Indian J Otolaryngol Head Neck Surg
(December 2013) 65(Suppl 3):S636–S644; DOI 10.1007/s12070-013-0674-2

ORIGINAL ARTICLE

Audiological Practice in India: An Internet-Based Survey of Audiologists

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Received: 15 February 2013 / Accepted: 24 July 2013 / Published online: 2 August 2013

Abstract The field of Audiology in India has expanded exponentially in recent years. Audiologists practice in a variety of work places. However, little is known about the practice trends across these several work places. An Internet-based survey probing into Audiology practice was conducted between June and September 2012. The survey focused on four domains, namely, demography, assessment, hearing aid (HA) fitting and protocol usage. A total of 199 audiologists completed the survey. A large proportion of these audiologists were from Southern India. Majority of the respondents provide hearing assessment and HA services for children and adults. Results indicate diverse practice among respondents, even in essential procedures such as otoscopy. Although a large proportion of audiologists reported performing HA fitting in children as well as adults, less than 12 % of them performed real ear or simulated real ear verification during any HA fitting. Implications for the development of preferred practice guidelines in India have been discussed.

Keywords Audiology · Audiology in developing countries · India · Professional practice · Hearing loss · Hearing aid fitting · Preferred practice guidelines

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Introduction

The treatment of ear diseases in India dates back to early fourth century BC [1, 2], which is now known as Ayurvedic Medicine. However, the profession of Audiology is relatively new and dates back to only half a century [3]. Within this short period of time, the profession of Audiology has grown exponentially. It has made significant progress in manpower development, service delivery, and public awareness. The prevalence of hearing loss/difficulty in hearing in India during 1999 and 2002 was estimated to be around 5.9–16.56 % [4, 5]. There is still a need for improvement in services, considering the prevalence of hearing loss, in addition to the diversity in access to ear and hearing healthcare services. The key to planned progress in a profession involves evaluation of current trends of practice. However, little is known about the trends in service delivery and professional practice of audiologists' in India.

There have been surveys from Western countries that probe into trends in professional practice, service delivery

and consumer satisfaction [6–11]. MarkeTrak in the USA and EuroTrak in Europe are examples of such consumer directed surveys which have proved useful in understanding changes in practice, and its influence on patient outcomes [12, 13]. These surveys have led to a better understanding of practices influencing patient outcomes. However, such information is currently lacking in India. Professional bodies in several countries recommend, and implement preferred practice guidelines for audiological practice that audiologists are required to follow [14–16]. Adherence to such guidelines will ensure high standards of practice. On the contrary, lack of such guidelines may diversify practices, possibly even leading to higher chances of unacceptable practices. This may in turn hinder patient outcomes and satisfaction. For this reason, the current study is aimed at understanding current audiological practices in India with an intention of identifying areas warranting change. This study reports the results of a survey, which, to our knowledge, is the first of its kind to be conducted in India in the field of Audiology.

Method

Four domains were chosen to frame questions in the survey to understand current audiological practices in India. These included demography, audiological assessment, hearing aid (HA) fitting, and protocol usage. The survey consisted of 32 mandatory questions in total, out of which, 10, 12, 8, and 2 questions corresponded to four domains demography, hearing assessment, HA fitting and protocol, respectively. A combination of multiple choice and open-ended questions were employed.

Questions in the demography domain probed into the current city of work, place of work, availability of HA services, speech–language services, vestibular services and newborn hearing screening services at work place, nature of the audiologists' patient population, number of patients catered to per day, respondent's qualification and years of experience, qualification of audiologists performing hearing tests and HA fitting in a private clinic, and number of audiologists working in their work place. Questions in the audiological assessment domain included frequency of calibration of audiometers, frequency of listening checks, otoscopic examination, performance of tympanometry and reflex audiometry, speech tests performed and assessment methods in infants and young children. Only those audiologists who reported seeing children under the age of 18 years answered questions regarding pediatric assessment techniques. Questions in the HA fitting domain included style of HAs prescribed, prescription rule used for HA fitting in children and adults, choice of verification methods during HA fitting in children and adults followed by choice of outcome measures validating HA fittings in children and adults.

The protocol domain included two polar ('yes/no') questions. One question asked about the existence of a local/in-house protocol. The second question asked about the audiologist's opinion on the need for a national-level preferred practice guidelines for Audiology in India.

The survey was created using Google Forms (Google Inc., Mountain View, CA, USA) posted on a social network forum (Facebook Inc., Menlo Park, CA, USA) to make it publically available to audiologists from all over India. The survey was also distributed among members of the Indian Speech and Hearing Association (ISHA) via electronic mail. We chose to conduct an online survey to reach and recruit a large number of audiologists practicing anywhere in India in a cost and time efficient manner. Audiologists who volunteered to participate in the online survey submitted their responses online. Any names provided were anonymized prior to analysis. The survey only included audiologists who were practicing at the time of completing the survey. Data from students and audiologists practicing in other countries were excluded prior to analysis.

Results

Results are presented in four sections that follow the order of domains listed in the "Method" section. The word 'audiologist' used here refers to the respondents of the survey.

Demography

A total of 199 audiologists were included in our analysis based on our inclusion criteria. Table 1 illustrates the distribution of audiologists across India who completed the survey. There is a skew due to the larger number of audiologists participating from South India, relative to other regions. Audiologists reported working in a variety of work places that varied in size and services provided (see Table 2).

A total of the 193 audiologists reported working with children. Of these, 35.23 % of the audiologists are not

Table 1 Geographical distribution of audiologists across India

Regions	Percent of audiologists
Central	7.61
South	53.30
West	13.71
East	6.09
North	19.29

involved in any newborn hearing screening services while 64.77 % of the audiologists provide newborn hearing screening services in either a clinic or a hospital. Of the 64.77 % of the audiologists (i.e., 125 audiologists), 44 % of them provide this service in their own clinic, 45.60 % of them provide this service in a hospital, and 32 % provide this service in a hospital for high-risk babies. The above-mentioned percentages do not add up to a 100 % because some audiologists reported that they performed newborn hearing screening both in their clinic, and in hospitals. Of the 64.77 % of audiologists that provide newborn hearing screening service, 3.2 % of them provide in both their own clinic and in a hospital on all newborn babies, while 4.8 % of them provide this service in both their own clinic and in a hospital on high-risk babies and the remaining 5.6 % of them provide this service in their own clinic and in a hospital for all babies including high-risk babies.

Regardless of the services provided in each of the above work places, the number of audiologists working in any particular work place varied from fewer than three audiologists to greater than six audiologists (see Table 2, bottom left panel). Also, the number of patients seen per day by each respondent varied from less than 5 to more than 15 patients (see Table 2, bottom right panel). Audiologists working across different setups varied in their qualification and years of experience (Table 3). Majority of the respondents held a postgraduate degree in Audiology or Speech–Language Pathology and Audiology (Table 3, left panel).

Among the 199 audiologists who completed the survey, 42 of them owned a clinic that provided audiological services. These clinics employed audiologists with varying qualifications. Figure 1 compares the qualification of audiologists who perform hearing tests and fit HAs in privately owned clinics.

Audiological Assessment

Equipment Check

Majority of the audiologists (48.74 %) who participated in the survey calibrated their audiometer at an interval of 1–2 years. 39.2 % of the respondents calibrated their audiometers more frequently, at intervals of less than a year. However, 12.06 % of the respondents calibrated their audiometers at intervals greater than 2 years. A large number of audiologists (52.26 %) reported performing routine listening checks on a daily basis. 22.11 % of the audiologists performed these listening checks once a week while 18.59 % performed the same every other day. However, only a small percentage of the respondents (7.04 %) performed listening checks more rarely, i.e., once a month.

Procedures/Tests

Otoscopy Of the 199 audiologists who responded in the survey, 63.32 % of the audiologists perform otoscopy routinely on all patients, 14.57 % of the audiologists do not perform otoscopy routinely on their patients and 22.17 % of the audiologists reported performing otoscopy most of the time.

Tympanometry It is interesting to note that 40.2 % of the audiologists perform tympanometry and reflex measures on

Table 2 Work place demographics of audiologists who took part in the survey

Place of work	Percent of audiologists	Type of service	Percent of audiologists
Hospital	29.15	Audiology service only	17.59
ENT clinic	3.02	Audiology and speech–language service	82.41
Institute (where speech and hearing courses are taught)	17.59	Audiology and vestibular service	35.18
Hearing aid clinic owned by someone else	23.62	Hearing aid services	89.94
Own a clinic/practice providing audiological services	21.11	Adult and paediatric clients	94.97
Hearing aid industry	4.02	Paediatric clients only	2.01
Other	1.51	Adults clients only	3.02

Number of audiologists per work place	Percent of audiologists' work place	Number of patients seen per day	Percent of audiologists
1–3	64.32	<5	21.61
4–6	12.56	5–10	44.72
>6	23.12	11–15	14.07
		>15	19.60

Work places such as special school/school were included in the 'other' option

all their patients while only 2.51 % of them performed only tympanometry on all their patients. 34.17 % of the audiologists reported performing either or both tests depending on the patient. The remaining 23.12 % of the audiologists report performing either or both measures as requested by another professional.

Pure-tone Audiometry Of the 199 audiologists who responded in the survey, 78.89 % of the audiologists used headphones for pure-tone audiometry while 20.1 % of the audiologists used both headphones and insert receivers. However, only a small percentage of the audiologists, 1.01 %, used insert receivers alone.

Speech Audiometry 24.12 % of the respondents reported that they perform only speech recognition threshold (SRT) while 53.27 % of the respondents reported they performed SRT in combination with other speech measures. Of these combinations, 39.7 % were SRT+ speech identification scores (SISs) and 2.51 % were SRT+ speech in noise (SIN) test. Only 2 % of the respondents reported that they performed SIS in isolation while SIS was performed in combination with other speech measures by 50.75 % of the respondents. None of the audiologists reported performing SIN in isolation; it was typically included in their test battery. The SIN test was reported to be performed in combination with SRT and SIS by 9.55 % of the respondents. However, 19.6 % of them reported that they do not perform any form of speech testing routinely.

Table 3 Qualification (left panel) and experience (right panel) of audiologists

Qualification of audiologists	Percent of audiologists	Work experience (in years)	Percent of audiologists
BSc	32.66	<2	37.19
MSc	62.31	2–5	27.61
PhD	3.52	5–10	13.37
Diploma	1.51	>10	21.61

Procedures/Tests for Infants and Children

Testing Children of Younger than 2 Years of Age Of the 193 audiologists who work with children, only 20.73 % of them perform just the behavioural tests that were provided in the survey (conditioned play audiometry [CPA], behavioural observation audiometry [BOA], visual reinforcement audiometry [VRA]), and 15.56 % of the 193 audiologists perform only objective tests such as auditory brainstem response (ABR) and auditory steady state response (ASSR). Majority of the audiologists (63.71 %) however perform a variable combination of both behavioural and objective tests. Of these variable combinations, 19.69 % of the audiologists perform a combination of BOA and ABR, 13.47 % perform a combination of BOA, ABR and ASSR, 8.81 % perform VRA, BOA and ABR and 6.22 % perform CPA, BOA and ABR. Remaining combinations accounted to less than 4 % each.

Testing Children Between 2 and 5 Years of Age Of the 193 audiologists who work with children, only 29.53 % of them perform just the behavioural tests that are mentioned in the survey (CPA, BOA, VRA) and 6.74 % of the 193 perform only objective tests such as ABR and ASSR. A majority of the audiologists, 63.73 %, however perform a variable combination of both behavioural and objective tests. Of these variable combinations 13.99 % of the audiologists perform a combination of CPA and ABR, 10.88 % perform a combination of CPA, BOA and ABR, 8.29 % perform CPA, ABR and ASSR and 5.18 % either do a combination of BOA and ABR or CPA, VRA and

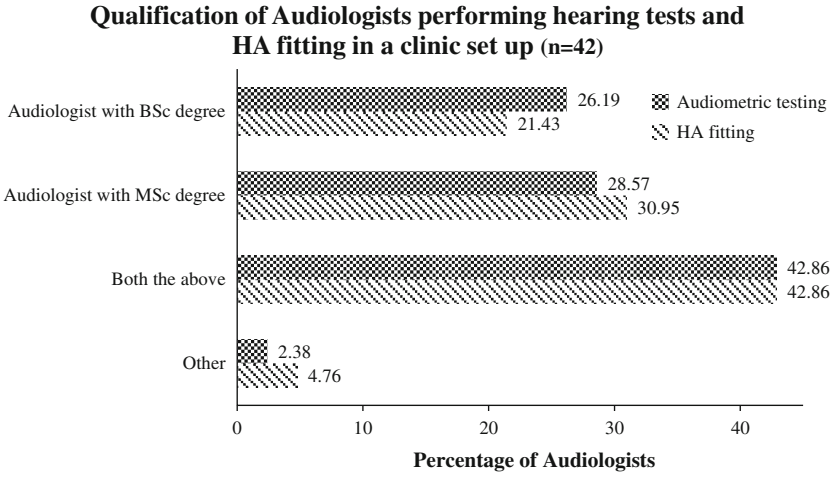

Fig. 1 Qualification of audiologists working in a clinic set up who perform audiometry and audiologists who fit hearing aids. The respondents for this question were audiologists who owned a clinic

ABR. The remaining combinations accounted to less than 4 % each.

HA Fitting

HA Style

As mentioned previously, 20 out of 199 audiologists did not dispense HAs. Among the HA dispensing audiologists, behind-the-ear (BTE) was the most commonly prescribed HA style, accounting for 24.54 % of the prescriptions. Custom HAs were the second most commonly prescribed HA style (22.15 %). RIC was prescribed 20.75 % of the time followed by open-fit BTEs being prescribed 18.93 % of the time. Body-level was prescribed 13.46 % of the time, while other HA styles such as contralateral routing of signal HAs accounted for less than 1 % of the prescriptions.

Prescription Rule (Adults)

Of the 179 audiologists who dispense HAs in adults, 29.05 % of them only fit HA to National Acoustic Laboratories (NAL)-NL1 [17] prescriptive formula, 15.08 % only fit to NAL-NL2 [18] prescriptive formula, 2.79 % only fit to desired sensation level (DSL) v4 [19] formula, 3.35 % only fit to DSL v5 [20], 2.23 % only use CAMFIT [21] as their only prescriptive formula. 3.91 % of the dispensing audiologists reported using fitting rules other than the ones mentioned above; this included manufacturer-specific prescriptive formulae.

Prescription Rule (Children)

Of the 179 audiologists who dispense HAs, only 163 of them fit HAs in children. Of these 163 audiologists, 15.95 % of them only fit HAs to NAL-NL1 prescriptive formula, 12.88 % only fit to NAL-NL2 prescriptive formula, 26.38 % only fit to DSL v4 formula, 12.26 % only fit to DSL v5 prescriptive formula. 3.06 % of the dispensing audiologists reported using fitting rules other than the ones mentioned above; this included manufacturer specific prescriptive formulae.

Many audiologists used different formulae across their adult and paediatric patients, and hence reported using more than one formula. In order to find the most frequently used prescription rule, data were pooled across all audiologists and their response options (see Table 4, top panel). The *n* is higher when responses are pooled across audiologists, and response options since many audiologists chose more than one option.

Table 4 Prescriptive formulae (top panel) and verification methods (bottom panel) for fitting hearing aids in adult and children

Clients	NAL-NL1	NAL-NL2	DSL v4	DSL v5	Other
Prescription rule for HA fitting (% of fittings)					
Adults	40.70	32.63	9.82	10.88	5.96
Children	19.48	16.88	32.03	22.08	6.93

Clients	Real ear	Simulated real ear	First fit	Functional verification	Fit according to patient feedback (post-real ear/first fit)	Only according to patient/parent feedback	Other
Verification methods (% of fittings)							
Adults	9.39	<2.00	9.02	30.07	38.72	10.15	<1.00
Children	14.36	11.25	26.76	29.01	NA	18.02	<1.00

Prescriptive formula CAMFIT and the 'other' option in the survey questionnaire have been clubbed into the category 'other'. 'Other', in the bottom panel refers to use of verification methods other than what is used here

Verification Measures (Adults)

Of the 179 audiologists who fit HAs, 8.37 % of them perform real-ear verification to verify their fitting. 6.7 % use only the first-fit option in the HA manufacturer's software while 3.35 % of the audiologists use functional verification measures such as sound field aided thresholds. 7.82 % of the audiologists fit HAs only based on patient's feedback. Slightly more than a quarter of the (26.25 %) audiologists fit HAs according to patient's feedback after using either real-ear verification or simulated real-ear verification with average or measured real ear to coupler difference (RECD), or after first-fit.

Verification Measures (Children)

Of the 179 audiologists who fit HAs, 8.37 % of them perform real-ear verification to verify their fitting. 2.79 % of the audiologists use simulated real-ear verification (with average or measured RECD). 10.61 % use only the first-fit option in the HA manufacturer's software while 12.29 % of the audiologists use functional verification measures such as sound field aided thresholds. 6.70 % of the audiologists fit HAs only based on patient's or parent's feedback.

Audiologists reported using more than one method of verification for adults and children hence data was pooled across all audiologists and response options (See Table 4, bottom panel).

Outcome Measures (Adults)

Pooled across all audiologists and response options, HA benefit questionnaires were used 15.97 % of the time. Aided pure-tone or warble thresholds were used 15.31 % of the time while aided Ling sound thresholds were used 18.16 % of time. Aided speech discrimination scores were measured 24.72 % of the time. Informal patient's feedback was obtained 25.82 % of the time.

Outcome Measures (Children)

Pooled across all audiologists and response options, HA benefit questionnaires were administered for parents 12.90 % of the time. Aided pure-tone or warble thresholds were used 31.67 % of the time while aided Ling sound thresholds were used 35.48 % of time. Aided speech discrimination scores were measured 19.06 % of the time and less than 1 % reported using other measures.

Protocol

It is encouraging to note that 71.86 % of the audiologists report having an in-house or local clinical protocol whereas the remaining 28.14 % of the respondents report having no such local protocols to follow. Inspite of a high existence of in-house clinical protocol, 94.47 % of the audiologists feel the need to have a nation-wide clinical protocol. The opinion of remaining 5.02 % was that such a protocol is not required and one audiologist did not choose either of the options.

Discussion

Audiology as a profession started in India more than 45 years ago and there has been a considerable increase in the number of audiologists offering services both in public and private sectors [3]. To our knowledge, there are no data available about audiological practices in India. Results from this study provides the first of its kind data regarding audiological practices in India. The online survey was aimed at understanding the demographics, current practices, and service provision of audiologists working in India. Our sample consisted of 199 practicing audiologists, which is roughly 15 % of the total number of audiologists estimated to be currently practising in India [22, 23].

Demography

Our data suggests that majority of the qualified audiologists work in private clinical set-ups, accounting for about 45 % of the respondents. The remaining audiologists work in hospitals, ENT clinics and Audiology institutes, totally accounting for almost 50 % of the respondents. We may infer that a large majority of the audiologists work as a part of a team in providing hearing health care. Also, this distribution may indirectly reflect the number of employment positions in private hearing care clinics relative to hospitals, ENT clinics, and institutes when considered individually. Although we cannot distinguish precisely the number of audiologists working in private versus public sectors, it appears that there are more audiologists working in private clinics. This agrees with the trend in the number of private clinics provided by Manchaiah et al. [3].

Our data also suggests that the majority of the audiologists provide audiological services including HA services for both adult and paediatric patients. More than three-quarters of the clinics also provide speech–language services within their practice. The proportion of clinics providing speech–language services may reflect the educational curriculum that combines Audiology and speech–language pathology in a single undergraduate or graduate course in India. Overall, these numbers are encouraging to note in view of the services provided given a particular setup. This may be seen as a convenience factor for patients seeking speech and hearing services. In

addition to the services provided, our data suggests that most of these work places employ one to three audiologists and see 5–10 patients per day. This further supports the increased awareness of audiologists' role in hearing health care and the number of people in need of such services. A majority of these work places employ audiologists with either a BSc or MSc degree in Audiology, indicating a preference for qualified audiologists for employment. Although HA services are offered extensively, there is a dearth of vestibular services. This may reflect the lack of awareness of audiologists' role in vestibular services. Additionally, this may either indicate that more resources need to be directed towards training audiologists in performing vestibular assessment and treatment or it may indicate the lack of resources for vestibular assessment and intervention. Lastly, this may indicate the involvement of professionals other than audiologists in the assessment and treatment of vestibular problems.

Audiological Assessment

It is reassuring to note that over 97 % of the audiologists have their audiometers calibrated at least every 2 years [14] and over 50 % also perform listening checks on a daily basis. This may be regarded as good professional practice as this is imperative for a reliable hearing test. However, inconsistencies were observed even in essential procedures such as otoscopy. Otoscopy being one of the basic procedures, cannot be ignored for the reasons of safety of the patient as well as maintenance of equipment (e.g., tympanometer). Otoscopy helps in identifying abnormalities in the external and middle ear that may be contradictions for other procedures such as tympanometry [15]. It also has important implications during the process of ear-impressions. Since majority of the audiologists dispense HAs, it is essential that they check the ear canal for contraindications. Over three-quarters of the audiologists either perform middle ear assessment on all patients or use their discretion for choice of test, while the remaining one-fourth perform such tests based on another professional's request. Lack of audiologist's discretion may lead to higher number of false negatives in detecting middle ear problems, especially in children. We speculate that middle ear assessment may be avoided by some audiologists in view of the costs incurred by the patient in administering the tests.

The results of the survey indicated that about 21 % of the audiologists use insert-earphones in addition to, or, in place of headphones. Maintenance cost of insert-earphones is higher than that of headphones due to the use of disposable ear tips. This may indicate the preference of cost effectiveness over other advantages that the insert-earphones may offer such as noise attenuation, infection control and higher inter-aural attenuation [24]. Including speech audiometry in the assessment test battery may serve to cross check the results of pure-tone audiometry. Any discrepancy between these tests may indicate neural problems such as Auditory Neuropathy Spectrum Disorders [25] or higher auditory processing disorders with SIN testing [26]. However, about 20 % of the audiologists reported that they do not perform any speech tests routinely. Not performing speech tests routinely may lead to a higher risk of missing these auditory problems, and hence may impact the nature of intervention.

It is encouraging to note that majority of audiologists assessing hearing in children perform a combination of objective and behavioural tests. However, some only perform either behavioural or objective tests. Preference for either methods of testing may indicate availability of clinical instrumentation, expertise of the audiologist and age of children referred to the audiologist. We are only able to infer about facilities available for testing children and not the appropriateness of tests used due to the nature of the survey questions. We therefore infer that about two-thirds of the set ups are equipped to administer electrophysiological tests such as ABR and ASSR, as well as behavioural tests.

HA Fitting

A combination of custom and traditional HA styles are being prescribed. Note that about 13 % of the audiologists still prescribe body-level HAs. This may indicate the affordability of a fraction of the patients, and also the provision of free HA through government-run Audiology institutes [23]. Recommended procedures for fitting HAs includes verification of HA output against output levels prescribed by a prescription rule for any given hearing loss. Our data suggests that DSL is largely used for children whereas NAL prescriptive rules are commonly used for adults. This appears to be consistent with the trends observed in the literature (e.g., [27]). However, it is interesting to note that only 25 % of the audiologists use some form of real-ear or simulated verification measure, although not consistently. The use of a prescriptive target may itself be questioned due to lack of verification measures. This trend is in line with reports from the literature; however, the proportion of audiologists performing real-ear or simulated verification measures is *lower* than the proportion reported in a recent survey [28]. Over the years, the use of verification measures with validated prescriptive targets during fitting of HAs has been emphasized for improved patient outcomes (e.g., [29–31]). It has been shown that first-fit provided by HA software may result in discrepancies from prescribed target due to factors such as individual differences in ear canal acoustics (e.g., [32, 33]). Additionally, this has important implications in children,

especially infants due to smaller ear canals. Reasons for lack of verification measures may vary (e.g., cost, time and skill/training), but this was not probed in the current survey.

Implications of This Study

It is important to evaluate our practice trends to identify gaps in services to track quality of practices and possibly in the planning of future services. The current study provides some understanding about the status of current audiological practices in India. The results of this survey also indicate the need to evaluate more focussed areas rather than the more generic approach adopted in the current survey. Considering the likelihood that this survey is the first of its kind in India, these survey results may be used for monitoring practice trends. Although most practices reported to have their own guidelines, there is a unanimous opinion about the need for a national-wide clinical protocol and preferred practice guidelines. We believe that these results may be helpful in developing such guidelines to suit the Indian context. We suggest that educational institutes address these identified gaps in their training programmes. As well, professional and regulatory bodies in the field of Audiology may take directed steps to improve and monitor audiological practice across the country. Furthermore, there is also a need to develop independent patient groups that are managed by service users. This may help monitor clinical practice and may also act as pressure groups in improving practice standards.

Study Limitation and Need for Further Research

Since most of the respondents were from Southern India, care must be taken while generalising these findings to other parts of the country. Like any online survey, this study may have limited representation of those audiologists' practices that may be less familiar with Internet or social networking forums. Future surveys could be designed to cater to fewer domains while providing better resolution in data distribution (e.g. urban vs. rural or public vs. private practice). Other areas that need to be explored are procedural variations as opposed to types of procedures used, like in the current survey.

Conclusions

The current study provides useful information about the diversity in current audiological practices in India. This study identifies the need for improving clinical practice, as inconsistencies were observed even in performing basic procedures such as otoscopy. We suggest that collaborative efforts from educational institutes, professional and regulatory bodies, non-government organisations and the government are necessary in developing, implementing, and monitoring clinical guidelines. This could greatly improve audiological practice and thereby, patient outcomes.

Acknowledgments The authors would like to thank the ISHA for their assistance in distributing the survey among their members. Portions of this work were presented at the 45th Annual National Convention of the ISHA, Chennai, February 2013.

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