SINGLE PURE TONE SCREENING TEST FOR DEAFNESS

BY

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INTRODUCTION

Purpose of the screening test is to discover a hearing disturbance in an early stage quickly and exactly. Recently a prevention of the deafness, chiefly perceptive one, has become an important problem. Recovery can be hardly expected in such deafness. So the most important attention must be payed to an early detection of the deafness for its prevention.

A purpose of an early detection is to find and treat a hearing disturbance before a subjective feeling of the patient. An exact and early detection of hearing disturbance, which is in a period of incubation, by a simple procedure is required. Occupational deafness due to a noise and intoxicative deafness by medicines like streptomycin advance showing peculiar type of audiogram (Fig. 1 and Fig. 2). In these deafness, it is theoretically supposed that the deafness can be detected in a period of incubation by a single pure tone screening test.

Needless to say that it is a good method to make an exact audiogram

Fig. 1 Audiogram of an early stage of occupational deafness

Fig. 2 Audiogram of an early stage of streptomycin deafness

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for each patient by routine audiometry. But this method is not suitable for wholesale hearing examination about a group because of too much works and times. So a simple screening test method is required. This investigation has been carried out from this requirement\textsuperscript{1,2,5,6}.

**Principle of Single Pure Tone Screening Test**

As previously mentioned, about the occupational deafness due to a noise in a factory, dip-tipe at 4000 cps (C\textsuperscript{5}) is peculiar and it is unnecessary to pay attention to hearing disturbance besides at 4000 cps in the screening test (Fig. 3). In this case at least C\textsuperscript{5}-dip can be detected by hearing test about 4000 cps only. In other words 4000 cps can be used for a screening test tone. Hearing loss at 4000 cps means not always occupational deafness\textsuperscript{5,6}. So further close hearing examination should be required to the screened group. High tone (8000 cps) can be used for the screening test of the perceptive deafness resulted from intoxication by medicines like streptomycin\textsuperscript{4} (Fig. 4). Briefly to say about the principle of single pure tone screening test, group of deafness with a typical type of audiogram is screened by fixing the out-put level of a single test tone at the critical level\textsuperscript{11}.

We established a fundamental theory "how a test tone of the screening". As for level of the screening test tone, it must be decided in each case. Reasons for adopting the out-put level of the screening test tone will be described in the following paragraphs.

I. **Screening Test for Streptomycin Deafness*\textsuperscript{*}\textsuperscript{*}

As for the streptomycin-deafness, if hearing loss extends to speech range

\* thereafter called SM deafness
and a subjective feeling appears in a patient, we have no proper treatment now. We must find it in a very early stage without a subjective feeling and prevent the further progression of hearing loss to speech range. For this purpose, hearing test must be repeated to the patients but the repeated hearing test can not be performed. In these cases, times and works can be saved by the screening test of a single pure tone which always appears in early stage of the deafness resulted from intoxication. It has been observed in our investigation that 8000 cps at the level of 15 db (SL) can be used for the screening test of the SM deafness. Reasons are as follows.

Reasons for using 8000 cps as the test tone of the single pure tone screening test:

Materials were 1045 patients with tuberculosis who were given streptomycin at the affiliated hospitals of the Tokyo Medical and Dental University and the Toshiba hospital. In those patients, we have carefully investigated “how the SM deafness appeared” by the hearing test with audiometer since their admittance to the hospitals. As a result, it became clear that the SM deafness appeared from 8000 cps\(^3\) (Figs. 2 and 5). When much higher tone (10000 cps) was used, it was always observed that SM deafness appeared from much higher tone range and a hearing loss extended to the speech range with the further progression of deafness in high tone\(^3\). Air conduction out-put level of the audiometer in higher test tone beyond 8000 cps has been standardized by JIS (Japanese Industrial Standard). So we chose 8000 cps as the test tone.

At the first test of some patients, dip was found at 4000 cps. There was a relationship between occupational deafness and occupational histories. In the present investigation there was no SM deafness which began or

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**Fig. 5** Audiograms for both ears of streptomycin deafness (Deafness is always bilateral and symmetrical.)
progressed from the dip-type of 4000 cps in 1045 patients with tuberculosis.

*Reasons for adopting the level at 15 db:*

It was always observed in the SM deafness that a hearing loss appeared in high tone range in early stage and it extended to speech gradually. The deafness never ceased its progress even after cessation of the SM administration. So it is necessary to detect the deafness in early stage before a subjective feeling and control the SM administration. Even a little change from the normal hearing threshold must be discovered and the progression of deafness to speech range must be prevented by examining the patients repeatedly. In the present investigation, the level of 15 db at 8000 cps was statistically obtained with consideration of measurement errors from rejection limit at the level of 5% of normal hearing threshold (Table 1).

<table>
<thead>
<tr>
<th>Rejection limit at the level of 5% (db)</th>
<th>125</th>
<th>250</th>
<th>500</th>
<th>800</th>
<th>1000</th>
<th>2000</th>
<th>3000</th>
<th>4000</th>
<th>8000 cps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard deviation (db)</td>
<td>8.1</td>
<td>6.5</td>
<td>6.0</td>
<td>4.8</td>
<td>4.8</td>
<td>5.2</td>
<td>6.0</td>
<td>5.8</td>
<td>7.5</td>
</tr>
</tbody>
</table>

Standard deviation of air conduction thresholds contained measurement errors and rejection limit at the level of 5% for ears without clinical findings.

So 15 db was adopted as the screening test tone level. When the sound-proof room was not applicable, the level at 20 db could be used in a relatively quiet room.

Unilateral ear can be used for the screening test of SM deafness.

The streptomycin deafness appeared in both ears symmetrically and advanced with the same progress (Fig. 5). The deafness never appeared in unilateral ear only, so ear of one side was enough for the screening test. There was an exception in the middle grade progressed SM deafness that unsymmetrical deafness was more or less detected at 4000 cps and 8000 cps. In early stage of the SM deafness, none of 1045 patients had hearing loss within 15 db in one ear and more than 30 db in the other side ear. The deafness of worse ear of those patients (within 15 db in one ear and more than 30 db in the other side ear) was combined with chiefly conductive deafness. If this unsymmetrical type of audiogram was found after more than 20 g of streptomycin administration, the deafness never progressed to speech range rapidly. In this case the streptomycin administration could be continued. However, streptomycin deafness, which appeared after less than 20 g of streptomycin administration, usually progressed very rapidly. The
course should therefore be carefully watched. Six of such patients were
found out of 1045 cases treated with streptomycin.

When the test was performed about the worse ear with a subjective
feeling, other high tone hearing loss due to otitis media chronica or un-
known reason was screened out. As a result materials which needed re-
examination increased and the SM deafness became hard to be detected.
This is against the meaning of the screening test.

Results

The screening test was performed with 800 cps at the out-put level
of 15 db.

Efficiency: By the screening test 185 persons out of 1045 patients were
screened out. The SM deafness was detected in 118 patients. The rest
(67 patients) contained presbycusis, occupational deafness and perceptive
deafness due to unknown reason. The SM deafness was detected by the
test without “too much pass”**. Result were shown in Table 1.

Time needed for the screening test: Thirty seconds for each patient
and one hour for about 150 patients (Table 2).

Table 2. 1) Evaluation of the screening test for SM deafness.

<table>
<thead>
<tr>
<th>Efficiency of examination</th>
<th>Persons tested</th>
<th>Persons screened out</th>
<th>SM deafness</th>
<th>Hearing loss other than SM deafness</th>
<th>SM deafness not screened</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1045</td>
<td>185</td>
<td>118</td>
<td>67</td>
<td>0</td>
</tr>
</tbody>
</table>

* Presbycusis, occupational and other perceptive deafness are contained.
2) Time needed for the screening test:
   a) For routine audiometry..............ca. 4~5 persons/hour.
   b) For the screening test .............ca. 150 persons/hour.

Summary

In order to discover the SM deafness as soon as possible and prevent
its progression, the screening test was performed about better ear of subjec-
tive feeling with 8000 cps at the out-put level of 15 db. But if the adminis-
terated streptomycin was within 20 g better result could be expected by the
test about both ears.

Routine audiometry was performed in the patients who were screened
out. By this procedure, times and works were greatly saved; the SM deafness

** Even ears with hearing loss more than the critical level of screening test pass through
the screen.
was detected accurately from the patient without a subjective feeling; further streptomycin administration was controled; progression of the deafness to speech range was prevented.

II. The screening test for occupational deafness

Similarly to the SM deafness, there is not so effective therapy for the occupational deafness which extends to speech range. Preventive treatment of the deafness and detection of hearing loss before it extends to speech range must be needed.

Control of a noise level, use of noise reduction materials in a noisy environment or ear-plugs are important preventive treatments for the deafness. But presently there is no proper method to prevent the occupational deafness. From this reason, detection of the occupational deafness in its early stage and prevention of its progression must be required.

In order to discover the occupational deafness in its early stage without a subjective feeling, the following two things must be clarified. 1) What kind of frequency characteristics of noise level induces the occupational

<table>
<thead>
<tr>
<th>Noise Level (cps)</th>
<th>500</th>
<th>1000</th>
<th>2000</th>
<th>3000</th>
<th>4000</th>
<th>8000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survey of factories* (db)</td>
<td>90</td>
<td>85</td>
<td>80</td>
<td>80</td>
<td>80</td>
<td>80</td>
</tr>
<tr>
<td>Experimental study on auditory fatigue** (db)</td>
<td>85</td>
<td>80</td>
<td>75</td>
<td>75</td>
<td>80</td>
<td>80</td>
</tr>
</tbody>
</table>

* M. Ideimitsu.
** M. Harigaya.

db: sound pressure level (re: 0.0002 dynes/cm²).

Fig. 6 Some cases of 5000 cps. and 6000 cps. dip type of occupational deafness
deafness? 2) How does the deafness progress? The former shows a damage risk criteria of noise level and a test tone for single pure tone screening test is obtained from the latter. IDEMITSU and HIRIGAYA have already obtained a definite information about a damage risk criteria of the noise level (Table 3). According to them, 4000 cps-dip type of audiogram preceded in the occupational deafness and hearing loss extended to speech range with a pan-bottom curve (bottom was 4000 cps). In some occupational deafness, 5000 cps- or 6000 cps-dap preceded (Fig. 6 and Fig. 7).

Even in these cases no influence of hearing loss was scarcely found at 4000 cps. On the contrary, in the occupational deafness which began from 4000 cps-dip, no influence of hearing loss was occasionally found at 5000 cps or 6000 cps. From these observations 4000 cps at the level of 30 db was adopted as the test tone of screening.

*Reasons for using 4000 cps as the test tone of the pure tone screening test:*

In the occupational deafness 4000 cps-dip preceded. Bottom of audiogram was not always 4000 cps and sometimes it was 5000 cps or 6000 cps. Also 3000 cps was observed as a bottom in a few cases. Whichever the dip might be 3000 cps, 5000 cps or 6000 cps, hearing loss should be found at 4000 cps in most cases (Fig. 7).

![Graph](image)  
Fig. 7 Dip type for various tones:  
(1) 3000 cps dip  
(2) 4000 cps dip  
(3) 5000 cps dip  
(4) 6000 cps dip

The occupational deafness, which passed a beginning stage, extended to both of low and high tone ranges from 4000 cps-dip as the bottom of hearing loss. In the other case the deafness extended to high tone range only from 4000 cps-dip and showed abrupt high tone loss type of audiogram.
From these observations it was clearly thought that the occupational deafness began from 4000 cps. Also since 4000 cps was standardized by JIS, we decided to use 4000 cps as the test tone.

**Reasons for adopting the level at 30 db:**

There was a possibility that presbycusis intervened to the materials for the screening test of occupational deafness, because the materials contained many people more than 50 years old. When the level of rejection limit (15 db, 20 db) of ear with normal hearing was selected as the level of the screening test tone, presbycusis and conductive deafness were screened. This is against the purpose of the screening test. Average of physiological hearing threshold of fifties were 21 db at 400 cps and 10 db at 2000 cps\(^7\) (Figs. 8 and 9). If the level of 30 db was adopted with consideration of

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**Fig. 8 Age changes in audiogram:**

1. average of 30~39 years old
2. average of 40~49 years old
3. average of 50~59 years old
4. average of 60~69 years old
5. average of 70~79 years old

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**Fig. 9 Overlapping of audiograms of occupational deafness and presbycusis. Dotted area shows distribution limit of hearing loss in group of 50~59 years old.**

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measurement errors as a screening tone level at 4000 cps, the occupational deafness could be discovered in early stage without a subjective feeling.

As a screening test tone level of young people, the level of 30 db at 4000 cps is not suitable for detection of the occupational deafness in early stage. But it can be used for detection of hearing loss before its extension to speech range.

**Result:**

**Efficiency:** The screening test was performed with 4000 cps at the level of 30 db about 1128 ears at the moving soundproof room in the factory. Simultaneously routine audiometry was performed and results were compared (Table 4).
Table 4. 1) Evaluation of the screening test for occupational deafness.

<table>
<thead>
<tr>
<th>Efficiency of examination (ears)</th>
<th>Ears tested</th>
<th>Ears screened out</th>
<th>Hearing loss caused by occupational deafness</th>
<th>Hearing loss within 30 db</th>
<th>Occupational deafness not screened out</th>
</tr>
</thead>
<tbody>
<tr>
<td>1098</td>
<td>616</td>
<td>595</td>
<td>21</td>
<td>17</td>
<td></td>
</tr>
</tbody>
</table>

2) Time needed for the screening test:
   - For routine audiometry .......... ca. 4~5 persons/hour.
   - For the screening test ............ ca. 150 persons/hour.

Note. Hearing loss other than occupational deafness .......... 30 ears.
(mainly conductive deafness contained)

The test was performed before work in the next morning of holiday. Because hearing fatigue intervened to the occupational deafness after work and tinnitus or stuffy feelings increased in the ear.

Results from 30 ears were neglected in the present paper. Because remarkable perforation of ear drum and conductive deafness of middle ear were found with the otoscope. Results from 1098 ears were shown in Table 4. As shown in Table 4 “too much remain*” was screened in 1.9% (21 ears) of 1098 ears and “too much pass” was observed in only 1.5% (17 ears). Most of these 38 ears threshold at 4000 cps ranged from 25 db to 35 db.

Time needed for the screening test: Routine audiometry needed one hour for 4 or 5 patients. The screening test at 400 cps at the level of 30 db needed one hour for 150 patients. In the latter case patients were adults.

Generally the time was influenced by S/N ratio of hearing test room. But if relatively quiet and warm room was selected the test could be performed at the level of 30 db without soundproof room.

III. The screening test for school children deafness

There are two purposes in the hearing test for school children. 1) In order to decrease the deafness in adult with fixed symptom, it is necessary to discover hearing disturbance in its early stage and treat it during school children. 2) It is to keep hearing which is needed for school education. In the case of 1) discovery of perceptive deafness in early stage particulary important.

It goes without saying that pure tone is superior to speech sounds for the test to detect the deafness in its early stage. However, it is still argued about accuracy of the test, time needed for the test and the test method (instruments, expenses, group or individual).

* screened even ears of hearing loss less than critical level.
Principle of screening test for deafness in general:

Some ears with hearing loss showed various audiograms. Previously mentioned single pure tone screening test was available for the screening of the deafness with a peculiar audiogram only. Can this principle extend to discovery of deafness in early stage generally? This possibility has been studied by Ebihara, Yanagisawa and Fujimori\(^8,9\).

Ebihara et al.\(^5\) have analysed threshold shift between each test tone about audiograms (test tones were 125, 250, 500, 800, 1000, 2000, 3000, 4000 and 8000 cps) of bone- and air-conduction of perceptive, conductive and mixed type of deafness. From the agreement between results of analysis of covariance and the chi-test in ogive of threshold difference between each test tone, 6 frequency bands, of which hearing disturbance shifted in the same mode, were observed. These bands were named the frequency correlation band by the authors (Fig. 10). Threshold difference between each test tone in each band could be considered as measurement errors. For instance, when 1000 cps was used for the test tone, limit of threshold of 500 cps or 800 cps should be within measurement errors of 1000 cps. From the above mentioned results, simplification of the present routine audiometry should be established.

The screening test is expected to satisfy the following 3 matters. 1) To screen the ear with hearing disturbance from normal ear. 2) To perform the test quickly. 3) To discover the deafness, which tends to extend to speech range, in early stage. It is possible to decrease the test tone moreover.
Ebihara, Fujimori\(^9\) have investigated about various types of audiogram using 5 test tones (250, 500, 1000, 4000 and 8000 cps) what test tone gave frequently a hearing loss and whether the disturbance preceded the deafness. If the tone, at which hearing disturbance took place frequently, was found, this tone could be adopted as a screening test tone. Ebihara et al. persisted that some combination of 1000, 4000 and 8000 cps must be adopted as the screening test tones. As the results by Ebihara et al., previously mentioned the screening test tones (4000 cps and 8000 cps) of the occupational deafness and the SM deafness were especially used in some deafness.

It was concluded that screening test generally could be performed by less than 3 tones for detection of deafness in early stage.

The authors thought that the screening test of school children had the following 4 practical purposes. 1) Screening the ear which needs medical therapy. 2) Discovery of progressive deafness in early stage. 3) Screening the ear which must be continuously observed. 4) Screening the ear which needs evaluation and classification of the residual hearing. Also the screening test method must satisfy the following 5 conditions. a) It must be an objective method. b) Even a slight hearing disturbance could be found by it. c) Time needed for the test must be short and many people can be examined in a short time. d) Procedure must be simple and can be done by anyone. e) Expenses must be cheap.

In order to shorten the time for the test, numbers of the test tones could be decreased and an intensive tone, which was not masked by noise, could be adopted. But to find a slight hearing disturbance, lower out-put level of the screening tone should be used. Considering the test conditions, type of hearing disturbance and progression of the deafness, 1000 cps and 4000 cps at the level of 20 db were adopted as the screening test tones. Because a slight hearing disturbance must be detected before it extended to speech range.

Reason for using 1000 cps and 4000 cps as the test tone of the pure tone screening test\(^9\).

Audiograms from 3437 ears of school children (4 schools) were carefully observed with other clinical examinations. Distribution of air conduction threshold in 1286 ears without findings was within level of 20 db with rejection limit at the level of 1% (Table 5). The critical level between ears with an without findings was found at the level of 20 db. If the under limit of normal audiogram was decided within 20 db, in 2.6% hearing loss more than 25 db was detected in low tone range (below 1000 cps); in 2.4% hearing loss was detected in high tone range (more than 2000 cps and 4000 cps); in 2.4% hearing loss extended to more than
Table 5. Distribution of air conduction threshold of school children without findings. (Total 1206 ears)

<table>
<thead>
<tr>
<th></th>
<th>500</th>
<th>1000</th>
<th>2000</th>
<th>400  (cps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average of threshold (db)</td>
<td>9.28</td>
<td>9.15</td>
<td>7.14</td>
<td>7.65</td>
</tr>
<tr>
<td>Standard deviation (db)</td>
<td>4.31</td>
<td>4.34</td>
<td>4.20</td>
<td>4.43</td>
</tr>
<tr>
<td>Rejection limit at the level of 1% (db)</td>
<td>±11.05</td>
<td>±11.15</td>
<td>±10.70</td>
<td>±11.28</td>
</tr>
</tbody>
</table>

25 db at over-all range. It was supposed that at least 1/3 ears with hearing loss might failed to be discovered by the use of only one test tone (Fig. 11).

Fig. 11. Audiogram of many type of hearing disturbance of school children. (Total 3473 ears) (When a single pure tone is used, one third of hearing disturbance inevitably escapes screening-out.)

Figures shows type of hearing loss audiogram:

1. type of low tone hearing loss (2.6%)
2. type of high tone hearing loss (2.4%)
3. flat type of hearing loss (2.4%)
4. ears without findings

From the purpose to discover hearing disturbance in high tone range before it advanced to speech range, 4000 cps was suitable for the test tone. Because 4000 cps closed to speech range. For the test tone of low tone disturbance, 1000 cps alone could be used. The 1000 cps is more important for the weight of frequency region for intelligibility than low tone range below 500 cps. Also 1000 cps is hardly masked by noise in the test room. So a quiet room in which test tone could be heard easily was chosen in a school if 20 db was used as the out-put level of the screening tone. From statistical conclusion about behavior of threshold shift which was frequency
correlation band and above mentioned 4 reasons, 2 tones of 1000 and 4000 cps were used for the screening test.

_Reason for adopting the out-put level at 20 db for each tone_: The weaker tone was used as fixed level of the screening test tone, much slighter hearing disturbance could be discovered. But level of the screening tone became masked easily by noise and even normal ear might be screened as deaf. Also time needed for the test postponed. It was necessary to decide a level of the screening tone with consideration of test.

As previously mentioned normal hearing of 1286 ears of school children showed nearly the Gaussian standard distribution and its rejection limit at the level of 1% was within 20 db. Level of 20 db (SL) as the critical level was not changed by differences of school environment like between city and village, intelligence between year grade and age changes of hearing. Moreover, besides the soundproof room in which level of 20 db (SL) could be heard, was easily chosen in the school.

If the screening test could be performed in moving hearing test room, numbers of ear with normal hearing were decreased and the test time became shorter. But if attention payed to “too much remain” by masking from noise the test time never postponed without soundproof room.

_Retults:_
Routine audiometry and the screening test in or out the soundproof room were performed about 2270 ears of primary school children (3 schools of city and village). The test was done for each individual person and a simple audiometer was designed for the screening test. Accuracy and time of the test were investigated.

_Efficiency:_ It was possible to screen the hearing loss more than 25 db by 1000 cps and 4000 cps at the level of 20 db of the screening test tone. According to audiogram hearing loss more than 25 db was detected in 103 ears at 1000 cps and in 80 ears at 4000 cps. Screened ear numbers were 87 (84.5%) at 1000 cps and 62 (77.5%) at 4000 cps. Ears with hearing loss more than 30 db were screened in 100%.

<table>
<thead>
<tr>
<th></th>
<th>Test tone</th>
<th>Ears tested</th>
<th>Ears screened out</th>
<th>Hearing loss more than 25 db</th>
<th>Hearing loss more than 30 db</th>
<th>Hearing loss within 20 db</th>
</tr>
</thead>
<tbody>
<tr>
<td>In soundproof room</td>
<td>1000 cps</td>
<td>1085</td>
<td>37</td>
<td>23 (88.5%)</td>
<td>6 (100%)</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>4000 cps</td>
<td>1085</td>
<td>23</td>
<td>18 (75%)</td>
<td>12 (100%)</td>
<td>5</td>
</tr>
<tr>
<td>In quiet room</td>
<td>1000 cps</td>
<td>1085</td>
<td>155</td>
<td>22 (84.6%)</td>
<td>5 (100%)</td>
<td>133</td>
</tr>
<tr>
<td></td>
<td>4000 cps</td>
<td>1085</td>
<td>57</td>
<td>18 (75%)</td>
<td>12 (100%)</td>
<td>39</td>
</tr>
</tbody>
</table>

Table 6. 1) Evaluation of the screening test examined only one time for school children.
Table 7. 2) Time needed for the screening test in a sound-proof room.

<table>
<thead>
<tr>
<th></th>
<th>1 year</th>
<th>2 year</th>
<th>3 year</th>
<th>4 year</th>
<th>5 year</th>
<th>6 year and those beyond 6 year</th>
</tr>
</thead>
<tbody>
<tr>
<td>For routine audiology (persons/hour)</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>4~5</td>
<td>4~5</td>
<td>4~5</td>
</tr>
<tr>
<td>For the screening test (persons/hour)</td>
<td>70</td>
<td>80</td>
<td>100</td>
<td>120</td>
<td>150</td>
<td>150</td>
</tr>
</tbody>
</table>

“Too much remain” was partially resulted from indifference of children about purpose and procedure of the screening test, but chiefly resulted from masking by noise in the test room. As shown in Tables 6 and 7, slighter hearing loss than level of the screening tone was remarkably increased by the screening test outside the soundproof room. Hearing loss of “too much remain” was 20 db in most cases by the screening test in the soundproof room. “Too much remain” took place chiefly in one year grade of primary school. From these results it was thought that understanding of purpose and procedure of the test was important.

A two-time test outside the soundproof room could prevent “too much remain”. A two-time test did not need so much time, because the test was performed to the patients who were screened at the first test (Table 8).

Table 8. 1) Evaluation of the screening test repeated more than two times for times for school children in a quiet room.

<table>
<thead>
<tr>
<th>Test tone</th>
<th>Ears tested</th>
<th>Ears screened out at 1st screening test</th>
<th>Ears screened out at 2nd screening test</th>
<th>Hearing loss more than 25 db</th>
<th>Hearing loss more than 30 db</th>
</tr>
</thead>
<tbody>
<tr>
<td>Efficiency examination</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1000 cps</td>
<td>1082</td>
<td>238</td>
<td>77</td>
<td>15 (84.5%)</td>
<td>5 (100%)</td>
</tr>
<tr>
<td>4000 cps</td>
<td>1082</td>
<td>52</td>
<td>40</td>
<td>27 (77.5%)</td>
<td>15 (100%)</td>
</tr>
</tbody>
</table>

2) Time needed for screening test performance repeated two times in a quiet room.

<table>
<thead>
<tr>
<th></th>
<th>1 year</th>
<th>2 year</th>
<th>3 year</th>
<th>4 year</th>
<th>5 year</th>
<th>6 year</th>
</tr>
</thead>
<tbody>
<tr>
<td>For screening test (persons/hour)</td>
<td>50</td>
<td>60</td>
<td>80</td>
<td>100</td>
<td>100</td>
<td>100</td>
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“Too much pass” by 1000 cps and 4000 cps at the level of the test tone was detected in 2 ears with hearing loss 30 db in low tone range below 500 cps and in 3 ears with hearing loss more than 30 db at 8000 cps. This was thought to be satisfied result.

Time needed for the test: Low year grade needed longer time for the screening test and the routine audiometry. The screening test needed one hour for 70 children of first year grade, 90 of second year grade, 100 of third year grade and 120 to 150 of over four year grade respectively. The
routine audiometry needed one hour for 3 to 5 children. So the screening test was thought to be superior to the routine audiometry in the time and accuracy. There was a possibility that it became difficult to hear the screening tone under the noise and the test time postponed.

From the present investigation the law of hearing test for school children was renewed by the ministry of education in Japan.

CONCLUSION

From the careful clinical investigation of onset and progress of the deafness, it was theoretically concluded that deafness could discovered in early stage. The screening test designed by the authors was performed about the SM deafness, occupational deafness and school children deafness. Good results about accuracy in discovery of the early stage deafness, time needed for the test, and simplification of the test method were obtained.

1) The screening test was performed with 4000 cps at the level of 30 dB (SL) about the occupational deafness. “Too much remain” was 1.8% of 1128 ears; “too much pass” was 1.5%; 97.2% of the occupational deafness was accurately detected. 2) The screening test for the SM deafness was performed with 8000 cps at the level of 15 dB (SL). “Too much remain” was 0% of 1045 ears; “too much remain” was detected in 67 ears with presbycusis, conductive and perceptive-deafness. 3) The screening test of the school children deafness was performed with 1000 cps and 4000 cps at the level of 20 dB (SL). Hearing loss over 25 db was detected in 77.5% and 84.5% and hearing loss over 30 db was detected in 100%. “Too much remain” due to a noise in the test room was decreased by a two-time test.

Each test needed one hour for 70 to 150 persons.

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REFERENCES


