagnostics	Diagnostic protocol
Nallamuthu, Selvarajan, Seethapathy, Nagarajan, 2012	7.5%	2.5%	61%	Two-step Well baby: OAE–OAE NICU/Hyperbilirubinemia: AABR–AABR	68%	ABR
Paul, 2011	9.4%	1.6%	96%	Two-step OAE–AABR NICU babies AABR	90%	ABR
Paul, 2016	15%	1.6%	99%	Two-step OAE–OAE	94%	ABR; All NICU babies underwent ABR
Rai and Thakur, 2013	5.6%	2.6%	77%	Two-step TEOAE–TEOAE	69%	ABR
Ul et al., 2015	5%	N/A	N/A	One-step TEOAE	100%	ABR
Vignesh, Jaya, Sasireka, Sarathy, Vanthana, 2015	22%	2.2%	100%	Two-step DPOAE–AABR	100%	BOA, Immittance Diagnostic OAE and ABR
Sharma, Mishra, Bhatt, Nimbalkar, 2015	2.05%	0.5%	73%		100%	ABR, All high risk babies underwent ABR irrespective of screening result

Table 2. Summary of incidence data from different studies. Incidence per 1000

Author	General	At risk	Not at risk
Nagapoornima et al., 2007	5.65	10.75	4.7
Vaid et al., 2009	4.96	7.95	1.62
Paul, 2011		10.3	0.98
Augustine et al., 2014	4.1		
Vignesh et al., 2015	1.42		
Sharma et al., 2015	2		
Paul, 2016		0.7	0.6

the large number of children who may be missed by targeted screening. Nagapoornima et al. (2007) reported, based on their NHS pilot, that screening of only at-risk neonates can result in missing detecting 70% of newborns with hearing impairment in India. Except for one, all programs followed a two-step screening protocol. The programs that initially followed a three-step protocol later modified it to the two-step protocol [20,23] OAEs seem to be preferred to the automated ABR, possibly due to the costs involved.

Information on the data registry and method of documentation used in these programs (for example, software, registers, Excel documents, etc.) is not available, although such information would be useful for program planners. For example, Sharma et al. (2015) suggest that hearing screening could be integrated into the electronic newborn tracking system in use in the state of Gujarat, West India. This system, currently used for antenatal care, delivery status, and immunization, could be used for NHS, allowing better follow-up and tracking of newborns with failed screenings.

From the data of these NHS programs, information on the incidence of hearing loss was obtained. The incidence data from programs with more than 1000 babies screened is listed in Table 2. Based on these reports, the incidence of hearing loss, in general, seems to be between 1 to 6 per 1000; among at-risk babies, it is between 7 to 10 per 1000; among babies not at risk the incidence is between 1 to 5 per 1000. In the absence of large-scale studies, data from these smaller cohorts throws light on the possible incidence of hearing loss in India.

These studies indicate that NHS programs are considered vital by ear and hearing care professionals. Although in the nascent stage, existing programs have conducted quality evaluations using benchmarks recommended by international bodies.

Community-based hearing screening programs

Hospital-based programs cater to the smaller population living in urban and semi-urban areas of the country. For

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larger coverage, the solution lies in community-based approaches, which the Government of India also supports.

In the state of Karnataka, Ramesh et al. (2012) reported that a trained health worker, under the supervision of a qualified audiologist, could satisfactorily screen 425 neonates using mechanical calibrated noise-makers [32]. A community-based program in rural south India was attempted with tele-ABR for diagnostic confirmation of hearing loss. Tele-diagnostic audiological testing in a hearing screening program is a novel practice, and this study is the first to explore its application in a rural community. Village health workers were trained to conduct DPOAE screenings and assist in tele-ABR. They were also trained to provide information about ear and hearing health, and facilitate follow-up visits for diagnostic testing when required. Two-step DPOAE screening was conducted on a door-to-door basis for infants and young children [33]. Unlike hospital-based NHS, the community-based program includes older children up to 3 years of age. It is reported that the health workers were effective in delivering community-based hearing screening services and that parents in the community acknowledged tele-diagnostics was as good as an in-person test experience [33–37].

Conclusions

The above review on NHS practices in India is based on published information and information available in the public domain. In addition to these programs, there is anecdotal evidence to suggest that several private birthing centres partner with private audiology clinics to carry out NHS. Also, several tertiary care hospitals with fully-fledged audiology clinics have implemented NHS. Yet the protocols followed, outcomes, success, challenges, and lessons learnt are not known.

Existing knowledge about NHS practices is based on outcomes reported by a handful of institutions and hospitals. It is important that all program implementers share their outcomes and lessons so as to evolve best practice. Outcome reports of community-based screening programs and government programs which are designed for larger coverage (especially among the rural population), are crucial to assess how India can achieve early identification and intervention for hearing loss. In addition, in a country like India with limited resources, economic evaluation of established programs will be important for program planners and policy makers.

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