Dear Colleague

CANDIDATURE GUIDANCE FOR ADULT HEARING AID FITTING AND PROCESSING FEATURES

Summary


- guidance on how such an approach should be achieved; and
- information to enable detailed interpretation of some of the key recommendations about matching hearing aid fitting and processing features to the clinical needs of patients contained in HDL(2001)19 “Good Practice Guidance for Adult Hearing Aid Fittings and Services” of 2 March 2001.

Action

2. Addressees should ensure that this letter and the attached annex are brought to the attention of all appropriate staff within their area of responsibility and that the guidance is used alongside the Good Practice Guidance for Adult Hearing Aid Fittings and Services within HDL(2001)19.

Yours sincerely

IAN GORDON
Director of Service Policy and Planning

30th April 2004

Addressees

For action
Chief Executives, NHS Boards

For information
Chief Executive, Common Services Agency
Chief Executive, NHSQIS
General Manager, State Hospitals Board for Scotland
Local Health Councils
General Manager, Health Education Board for Scotland
Chief Executive, NES Scotland

Enquiries to:
Ms Angela Graham
Health Planning and Quality Division
St Andrew's House
Edinburgh EH1 3DG
Tel: 0131-244 2839
Fax: 0131-244 2989

Further copies from:
Mr Raymond Murray
Health Planning and Quality Division
St Andrew's House
Edinburgh EH1 3DG
Tel: 0131-244 4049
Fax: 0131-244 2989
CANDIDATURE GUIDANCE FOR ADULT HEARING AID FITTING AND PROCESSING FEATURES

SUMMARY

1. The Public Health Institute of Scotland (PHIS) Needs Assessment Report “NHS Audiology Services in Scotland” identified the need for a consistent approach to audiological assessment and hearing aid provision across Scotland. This document provides guidance on how such an approach should be achieved.

2. It also provides information to enable detailed interpretation of some of the key recommendations about matching hearing aid fitting and processing features to the clinical needs of patients contained in HDL(2001)19 “Good Practice Guidance for Adult Hearing Aid Fittings and Services”.

3. It should not be implemented in a prescriptive or restricted manner and the initial prescription should always be subject to fine-tuning following reports and experience from the hearing-impaired person and informed suggestions by the managing audiologist.

Interpretation of HDL(2001)19

Processing and fitting features

3. Paragraphs 12, 22 and 23 of HDL(2001)19 require that processing and fitting features should be chosen on the basis of clinical need and ability to benefit. This document provides specific guidance on the merits of particular features and how they should be matched to clinical need.

Bilateral and BTE/ITE fittings

4. Paragraphs 9, 17 and 18 of HDL(2001)19 in the case of bilateral fittings, and paragraph 9 in the case of in-the-ear (ITE) and behind-the-ear (BTE) fittings, require that patients are offered an informed choice for these specific features. This document provides guidance on how to interpret these paragraphs in situations where resource limitations only allow choice to be offered to patients whose needs are high priority (Sections 3.1 and 3.2). This does not represent any dilution of the original paragraphs in HDL(2001)19, or the aspiration of the NHS in Scotland to move towards complete compliance with the good practice guidance contained within it. The aim should be to meet the recommendations in Paragraphs 17 and 18 of HDL(2001)19 wherever available resource allows, and to continue to build the evidence base for compliance.

Recommended self report instrument

5. Paragraph 8 of HDL(2001)19 requires that a formal self-report instrument should be used when carrying out needs assessment. This guidance confirms the decision of the Audiology Services Advisory Group that the Glasgow Hearing Aid Benefit Profile should be used.
CONTEXT

6. This guidance is framed around the routine provision of hearing aids that employ digital signal processing (DSP). This reflects the fact that modernised audiology services are likely to be almost exclusively issuing DSP devices.

7. It is likely that the majority of the processing features described below will be available within any individual hearing aid. Cost differentials between different devices are therefore likely to be minor compared to the differences that existed prior to modernisation. This guidance therefore focuses on maximising patient benefit rather than minimising costs.

8. The guidance is not intended to be restrictive. It attempts to identify a likely starting point for any individual fitting. That fitting then has to be fine-tuned in the light of patient reports and guidance from the audiologist. Systematic fine-tuning is an essential part of the modernised patient journey and should take place at both the initial fitting and follow-up visits.

9. Two issues which will continue to have substantial resource implications are: a) bilateral versus unilateral fittings, and b) ITE versus BTE devices. These involve a fundamental change in prescription, as opposed to the software activation of a feature, so are less likely to emerge from the fine-tuning process. This guidance addresses prescribing practices likely to be by a direct consequence of resource limitations. The aspiration for eventual compliance with the Good Practice Guidance recommendations for ITE and bilateral fittings remains.

HEARING AID PROCESSING AND FITTING FEATURES

10. In the context of DSP hearing aids likely to be available to the NHS in Scotland, it is possible to identify eight features which are dealt with in separate sections below. Although these are treated independently they will interact on occasion, and in some implementations selection of one feature may restrict the range of available choice on another. Where the interactions are strong they are identified in each of the individual sub-sections.

ITE and BTE fittings

Advantages and disadvantages

11. Hitherto the NHS in Scotland has used predominantly BTE fittings coupled to a listener’s ear via a custom ear mould. ITE fittings – including completely in-the-canal (CIC) devices – are often perceived to be cosmetically more appealing. In health care delivery systems where patient choice has not been systematically restricted these have often been the majority option. However, recent figures suggest both absolute and relative market growth in BTE fittings due to a) increased cosmetic acceptability of the smaller BTE devices now available and b) recognition that ITE aids are more limited in terms of fitting and processing features.

12. Where resource and clinical considerations allow choice to be offered, the patient should be made aware of the recognised advantages and disadvantages, as indicated in the table below:
Advantages and disadvantages of ITE fittings

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>• more acceptable cosmesis</td>
<td>• increased susceptibility to feedback</td>
</tr>
<tr>
<td>• improved high frequency response</td>
<td>• limited gain and output</td>
</tr>
<tr>
<td>• potentially reduced occlusion</td>
<td>• less robust and reliable</td>
</tr>
<tr>
<td>• increased comfort</td>
<td>• greater susceptibility to wax damage</td>
</tr>
<tr>
<td></td>
<td>• no quick replacement for custom devices*</td>
</tr>
<tr>
<td></td>
<td>• increased difficulty in manipulation &amp; small batteries</td>
</tr>
<tr>
<td></td>
<td>• more limited processing features</td>
</tr>
<tr>
<td></td>
<td>[* Not applicable to modular devices]</td>
</tr>
</tbody>
</table>

Contra-indications for ITE and BTE fittings

13. Some patients have very narrow ear canals which cannot accommodate an ITE device, and some patients have anatomical abnormalities of the external ear which preclude a BTE fitting. There are no other audiological or clinical considerations which would preclude offering informed patient choice, though clearly a patient characteristic such as reduced physical manipulation ability might indicate a BTE fitting as being more appropriate than an ITE fitting.

Resource issues for ITE and BTE fittings

14. There are very significant implications for workload of audiology services in supplying ITE rather than BTE devices due to their poorer reliability and increased susceptibility to wax. Where resource limitations are a factor, audiology services should take account of the advantages and disadvantages listed above in identifying any patients who have a priority need and ability to benefit.

Unilateral and Bilateral Fittings
Advantages and disadvantages of unilateral and bilateral fittings

15. The NHS in Scotland has traditionally provided unilateral hearing aid fittings. However, there is a widespread international consensus regarding the benefit of bilateral fittings and this is recognised in HDL(2001)19 which requires informed patient choice.

16. The recognised advantages and disadvantages of bilateral fittings, are indicated in the table below. Where resource and clinical considerations allow choice to be offered, patients should be made aware of these advantages and disadvantages.
Advantages and disadvantages of bilateral fittings

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>• improved speech intelligibility</td>
<td>• stigma and self-image</td>
</tr>
<tr>
<td>• improved sound quality</td>
<td>• increased susceptibility to wind noise</td>
</tr>
<tr>
<td>• avoidance of late-onset auditory deprivation</td>
<td>• increased problems with manipulating aids for people who</td>
</tr>
<tr>
<td>• improved spatial hearing</td>
<td>have decreased physical or other abilities</td>
</tr>
<tr>
<td>• suppression of tinnitus</td>
<td></td>
</tr>
</tbody>
</table>

Contra-indications for unilateral and bilateral fittings

17. One specific contra-indication for bilateral fittings is binaural interference where, for a very small proportion of patients, speech intelligibility is poorer for binaural rather than monaural listening. This would be the only clinical factor which should lead to a patient not being offered informed choice.

Resource issues for unilateral and bilateral fittings

18. Where resource considerations are a factor, the additional costs of providing two aids (and associated increases in resource load for fitting, fine-tuning and maintenance) will need to be balanced against clinical priority. This should be done by targeting resources at those patients with the greatest residual disability following a unilateral fitting (for example, if a service has resources to fit 30% of patients bilaterally, then they should be offered to the 30% of patients who score greatest on the residual disability sub-scale of the Glasgow Hearing Aid Benefit Profile following unilateral fitting).

19. Even where resource limitations necessitate targeting in this way it is recommended that the following groups of patient are offered bilateral fittings:

• all children as they move from the paediatric audiology service into an adult audiology service
• patients already provided with bilateral fittings
• patients with severe hearing losses (in accordance with the residual disability criterion in the preceding paragraph)
• patients with dual-sensory impairment

Amplitude Compression

20. This subsection deals with linear and compression systems, and with compression implementations with fast or slow time constants.
The function of amplitude compression systems

21. Most hearing losses are sensorineural in origin and have consequences over and above simple attenuation of sounds. Hearing losses usually slope from low to high frequencies, with consequent greater loss of the higher frequency consonant sounds in speech compared to the lower frequency vowel sounds. Whilst thresholds of hearing will be elevated, thresholds of uncomfortable listening will be close to normal, resulting in a restriction in the available dynamic range of hearing. This restriction will be greater at high frequencies than at low frequencies.

22. To compensate for these reductions in dynamic range, amplitude compression systems amplify quiet sounds by greater amounts than for louder sounds, and this differential amplification is dependent upon the dynamic range, and hence frequency. The result is an attempt to compress the auditory world into the reduced dynamic range resulting from a sensorineural hearing loss.

Linear Amplification

23. Given the reduced dynamic range accompanying sensorineural hearing loss described above, some form of amplitude compression is likely to benefit the majority of listeners. Research suggests that for approximately 20% of hearing-impaired people well-fitted low-distortion linear amplification is the optimal prescription.

24. The audiometric characteristics of such listeners are:

- relatively flat hearing losses (or ≤ 20 dB difference between the high frequency (2 and 4 kHz) thresholds and low frequency (500 and 1,000 kHz) thresholds, and
- less than 20 dB difference in dynamic range between the low and high frequencies.

25. Candidates for linear processing also experience a relatively limited range of listening environments. A typical example would be a person who lives alone with a relatively constrained lifestyle. Such candidates can be identified as part of the initial needs assessment from the initial disability and handicap subscales of the Glasgow Hearing Aid Benefit Profile.

26. Linear amplification should be provided where the patient is likely to disadvantaged by the shortcomings which accompany amplitude compression, e.g. reduction in the spectral and temporal contrasts in speech which carry important information and meaning.

Fast-acting wide dynamic range compression (WDRC)

27. WDRC aims to maximise the audibility of a speech signal on a moment-to-moment basis by rapidly adjusting the amplification characteristics. The processing fits as much of the input signal as is possible into the reduced dynamic range of the listener. Speech fluctuates rapidly, with relatively intense vowel sounds and less intense consonant sounds. To achieve maximum audibility, the hearing aid frequency-gain characteristic is required to alter across milliseconds and tens of milliseconds.
28. An inevitable consequence of WDRC is a reduction in the spectral and temporal contrasts within the speech signal. The amount of compression will vary as a function of frequency depending upon the residual dynamic range. Where the dynamic range is less than 40 dB, fast acting compression is unlikely to confer benefits and either linear processing or slow acting automatic volume control (see below) is likely to deliver maximum benefit. It should be remembered that different compression characteristics might be appropriate for different frequency bands for an individual listener. An overall prescription can be a composite of the different options.

29. WDRC is designed to maximise effective audibility and hence speech intelligibility. However, its performance is poorer in terms of listening comfort and sound quality compared to both linear processing and slow acting automatic volume control. Maximising speech intelligibility and sound quality are different goals and require different approaches. Patient requirements for speech intelligibility, as opposed to listening comfort and sound quality, should be ascertained as part of the needs assessment process so that a judgement can be made regarding the likely appropriateness of WDRC.

30. As noted above, compression characteristics will vary as a function of frequency. Providing the frequency crossover points are adjustable according to the audiometric characteristics of the listener, hearing aids with four independent frequency shaping and/or compression characteristics are appropriate for the great majority of listeners.

**Slow acting automatic volume control (AVC)**

31. In contrast to WDRC, AVC is designed to compensate for the changes that occur in the external auditory environment, as either the environment itself changes or the listener moves from environment to environment. These changes occur only slowly and hence the hearing aid processing attempts to compensate for those slow changes in environment. AVC, unlike WDRC, does not maximise effective moment-to-moment audibility, and is designed to provide optimal listening comfort and sound quality.

32. In contrast to linear processing, both WDRC and AVC are designed for more sloping losses (greater than 20 dB between low and high frequencies) and reduced dynamic ranges, with material differences between dynamic range in low and high frequencies. The primary candidature criteria for AVC are the types of listening environments encountered (rapidly changing-versus-slowly changing) and a preference for listening comfort and sound quality as opposed to maximal intelligibility.

33. Candidature guidance for linear-versus-compression systems, with compression implementations with fast or slow time constants, is summarised in the following table:
1.1.1 Indications and Contra-indications for linear and compression systems

<table>
<thead>
<tr>
<th>1.4 Indications</th>
<th>Linear</th>
<th>1.2 WDRC</th>
<th>1.3 AVC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flat losses (= 20dB slope)</td>
<td>1.5 Sloping losses</td>
<td>Sloping dynamic ranges</td>
<td></td>
</tr>
<tr>
<td>Flat dynamic range (= 20dB slope)</td>
<td>Patient emphasis on speech intelligibility</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Restricted range of auditory environments</td>
<td>1.6 Sloping losses</td>
<td>Patient emphasis on listening comfort</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>1.7 Contra-indications</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency with dynamic range = 40dB</td>
<td></td>
</tr>
<tr>
<td>Susceptibility to processing artefacts</td>
<td></td>
</tr>
</tbody>
</table>

### Directional Microphones

34. A primary need of hearing-impaired listeners is understanding speech in adversely noisy environments. To operate effectively in these circumstances, a hearing aid is required to amplify the desired signal (usually speech) and to reject the unwanted signal (which may either be non-speech noise or may be the speech of other talkers in the environment).

35. A directional microphone is the only reliable form of hearing aid processing to selectively amplify wanted signals at the expense of unwanted signals. It is therefore a feature which should always be considered for speech intelligibility in noise.

36. Conventional microphones have broadly omni-directional patterns (i.e. sound arriving at the hearing aid from any direction is accepted by the microphone). Directional microphones have patterns of spatial sensitivity which are maximal for directions straight ahead (the directions in which the listener is facing) and which to varying degrees, depending upon the particular spatial pattern, do not amplify signals from the side and/or behind. Directional microphones work on the assumption that listeners are able to orientate themselves in the environment in such a way that the signals that they desire are located straight ahead, and that unwanted signals are likely to be off to the side or behind. They have the potential disadvantage of reducing access to signals which may be desired but which can occur at angles other than straight ahead and for which rapid spatial re-orientation is not possible.

37. Candidature criteria for directional microphones are environmental rather than audiometric. The needs assessment requires to take account of the sorts of environments (and perceptual demands within those environments) that listeners are likely to encounter, and the extent to which directional microphones are likely to be effective in these circumstances.
The needs assessment therefore needs to take account of the following factors:
- wanted sources can be arranged to be straight ahead,
- unwanted sources can be off-to-the-side and behind,
- newly arising wanted sources are not likely to be predominantly to-the-side and behind,
- whether or not spatial re-orientation readily available.
(Note that spatial re-orientation can involve turning one’s head towards the sound and/or re-positioning in the environment).

38. Most directional microphones have fixed spatial sensitivity patterns, though microphones with adaptive spatial sensitivity are becoming available. Specific candidature criteria for adaptively-directional as opposed to fixed-directional systems have not yet been developed.

Feedback management
39. Feedback occurs when the output of the hearing aid leaks back to the hearing aid microphone. This is often the sign of a poorly fitting ear mould. Systems for feedback management should not be used to compensate for poor earmould technique. Earmoulds with acoustic vents improve listener comfort and can offset some components of occlusion effects but are more susceptible to feedback.

40. Feedback management takes the form of either passive or active processing. In passive systems, the likely onset of feedback is detected and the amplification in the frequency region in which feedback is likely to occur is decreased. For DSP systems this amplification reduction can occur in quite a narrow band and need not necessarily have a material affect on overall audibility. Active feedback management systems attempt to cancel the feedback by injection of an out-of-phase signal and hence maintain amplification and effective audibility.

41. Feedback management systems are potentially appropriate for all listeners, but are particularly important for those listeners for whom high amplification is required and who require as open an earmould fitting as possible. Although management systems should not replace good earmould technique, though they do allow more widespread utilisation of open ear mould techniques. Care should be taken that over-application of passive feedback techniques does not compromise effective audibility.

Noise reduction
42. Where the wanted signal (usually speech) and the unwanted signal have different spectral and temporal characteristics, the hearing aid processing can be configured to amplify the speech at the expense of the unwanted non-speech noise. The circumstances in everyday environments where these conditions are met and, where effective relative speech enhancement is achievable, are relatively limited. Often the unwanted signals are themselves speech from talkers other than the target individual.
43. Many noise reduction processing strategies can induce signal processing artefacts which compromise intelligibility. As such, most noise reduction processing schemes have limited effectiveness. Candidature for noise reduction schemes are environmental rather than audiometric. Important communication circumstances should conform to the above.

**Volume control**

44. Traditional linear hearing aids use a volume control to compensate for overall changes in the external auditory environment. Many modern DSP hearing aids can de-activate the volume control and react automatically to such changes. This removes the need for listeners to make adjustments to hearing aids – a substantial benefit particularly those with limited physical manipulation abilities such as many elderly listeners.

45. There are a minority of listeners who (either all the time or when in certain environments), wish to be able to override the automatic settings on hearing aids and to adjust the hearing aid characteristics to suit the conditions and desires of the moment. Such requirements are personal and not predictable from audiometric criteria, but flow directly from the patient’s needs assessment.

**Multi-programme hearing aids**

46. It will be apparent from the discussion above, that many features may be broadly desirable but not necessarily optimum for all listening environments and perceptual demands. At the simplest level, different frequency responses may be required for different listening environments and different objectives (e.g. speech intelligibility versus sound quality). Almost any one of the above features may be desirable in some circumstances but less desirable in others. Candidature for any one these features (or combination of them) also serves as a candidature criterion for a multi-memory facility. It should be noted that this is even true of the volume control capability where different programmes can contain different overall levels.

47. From the perspective of audiometric criteria, different frequency gain and compression characteristics are likely to be appropriate when high frequency hearing thresholds are worse than 55 dB and low frequency thresholds worse than 30 dBHL. All other candidature criteria follow the criteria for the individual features as outlined above.

48. Where a multi-memory capability is being considered, audiologists should ensure that patients can readily distinguish between features or combinations of features, and have physical and other capabilities to access effectively both the multi-program facility and the features contained therein.

**EARMOULDS**

49. All earmoulds for NHS fittings should be configured to minimally compromise the high frequency output of hearing aids. They should use libby horns or other acoustical modifications to maximise the availability of high frequencies from the hearing aid and its processing and fitting options, unless this would compromise optimal venting. Some manufacturer fitting rationales preclude this.