Questionnaire for monitoring auditory and language development in the first year of life

ABSTRACT

Purpose: To validate a monitoring questionnaire about hearing and language development applied by community health agents in the first year of life. Methods: Seventy six community health agents, previously trained on infant hearing health, administered a questionnaire to the families of 304 children with ages from 0 to 1 year. The questionnaire contains questions regarding hearing and language development and, for all age groups, the question “Does your child hear well?” was presented. The validity of the questionnaire was assessed by analyzing false positive and false negative rates of the identified children. A double-blind study was conducted so that all children assessed by the questionnaire were submitted to hearing evaluation performed by audiologists. Results: Four children (1.32%) were diagnosed with sensorineural hearing loss (two unilateral), and 69 (22.7%) with conductive hearing loss. The monitoring questionnaire showed specificity of 96% and sensitivity of 67%, with a false-negative rate of 33% for not identifying the unilateral hearing loss, and a false-positive rate of 4%. Conclusion: The questionnaire used has shown to be feasible and relevant to actions of the community health agents of the Family Health Strategy program, with high specificity and moderate sensitivity. The use of the validated instrument should be considered to complement Newborn Hearing Screening Programs, in order to identify late onset or acquired hearing loss.

Keywords
Monitoring
Hearing loss
Neonatal screening
Questionnaires
Family health program
Audiology

Descritores
Monitoramento
Perda auditiva
Triagem auditiva
Questionários
Programa saúde da família
Audiologia

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INTRODUCTION

Literature on the subject provides an ample discussion about the scientific evidence regarding the effectiveness of the newborn hearing screening (NHS) programs in promoting the diagnosis of hearing deficiency and making an intervention in the first months of life possible, mainly in developing countries.

The main point discussed is the fact that many programs are not inserted in programs of newborn hearing health that guarantee efficient and fast access to diagnosis and (re)habilitation. Moreover, the difficulty in the monitoring of children who pass the NHS and present a risk for hearing losses of late manifestation(13) is highlighted.

Other problems are inherent to this type of program, such as a percentage of newborn babies that do not go through the hearing screening and the high abandonment rate of newborns that do not continue on to the other stages of the identification process (NHS retest) and/or audiologic diagnosis, when necessary. The abandonment rate throughout the identification process—that is, children who do not undergo the diagnostic—is one of the difficulties in the implementation of newborn hearing screening programs both nationally(2-4) and internationally(5-7). In this sense, the audiologic evaluation with a diagnostic purpose must occur a few weeks after discharge from the hospital in order to minimize the number of children who do not return, as the probability of these newborns coming to the appointment is greater in the first weeks of life(8).

When it is verified that the diagnostic process of newborns identified in the NHS already imposes difficulties, the monitoring of those who “pass” in NHS but present some risk indicator requires different and efficient strategies. Periodic follow-up in the reference centers of all newborns with risk indicators but who “pass” the NHS has proven many times to be an unfeasible practice, creating a scheduling flow that requires a large team of specialized professionals, making the cost-effectiveness of the program very high. Because of this reality, it is recommended that the follow-up appointments with the newborns occur according to the risk indicators—that is, the number of evaluations and the moment they will occur must be defined individually, in accordance with the scientific evidences of the possibility of hearing loss with late onset(9). Congenital infection by Cytomegalovirus, many times asymptomatic, mitochondrial mutation A1555G, and the widening of the initial aqueduct (widened vestibular aqueduct syndrome) are described as being responsible for 60% of the hearing losses of late onset(10).

Experience shows that isolated NHS programs are destined to fail if they are not part of a wider program of auditory health that establishes a connection with the several levels of attention to health, thus creating a network of identification, orientation, and support to the families, diagnosis, and intervention. The success of the programs of hearing health depends on the interrelation of some factors, including the support and the public policies for research and monitoring, continued education of the involved professionals in all levels of attention to health, and the existence of centers of excellence for diagnosis and intervention(12).

Considering the problems presented, the creation of strategies that extend the identification and early detention of the hearing deficiency in all levels of attention to health, and not only the NHS, becomes necessary.

In Brazil, the Family Health Strategy (FHS) started in 1994, having as a precursor the Community Health Agents Program (CHAP) implemented in 1991, supported in international and national experiences of the extension of health coverage by means of assistance to families in their own homes along with the health units(13). In this context, the community health agents (CHAs) are the health professionals who have greater contact with the community, and thus are able to play an important role in infantile auditory health, making diagnosis of and intervention in auditory deficiencies in the critical period of development of the child possible(2,14,15).

The World Health Organization (WHO) since 1998 has recommended the training of CHAs for primary attention to the hearing and ailments of the ear, supported by a reference and counter-reference system(16). The recommendations of the International Workshop on Primary Ear and Hearing Care resulted in three manuals published by the WHO that correspond to the three levels of training of community health agents: basic, intermediate, and advanced(17). A questionnaire to help CHAs identify hearing alterations is proposed in the training manuals for the intermediate and advanced levels. The question “Can your child hear well?” is suggested so that the parents’ suspicions are valued and verified(17).

The use of questionnaires applied to the parents is recommended by the American Academy of Pediatrics for the programs of identification and development alterations, with posterior referral for specialized evaluations, adding to the pediatrician’s clinical observation(18).

As such, the objective of the present study was to validate a monitoring questionnaire of the development of auditory and language functions applied by community health agents in the first year of life.

METHODS

This study was approved by the Ethics Committee in Research of the Bauru School of Dentistry – Universidade de São Paulo (FOB-USP), under n° 73/2006. The parents/guardians of the participants, as well as the community health agents (CHAs), consented to participate in the research by signing the free and clarified consent form.

Casuistry

Seventy-six CHAs previously trained in the area of infantile hearing health participated in this study. The questionnaire was applied by the CHA to the families of 418 children during the home visits of the Family Health Strategy. Of this total, 304 children (73%) came to the Nucleus of Health and participated in the validation stage of the questionnaire. The distribution of the children, according to their age group (months), is presented in Figure 1.
Methodology

The CHA that participated in the study had previously participated in the present qualification course in the area of infantile hearing health, with eight contact hours\(^{(14)}\). The content was adapted from the World Health Organization’s ear and hearing care training resource\(^{(17)}\), involving the subjects: hearing and auditory deficiency, types and causes of hearing losses, identification techniques, diagnosis, and hearing deficiency rehabilitation. Another aspect covered was the standard of normality for motor and language development. The CHAs received a booklet with the content taught so that they could follow the activities carried out interactively.

The questionnaire applied by the CHAs contained questions about hearing and language development, considering the behaviors expected each month, in the period of 0 to 1 year. The question “Can your child hear well?” was included in every month in order to verify the parents’ opinion about their children’s hearing (Appendix 1).

The validity of the questionnaire applied by the CHAs as an identification tool of children with hearing alteration was verified through the analysis of the false-positive and false-negative rates of the children investigated. A double-blind study was used where all the children investigated for the questionnaire were submitted, in the same week, to an audiologic evaluation carried out by speech and language therapists – thus considered the gold standard.

The audiologic evaluation was carried through in the Nucleus of Health, in which the Family Health Strategy is inserted by means of anamnensis, transient evaluation of the auditory behavior with the Ling sounds\(^{(19)}\), transient evoked otoacoustic emissions, and acoustics immittanceometry (tympanometry and research of the acoustic reflex). The criteria adopted for analysis were, respectively: auditory behavior in accordance with the standard expected for their age, based on a national study\(^{(20)}\); presence of transient evoked otoacoustic emissions in at least three non-consecutive frequencies, including 4 kHz, with reproducibility $\geq 70\%$ and relation signal noise $\geq 6\$dB; tympanometric curve with complacency of 0.3 and 1.3 ml and pressure of +90 to -100 daPa; and the presence of acoustic consequences in the intensity $<100\$dB.

Children who presented alterations in any of the applied tests were referred to the clinic of the Language and Speech Therapy Course of the Faculdade de Odontologia de Bauru, Universidade de São Paulo for medical evaluation and supplementation of the audiologic evaluation with the research of the brainstem auditory evoked potentials (BAEP) and audiometry with visual reinforcement, and if necessary, specific treatment. For BAEP analysis, the presence of waves I, III, and V was considered, with absolute latencies and inter-peak intervals within the normality standards for the age group and in the visual reinforcement audiometry, with a threshold of 20 dB HL in the frequencies from 500 HZ to 4 kHz. The speech and language therapists that performed the audiologic evaluation had not had previous contact with the information in the questionnaire applied by the CHAs.

Children were identified as “at risk for auditory alteration” if the response “no” was obtained for at least one of the questions on the questionnaire for the age of the child. On the other hand, when all the answers were adequate, the child was considered as presenting development expected for his or her age. For the analysis of the data, the possible results of the audiologic evaluation were: normal hearing, conductive hearing loss, and sensorineural hearing loss.

Data analysis

The data were tabulated in the Microsoft Office Excel database, version 14.0, and later submitted to statistical descriptive analysis by means of the calculation of the sensitivity index, specificity, false positive, false negative, positive, and negative predictive values; the reliability interval was 95% for all the measurements. Additionally, the reason of likelihood ratio was calculated.

RESULTS

In the audiologic evaluation, out of the 304 children, 75...
(24.67%) presented hearing alteration and 229 (75.33%) presented normal results. The hearing alteration classification in regard to type, in accordance with the audiologic evaluation, is described in Table 1. As for the degree, the observed auditory alterations were mild or moderate, regardless of type.

Table 1. Distribution in regard to the type of hearing alteration of the diagnosed children

<table>
<thead>
<tr>
<th>Hearing alteration</th>
<th>Number of children</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unilateral conductive</td>
<td>28</td>
<td>37.3</td>
</tr>
<tr>
<td>Bilateral conductive</td>
<td>41</td>
<td>54.7</td>
</tr>
<tr>
<td>Unilateral sensorineural</td>
<td>2</td>
<td>2.7</td>
</tr>
<tr>
<td>Bilateral sensorineural</td>
<td>4</td>
<td>5.3</td>
</tr>
<tr>
<td>Total</td>
<td>75</td>
<td>100</td>
</tr>
</tbody>
</table>

Of the 69 children with conductive hearing loss due to serous otitis media, according to the audiologic evaluation and the diagnosis carried out by the ENT doctor of the institution, only one (1.45%) was identified by the applied questionnaire.

Considering only the sensorineural hearing losses, Table 2 presents the distribution of the casuistry according to the results obtained in the follow-up questionnaire and the audiologic evaluation.

Table 2. Distribution of the casuistry according to the results obtained in the monitoring questionnaire and the audiologic evaluation, considering the sensorineural hearing losses

<table>
<thead>
<tr>
<th>Questionnaire result</th>
<th>Audiologic evaluation</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Normal</td>
<td>Abnormal</td>
<td>Total</td>
</tr>
<tr>
<td>Identified as at risk</td>
<td>11</td>
<td>4</td>
<td>15</td>
</tr>
<tr>
<td>Identified as not at risk</td>
<td>287</td>
<td>2</td>
<td>289</td>
</tr>
<tr>
<td>Total</td>
<td>299</td>
<td>6</td>
<td>304</td>
</tr>
</tbody>
</table>

The analysis of the validity of the follow-up questionnaire applied by the CHAs for identification of sensorineural hearing loss, including the reliability interval of 95% and the analysis of the reason of positive likelihood, can be found in Table 3.

Table 3. Analysis of the validity of the monitoring questionnaire applied by the community health agents for identification of sensorineural hearing loss

<table>
<thead>
<tr>
<th>Measurements</th>
<th>Rates</th>
<th>Confidence interval of 95%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Lower limit</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>67%</td>
<td>29%</td>
</tr>
<tr>
<td>Specificity</td>
<td>96%</td>
<td>94%</td>
</tr>
<tr>
<td>False positive</td>
<td>4%</td>
<td>1.5%</td>
</tr>
<tr>
<td>False negative</td>
<td>33%</td>
<td>-4%</td>
</tr>
<tr>
<td>Positive predictive value</td>
<td>27%</td>
<td>4%</td>
</tr>
<tr>
<td>Negative predictive value</td>
<td>99%</td>
<td>98%</td>
</tr>
<tr>
<td>Likelihood ratio</td>
<td>18%</td>
<td>8</td>
</tr>
</tbody>
</table>

DISCUSSION

The use of questionnaires as a way of identifying alterations in the auditory development in different age groups is widely discussed in the literature\(^{21-24}\).

In the present study 69 children (22.7%) were diagnosed with conductive hearing loss and four with sensorineural losses (1.32%), both with a mild or moderate degree.

A high rate of middle ear alteration was not identified by the questionnaire (Table 1). In this case, the hearing loss found is conductive, generally of a mild degree, which makes identifying it through the questions answered by the parents difficult; once the child reacts to and observes medium/strong-intensity sound, as well as observes verbal language acquisition and development, what turns to suspicion of auditory alteration on the part of the extremely difficult family. Previous studies demonstrated that questionnaires are not considered effective tools for the identification of conductive hearing losses, since they do not differentiate children with or without conductive disorders\(^{25,26}\).

However, the fact that the questionnaire does not identify conductive hearing losses presented itself as an advantage for the program that uses it, since early identification of the serous otitis media in asymptomatic children does not improve the results of the intervention; thus, the hearing screening in this situation is not recommended\(^{27}\).

Generally, the studies pointed out that questionnaires directed to the identification of alterations in the hearing function present specificities between 94% and 100% and sensitivity varying from 10% to 75%\(^{21-24}\). This variability in sensitivity can be justified by the methodological differences in regard to the age group studied, comprised of children between 6 months and 7 years of age; or with regard to the value of audibility considered as hearing loss, which in some studies had been considered 40 thresholds above the dB HL definition of incapacitating loss of the WHO\(^{20}\) or above 20 dB HL when considering children of 0 to 1 year\(^{29}\).

As observed in Tables 2 and 3, when the sensorineural hearing loss is considered, the applied questionnaire demonstrated specificity of 96% and sensitivity of 67% – data consistent with the previous studies that used the questionnaire as methodology\(^{21-24}\). It is important to highlight that the sensitivity of the tool and the false negative index obtained (33%) were the result of the non-identification of the two children with unilateral sensorineural hearing loss. This should not be analyzed as a weakness in the procedure, since a point that must be considered is the family’s perception of the development of the child’s auditory and language function\(^{23}\).

In general, regardless the socio-economic level, the non-reaction to sound\(^{29}\) and the non-acquisition of the language\(^{30}\) are the main indications that make families suspect hearing alterations. In the presence of unilateral hearing loss such indications are minimized, which makes it difficult for the families to suspect something is wrong. The monthly application of the questionnaire increases the possibility of identifying these alterations without increasing the cost of the procedure since the proposal is that such action be included in the routine of the NHS.

As for the false positive rate (4%), it is within the proposed rate of the committees for the hearing screening programs, thus suggesting that the procedure does not require extreme costs by
virtue of a large amount of children referred to the audiologic evaluation who do not present alteration. Such data are also evidenced by the likelihood ratio, defined as the possibility of the positive result to diagnose the true illness and not a false result. The obtained value was 18, which is equivalent to saying that the possibility of the result in the questionnaire being a true-positive is 18 times greater than the possibility of it representing a false-positive result.

Considering the results presented, we can consider the use of the questionnaire effective, not as a screening tool for hearing, but as a complement to the NHS Program, using the tool as a way to monitor the development of the auditory and language functions of all children in the first year of life, regardless of whether they were submitted to the NHS by professionals such as the CHAs. The characteristic of the HFS allows for the monthly follow-up by the CHAs, with the application of the questionnaire in the home visits. The questionnaire assumes, thus, an informative role for the family, who start to value hearing and observe the children's responses. The questionnaire had, therefore, an educational and multiplying role in the prevention of the hearing deficiency.

However, it is necessary to understand that when this tool is used, it is possible to identify bilateral hearing losses of higher severity, not detecting unilateral cases of mild losses or unilateral auditory losses. In the first year of life the family's suspicion of mild alterations is extremely uncommon due to the fact that speech and language development in these cases can be similar to that of children with normal hearing. The proposal to restrict the monitoring to the first year of life has as its objective the gradual insertion of this procedure in the NHS routine, in an effort to improve organization and understand the difficulties. However, it is a fact that in the future this age group will have to be extended, in view of the occurrence of acquired hearing losses or late manifestation.

CONCLUSION

The use of the questionnaire proposed in this study proved to be viable and pertinent to the actions developed by the community health agents of the Family Health Strategy teams. Associated with this, it stirred the families' interest and observations of the hearing development of their children, in addition to raising questions about the causes of the hearing loss, playing, thus, an educating and multiplying tool in the prevention of hearing deficiency.

ACKNOWLEDGEMENTS

The National Council for Scientific and Technological Development (Conselho Nacional de Desenvolvimento Científico e Tecnológico – CNPq) for the research grant provided for the accomplishment of the study, process number 403719/2004-6.

* KFA contributed substantially to acquisition, analysis and interpretation of data, drafting the article, critical review and final approval of the manuscript.

ES A contributed substantially to analysis and interpretation of data, drafting the article, critical review and final approval of the manuscript. TMM contributed substantially to acquisition, analysis and interpretation of data, drafting the article and final approval of the manuscript. MANM contributed substantially to acquisition, analysis and interpretation of data, drafting the article, and final approval of the manuscript. MCB contributed substantially to analysis and interpretation of data, drafting the article, and final approval of the manuscript.

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Appendix 1. Questionnaire of monitoring of the development of the hearing and the language

| Name: | Date of birth:__/__/__ |
| Area: | Micro area: |
| Family: | |

### 1st day to 30/31 days

1. Can your child hear well? ( ) yes ( ) no
2. Does your child get startled with loud noises? ( ) yes ( ) no

### 2nd month

1. Can your child hear well? ( ) yes ( ) no
2. Does your child pay attention to sounds? ( ) yes ( ) no
3. Does your child recognize your voice? ( ) yes ( ) no

### 3rd month

1. Can your child hear well? ( ) yes ( ) no
2. Does your child calm down with music? ( ) yes ( ) no
3. Does your child make cooing sounds? ( ) yes ( ) no

### 4th month

1. Can your child hear well? ( ) yes ( ) no
2. Does your child turn his/her head towards sounds? ( ) yes ( ) no
3. Does your child make more sounds, i.e. fffff, oooo? ( ) yes ( ) no

### 5th month

1. Can your child hear well? ( ) yes ( ) no
2. Does your child look when you call? ( ) yes ( ) no
3. Does he/she say mamama, dadadada as trying to talk? ( ) yes ( ) no

### 6th month

1. Can your child hear well? ( ) yes ( ) no
2. Does your child look around when called? ( ) yes ( ) no
3. Does he/she say mamama, dadadada as trying to talk? ( ) yes ( ) no

### 7th month

1. Can your child hear well? ( ) yes ( ) no
2. Does your child recognize names of family members? ( ) yes ( ) no
3. Does he/she say several different syllables? ( ) yes ( ) no

### 8th month

1. Can your child hear well? ( ) yes ( ) no
2. Does he/she try to imitate sounds? ( ) yes ( ) no
3. Does he/she play with toys that make noise? ( ) yes ( ) no

### 9th month

1. Can your child hear well? ( ) yes ( ) no
2. Does he/she speak when you say no? ( ) yes ( ) no
3. Does he/she babble as if talking? ( ) yes ( ) no

### 10th month

1. Can your child hear well? ( ) yes ( ) no
2. Does he/she wave when he hears bye bye? ( ) yes ( ) no
3. Does he babble as if talking? ( ) yes ( ) no

### 11th month

1. Can your child hear well? ( ) yes ( ) no
2. Does he/she turn quickly when called? ( ) yes ( ) no
3. Does he/she play with toys that make noise? ( ) yes ( ) no

### 12th month

1. Can your child hear well? ( ) yes ( ) no
2. Does he/she say his first word? ( ) yes ( ) no
3. Does he understand commands such as “where’s it” and “give it to me”? ( ) yes ( ) no