

Recommended procedure

Hearing assessment in general practice, schools and health clinics: guidelines for professionals who are not qualified audiologists

P.A. Smith and P.I.P. Evans

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1 Introduction

Most hearing assessments are conducted by qualified audiological professionals in purpose-designed audiology departments. However, there are many situations in which it may be desirable for hearing threshold levels to be measured in non-optimum conditions, or by personnel who are not qualified audiologists (for example in general practice, schools and health clinics). Specifically, in the case of general practice, it can help improve the quality of referrals to otorhinolaryngology (ORL) or specialist audiology departments. To measure hearing accurately, it is necessary to follow appropriate test protocols because, although audiometry is a relatively simple test to perform, incorrect procedures or high levels of ambient noise, for example, may render the results invalid. This document is an aid to general practitioners (GPs) and other healthcare personnel who are not qualified audiologists, but who wish to carry out pure tone audiometry and tympanometry as part of their service. The Society wishes to encourage these personnel to adopt high-quality procedures which conform with national standards.

This document does not relate to either industrial audiometry (for which alternative recommendations are available), nor to hearing screening procedures. *Screening* means a procedure which simply has a pass or fail outcome for a specific sound presentation. For example, does the patient hear a 20 dB HL pure tone at 1000, 2000 and 4000 Hz (yes or no)? *Hearing assessment* means measurement of hearing threshold levels.

2 Scope of the document

2.1 Patients

This document applies to adults and children aged six years and older (who are not developmentally delayed) who are capable of performing pure tone audiometry with earphones. The Society recommends that children below the age of six years are always referred to specialist services. For children aged between six and 16 years, it is recommended that any hearing loss or possible hearing loss is referred to specialist services. The only exception would be in cases of otitis media with effusion (OME) if the diagnosis has already been confirmed and the child is undergoing a period of 'watchful waiting'.

2.2 Procedures

Two procedures are relevant in the situations described above.

2.2.1 Pure tone audiometry by air conduction without masking

This is the measurement of hearing threshold levels through earphones in each ear separately.

2.2.2 Tympanometry

This is not a test of hearing but is rather a test of middle ear function. Together with otoscopy, which is an essential prerequisite for tympanometry, it gives information on the mobility of the tympanic membrane and middle ear structures. It may therefore be used to support a diagnosis of OME, and monitor this during a period of 'watchful waiting'. When a hearing loss is present, tympanometry may be used to determine

whether this loss is likely to include a conductive component, and if so, its cause. It is important to realize that detection of a middle ear disorder does not rule out the possibility of an underlying sensorineural loss.

2.3 Resources

This document makes recommendations for appropriate equipment, its safety and calibration, acoustic environment and staff training.

2.4 Referral of patients to specialist services

This document covers the procedures for pure tone audiometry and tympanometry. It does not include any guidance on criteria for referral to specialist services (other than for children, as described above). However, the Society recommends the use of locally agreed referral guidelines. It is clearly important for personnel running this type of service to be trained in the interpretation of results. However, this is outside the scope of this document. Further information on who should be referred for specialist assessment can be found in the *Hearing Aid Council Code of Practice**.

3 Equipment

3.1 Audiometers

Specifications for pure tone audiometers are stated in BS EN 60645 Part 1 (1995). For the purposes defined above, a Type 4 instrument will be adequate. This standard specifies minimum facilities required which are for air conduction (earphone) stimuli at frequencies of 0.5, 1, 2, 4 and 8 kHz at intensity levels from -10 dB HL to 70 dB HL. The audiometer must also meet the appropriate safety standard BS 5724 Part 1: 1989 (IEC 601-1: 1988) and be checked annually for safety, like other electrical equipment. A local medical physics department may be a useful contact for safety procedures.

3.1.1 Calibration of audiometers

A full calibration programme is an essential part of a service testing hearing to ensure results are repeatable and reliable. Audiometry is not worth carrying out unless equipment is rigorously calibrated regularly.

A calibration programme includes three stages:

- *Stage A* is the daily listening check, and involves a listener with known thresholds checking the stimuli produced by the audiometer. This is a very important part of the whole calibration procedure, and is useful in detecting changes in the equipment promptly.
- *Stage B* is the periodic (3–12-monthly) objective calibration whereby all stimuli are measured acoustically by use of a sound level meter and other specialist equipment. It is recommended that this is carried out by a specialist company and it is usual for the audiometer to be sent to them to do this. Although the relevant international standard states that this should be carried out at intervals of between three and 12 months, realistically, it is suggested that 12-month intervals are adequate, providing that Stage A checks are carried out at the start of each session, and show no problem.
- *Stage C* is the baseline, full acoustic calibration required initially and after repair, also carried out off-site.

The relevant international standard that defines this schedule of calibration is ISO 8253-1 (1989). As well as specialist companies, several medical physics departments also offer a calibration service.

3.2 Tympanometers

A basic screening instrument offering tympanometry alone is suitable. The standard BS EN 61027 (1993) states specifications for tympanometers (otoadmittance meters).

3.2.1 Calibration of tympanometers

As for an audiometer, a tympanometer must meet appropriate safety standards and requires stage A, B and C calibration checks. Stage A simply requires the probe to be inserted into a hard-walled cavity with known acoustical characteristics, which will be supplied with the machine. The suppliers are also required by the standard to provide instructions for the use of the cavity. The periodic calibration checks (stages B and C) involve measurement of the frequency and intensity of the probe tone, in a way similar to that of an audiometer. The same personnel will be able to

*Obtainable from: Hearing Aid Council, Witan Court, 305 Upper Fourth Street, Central Milton Keynes MK9 1EH.

perform both audiometer and tympanometer calibration.

4 Acoustical environment

4.1 Maximum ambient noise levels for pure tone audiometry

In order to reliably achieve the ambient noise levels required to test pure tone thresholds down to 0 dB HL at all frequencies (which by definition represents normal hearing in young adults), a sound-treated booth is required. The acoustical environment must comply with the sound levels as specified in ISO 8253: 1 (1989). In many non-hospital environments, the finance required to install a booth will be prohibitive, although, consideration can be given to use of a portable sound-attenuating booth.

In order to test pure tone thresholds reliably down to 20 dB HL (a level which is considered to be clinically important), at frequencies between 0.5 and 8 kHz only, the ambient noise levels shown in Table 1 must **all** be achieved. (If frequencies below 0.5 kHz are to be tested, even more stringent permissible levels apply.) It is particularly important that ambient noise at low frequencies does not exceed the stated levels, because low-frequency noise is effective at masking higher-frequency signals.

4.2 Measurement of ambient noise levels

Initially, measurements need to be made at each octave band across the whole frequency range to determine whether the room is suitable. To achieve this, specialist acoustical equipment is

required and companies/medical physics departments will be able to advise or carry out this task. If these levels cannot be achieved, it is advisable that an audiometry service should not progress.

In addition, a single reading of the ambient noise in dB(A) across all frequencies should be made and a note of this reading included on each audiogram. The dB(A) scale weights the reading according to the response of the human ear. To achieve this a simple portable sound level meter is required and it is technically a simple task (specialist not required). Assuming that the ambient noise is fairly constant, it is adequate to make this measurement when the service is set up, and thereafter once a year, (sooner if there is a change). The ambient noise should not exceed 35 dB(A). If it is higher than this, it is recommended that audiometry should not progress.

4.3 Achieving required ambient noise levels

Note that the background noise can be reduced in some of the following ways:

- Testing in a room away from noise (e.g. traffic, waiting area, playground, staff rooms).
- Timetabling audiometry sessions for quiet times of the week.
- Applying sound damping by having soft furnishings, carpets, curtains etc.
- Fitting double glazing.

Use of noise reducing earphones is advised. These are earphones designed with an extra outer cushion around them to reduce background noise

Table 1. Maximum permissible ambient noise levels for measuring air conduction audiometry to a minimum hearing level of 20 dB between frequencies 500 Hz and 8 kHz*

Mid-frequency of one-third octave band (Hz)	dB Ref: 20 μ Pa	Mid-frequency of one-third octave band (Hz)	dB Ref: 20 μ Pa	Mid-frequency of one-third octave band (Hz)	dB Ref: 20 μ Pa
31.5	98	250	57	2000	50
40	93	315	53	2500	52
50	88	400	44	3150	54
63	84	500	38	4000	56
80	79	630	38	5000	55
100	75	800	40	6300	54
125	71	1000	43	8000	53
160	67	1250	45		
200	62	1600	47		

* Adapted from ISO 8253-1 (ISO, 1989).

at the ear. It is necessary for any earphones to meet the requirements for calibration and they must not be replaced without recalibration of the audiometer.

4.4 Acoustical environment for tympanometry

Tympanometry may be carried out in any room. Sound treatment is not required, although the ambient noise should preferably not exceed 50 dB(A).

5 Staff training

Training is essential for reliable results and all staff undertaking pure tone audiometry and/or tympanometry need to have knowledge and skills in the following areas.

5.1 Knowledge and understanding

- a Anatomy and physiology of the outer, middle and inner ear.
- b Basic physics (acoustics), including decibel scales, in particular dB HL, dB(A), frequency scale.
- c Principles of pure tone audiometry and test procedure (BSA Recommended Procedure).
- d Definitions of normal hearing, conductive hearing loss, sensorineural hearing loss, and common pathologies causing them.
- e Non-organic hearing loss.
- f Principles of tympanometry (BSA Recommended Procedure).
- g Basic otoscopy, including the effects of wax on audiometric results.
- h Contraindications for tympanometry.
- i Function of all equipment and the need for regular calibration at stages A, B and C.
- j Factors which could affect the reliability or validity of the test results.
- k Documentation of test results using the BSA Recommended Format.
- l Relevant specialist services available locally.
- m Communication needs of hearing-impaired people.
- n Medical ethics, including consent and confidentiality.
- o Relevant health and safety issues (e.g. discharging cars).

5.2 Skills

The tester must be able to:

- a Perform otoscopy as a prerequisite for testing.

- b Reliably perform air conduction audiometry and tympanometry, and accurately record results according to the BSA Recommended Procedures.
- c Carry out daily checks of equipment for faults, and organize objective calibration procedures at regular intervals.
- d Operate a sound level meter to monitor ambient noise and/or arrange noise measurement.
- e Give clear instructions to patients (including those with hearing impairment) as to the response required in each test.
- f Communicate information to other professionals.

The knowledge and the associated skills may be acquired during a short course, of three days' recommended minimum duration (minimum 20 hours), including practical sessions. The course should be approved by the British Society of Audiology. There are no formal entry requirements. However, staff should have hearing levels sufficiently acute for them to perform audiometer listening checks.

Further practical evaluation courses are recommended at intervals not exceeding three years, which aim to update knowledge and evaluate practical techniques. These courses will be most valuable in cases for people who are not routinely doing hearing assessments, and who may deviate from recommended procedures.

Professionals with any of the following qualifications would not need to attend such a course:

- British Association of Audiology technicians (BAAT) Part I and II.
- Hearing Aid Council (HAC) qualification.
- MSc/Diploma in Audiology or equivalent.

6 References

6.1 Protocols

The British Society of Audiology has published the following protocols.

Air conduction thresholds

- 'Recommended procedures for pure tone audiometry using a manually operated instrument' (British Journal of Audiology 1981; 15: 213-6).
- 'BSA recommended format for audiogram forms' (British Journal of Audiology 1989; 23: 265-6).

Tympanometry

- 'Recommended procedure for tympanometry' (British Journal of Audiology 1992; 26: 255–7).

Reprints of all these protocols are available from the British Society of Audiology, 80 Brighton Road, Reading RG6 1PS. Tel 0118 966 0622. Fax 0118 935 1915.

6.2 Standards

- IEC 645-1 Audiometers. Part 1. Pure tone audiometers. Geneva, Switzerland: International Electrotechnical Commission, 1992. (Identical to BS EN 60645-1; 1995).
- ISO 8253-1 Acoustics – audiometric test methods – Part 1: Basic pure tone air and bone conduction threshold audiometry (1989).
- IEC 1027 Specification for Instruments for the

measurement of aural acoustic impedance/admittance 1991. (Identical to BS EN 60127; 1993).

- BS 5724:1 British Standard for Medical Equipment Part 1 General requirements for safety 1989. (Identical to IEC 601-1; 1988).

Copies of British and International standards are available from British Standards Institution (BSI), 389 Chiswick High Road, London W4 4AL. Tel 0181 996 7002. Fax 0181 996 7001.

6.3 Advice

Further advice to people wishing to set up a service for testing hearing is also available through the Education Committee of the British Society of Audiology. It may also be useful to contact a local specialist audiology centre for further information and advice.