GUIDELINES FOR THE DEFINITION & MANAGEMENT OF 'OPTIMALLY AIDED' FOR EXPERIENCED ADULT HEARING AID USERS WITH SEVERE & PROFOUND HEARING LOSS

Aim and scope

The specific goal of these guidelines is to provide a set of statements, recommendations, and strategies for both the hearing healthcare professional and the patient to recognise when hearing aids are optimally aided and therefore cannot be improved further in the audiologic management of adults with severe and profound hearing loss. This may also lead to further conversations about other rehabilitative management options for the patient (see sections 4 and 5) and faster referrals for cochlear implant assessment.

The guidelines are focused on adults with severe and profound hearing loss in the better ear. Conductive hearing losses are largely excluded. Precipitous and asymmetrical hearing loss with at least a severe degree of hearing loss in the better ear, are included.

For the purposes of these guidelines the British Society of Audiology's (2018 A) definitions will apply where severe hearing loss is an average hearing loss of 71-95 dB HL (across hearing threshold levels at 250, 500, 1000, 2000 and 4000 Hz). Profound hearing loss is an average hearing loss of >95dB HL.

This document relates to optimising amplification when listening to speech for people with severe and profound hearing loss. In this document, hearing aid settings are advised with the goal of achieving and maintaining a level of speech audibility which supports aided speech recognition.

It is, however, important to consider that not all users of hearing aids have the goals of hearing speech. Deaf adults, who use British Sign Language to communicate, may have different listening goals. It is also important to use culturally competent practices to assist hearing aid clinics, although this is outside the scope of this document. (Hulme at al., 2021, 2023 & 2024).

Introduction to severe and profound hearing loss

It is important to note that people with severe and profound hearing loss need additional support when compared to their better hearing peers. They have additional complexities within the auditory system whereby adding gain will not eliminate their communication problems. Clinicians need to consider that the result of a hearing aid fitting is limited by the processing capability of the peripheral and central auditory system and that few patients with severe sensorineural hearing loss will achieve high levels of speech recognition in complex listening situations (Souza, 2020).

Individuals are often long-term, full-time users of hearing aids who, because of their degree of hearing loss, are highly reliant on their devices, having unique amplification needs. They require that a wide range of input levels be made audible, comfortable, and safe within a narrow range of residual hearing (Convery, 2011). They often experience inadequate speech audibility (Souza & Bishop, 1999) and they are likely to experience poor frequency selectivity and distortion due to cochlear dead regions (Aazh & Moore, 2007). High powered hearing aid technology has drastically improved over the last two decades; however, hearing aids may never be fully sufficient for those people with severe cochlear damage (Lesica, 2018). Conversely, patients with a severe conductive hearing loss often have very good speech discrimination and get very good results from amplification. See section 6 for further resources in severe and profound hearing loss.

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Options for optimally aiding adults with severe and profound hearing loss

1. To ensure adults are optimally aided, audiologists ***should*** ***consider***:

1.1 Person Centred Care: Hearing aid settings should be optimised to suit individual needs and goals (BSA, 2016), e.g., adults may prefer an omnidirectional setting with noise reduction off to maximise audibility of environmental sounds.

1.2 Binaural aiding: can be considered for all adults with bilateral hearing loss, irrespective of level of hearing loss, duration of hearing loss and previous experience with amplification, two hearing aids should be offered [even if this has been unsuccessful in the past]. (NICE, 2018; Turton et al. 2020). Binaural aiding increases opportunity for binaural listening advantages, it also ensures both ears/auditory nerves are stimulated which limits/prevents auditory deprivation meaning a Cochlear Implant can be considered in either ear (now or in the future). Some adults may experience binaural interference (Gallun, 2021) and there may be complications from distortion and dead regions (Cox et al. 2011) so careful validation and evaluation is required (see section 3).

1.3 In-situ Real Ear Measures (REMs): Should be used to confirm the electroacoustic properties of the hearing aid and ear-mould in the ear i.e., frequency response, output and compression (BSA, 2018). Verification should include:

1.3.1 **A validated prescriptive procedure** should be used to guide frequency-gain settings e.g., NAL/DSL can be used as a start-point when prescribing output.

1.3.2 Previously used settings/prescriptions are important to consider; patient-preference and best-outcome settings will vary for each adult e.g., long-term users of amplification may prefer significantly more gain than the prescription recommends.

1.3.3 Adults transitioning from paediatric services should be offered the opportunity to remain on their chosen prescription (likely to be DSL).

1.3.4 For adults with an air-bone gap, bone conduction thresholds should be incorporated into the prescription.

1.3.5 When REAR is not possible, a measured RECD and coupler fitting can be used and is equally as accurate as REAR with small vents or closed ear moulds (BSA, 2018).

1.4 Amplitude compression ratios and compression speeds: Fast-acting compression distorts the speech envelope. To limit this distortion, lower compression ratios are recommended [≤ 1.5], (Windle et al. 2023). Slow-acting compression does not distort the speech envelope significantly so compression ratios of ≤ 3.0 can be used (Dillon, 2012). There may be times with patients who have extremely narrow dynamic ranges where this is unavoidable, alternative options are to either reduce the low input gain or increasing high input gain with these specific patients.
Speak to your manufacturer as these are often labelled in the software under manufacture specific names so you understand what is being provided through the software and model of hearing aid being fitted.

1.5 Directionality: Directionality improves the signal to noise ratio without causing distortion, so can be employed for all individuals. It offers benefit when the signal and noise are separated or moving (i.e., in constantly changing listening situations where the speaker and noise are moving/changing). Automatic/adaptive directionality should be used rather than fixed directionality as default, although the individual may like more directional programs to be available (Turton et al. 2020).

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1.6 Volume controls: Should be offered, especially to experienced users of VCs (consider a remote control or suitable app interface if dexterity problems). Separate volume controls for each ear/aid can allow for the sound/signal on one side of the listener to be increased, without increasing the volume of all sounds around the listener and this may improve the signal to noise ratio/listening in noise [but settings should always be based on patient-preference] (Turton et al. 2020).

1.7 Earmoulds: Comfortable, deep, and well-fitted moulds using appropriate materials should be provided, that form an acoustic seal such that feedback does not occur (and feedback managers do not limit gain or are not required), and the occlusion effect is minimised.

1.8 Telecoil loop and wireless connectivity (directly or via streamer) discussed and offered e.g., for music, phone calls, conversation in background noise or listening over a distance.

1.9 Remote microphones: Adults with severe and profound hearing loss can benefit from remote microphone systems in a range of situations and should be fully informed about them (NICE, 2019; Turton et al. 2020).

2. To ensure adults are optimally aided, audiologists *may wish to consider*:

Additional hearing aid features that could provide benefit:

2.1 Frequency-lowering (FL): Selected, verified, and validated to ensure; a) aided audibility is improved **[important note: adults with profound losses may never have audibility restored with FL enabled]**., b) speech quality is not impaired, and c) the patient reports good outcomes/benefit with FL after a real-world trial. High frequency focussed speech tests (such as the Phoneme Perception Test by Phonak), can be sensitive to the effects of FL but are not reflective of real-world listening. No gold standard exists for the validation of FL. Settings should be as conservative as possible to maximize audibility but minimise distortion. For further guidance on verification of FL see BSA, 2018. For a useful systematic review of the benefits of FL see Simpson et al. 2018 and Akinseye et al. 2018. For detailed advice on FL selection and verification (including the use of Maximum Audible Output Frequency/MAOF) see the 'Frequency Lowering Fitting Assistant', available at: https://web.ics.purdue.edu/~alexan14/fittingassistants.html

2.2 A music programme: Selected and adjusted based on patient preference and musical listening needs. For advice and resources on hearing aids for music (for professionals and patients), see '*Hearing aids for music'* website: https://musicandhearingaids.org/resources/ (Hearing Aids for Music, 2017).

2.3 Digital noise reduction: Select any noise reduction technology within the hearing aid software. Individuals with severe and profound hearing loss still experienced advantages from this technology in both listening effort measure and subjective sound quality assessments without adversely affecting speech intelligibility. (Dong et al. 2024).

2.4 Other technologies: Provide information on accessing a range of technologies which can connect the patient with the hearing community (e.g. speech to text apps / speech to sign language technology), technology for emergency situations and alerting the patient to different situations (e.g. doorbells), technology for perceiving music and for environmental sound awareness and localisation. (Hermawati et al. 2019).

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3. Fundamental considerations

3.1 Maximising audibility and minimising distortion: Individuals with a severe-to-profound hearing loss do not have access to the temporal fine structure of a speech signal and are more dependent on the overall speech envelope for understanding (Jorgensen et al. 2018; Moore, 2021; Souza, 2009). Many advanced hearing aid features are focused on exaggerating temporal fine structure and are therefore not appropriate. Features that cause significant distortion include fast-acting compression and high compression ratios, noise reduction, and frequency-lowering. **As a rule, the clinician should seek to introduce minimal distortion to the speech signal, whilst aiming to maximise speech recognition.**

3.2 Self-report preference: Experienced users of amplification will be able to reliably self-report on hearing aid sound quality, comfort, and benefit, within a clinic setting. Patient opinion and feedback should be used to fine-tune hearing aids during the fitting/exchange and patients should feel happy with the settings of their hearing aids before they leave the clinic.

3.3 Verification: It is important to recognise that, although REMs are the recommended approach and provide objective setting guides, there are potential errors in the REM process (e.g., probe tube placement / wax blocking the probe) and all gain settings should be assessed by the clinician. For example, a "sense-check" would ensure that gain/output is broadly equal in both ears where an individual has symmetrical hearing loss, that gain/output is neither excessive nor minimal in relation to hearing thresholds, or that the hearing aid gain/output does not have an unusual shape.

3.4 Validation and evaluation: It is important that subjective and functional outcomes are assessed after a period of acclimatisation, and this may range from 6 weeks to 3 months. The results from outcome measures and speech tests may indicate a need for further optimisation and fine-tuning.
Subjective outcome measures include validated **self-report questionnaires** (relating to hearing, tinnitus, or quality of life) e.g., COSI, GHABP, IOIHA, HHI. **Aided speech testing in quiet** including live voice or recorded speech tests, using phonemes, words, or sentences e.g., CVC test, AB words, BKB sentences, IHR sentences, CUNY sentences. See BSA (2019). Clinicians should consider that subjective feedback/self-report of real-life situations then complements in for further validation, essentially the patient is an expert of their own hearing loss and will provide further insight which validated tests may not.

3.5 Adults with low vision or blindness require minimal disruption/distortion of acoustic cues to support localisation. Consider offering a fully omnidirectional setting/programme and reducing compression speed and compression ratios further or using a fully linear setting, particularly in the high frequencies due to interaural time differences [whilst considering loudness tolerance/listening comfort] (Simon and Levitt, 2007).

3.6 Cochlear dead regions: Adults who report distortion/poor sound quality with amplification and have poor outcomes with hearing aids (despite optimisation) may have cochlear dead regions. For adults with extensive dead regions, benefit from amplification may increase if gain/output is decreased at the 1.7 x edge frequency of the cochlear dead region. (See Figure 6, page 28 in Pepler et al. 2016 for a useful flow chart of clinical decision making with adults who have dead regions). A TEN test can be useful to estimate the size and place of dead regions [although this is only accurate to the nearest octave, and the test cannot be used once thresholds exceed 90 dB HL] (Moore, 2001; Bird, 2010; Pepler et al. 2016).

3.7 Expectations: Does the person have realistic expectations about what amplification can deliver for their level of hearing? When customised counselling is provided for the social and emotional wellbeing of patients these two areas improve distinctly (Yadav, 2023). Make sure this is explored and addressed at (re)assessment before proceeding with hearing aid fitting when goals and management plan are agreed e.g., Motivation tools by the IDA Institute: https://idainstitute.com/tools/motivation_tools/. Additional rehabilitation may need to be provided through auditory training / lipreading classes or group rehabilitation or peer support volunteers. (Löfvenberg et al. 2022).

3.8 Hearing aid use: All barriers to consistent hearing aid use should be explored; is the user able to consistently use the hearing aid(s) confidently? Is the patient aware of the acclimatisation period for adjusting to new hearing aids or other technology provided? Should they be provided with incremental changes to the amplification help with adaptation? It may be beneficial for regular follow ups to offer further advice, practise, and/or support.

4. Cochlear Implant referral

Evidence shows that for the appropriate candidates, there are large, life-changing benefits post implantation, the magnitude of which cannot be achieved using hearing aid technology alone. Educating and counselling our patients regarding the continuum of available hearing technologies equips them with the knowledge that hearing aids need not be the final stop on their hearing journey (Turton et al. 2020).

4.1 Adults whose hearing thresholds meet the NICE criteria may be eligible for referral for a CI assessment i.e., **thresholds of 80dB HL or greater in both ears at any 2 frequencies [0.5, 1, 2, 3, 4 kHz]** (NICE, 2019). Please note, this includes reverse slope losses, cookie-bite losses and ski slope losses. **Aided AB word speech testing** is useful to check benefit from hearing aids and confirm eligibility for referral in these adults. **NICE guidelines state that inadequate benefit from hearing aids and suitability for CI is defined as a score of less than 50% on the AB word test with a 70 dB A presentation level (NICE, 2019).**

4.1.1 Adults who don't meet the NICE audiometric criteria but do show poor benefit from hearing aids (and score poorly on speech tests) may have Cochlear Dead Regions and should still be considered for CI referral. TEN testing prior to referral is useful but not essential (Bird, 2010).

4.2 For adults to be considered for CI they need to have trialled hearing aids with optimised settings for speech (as defined in this document). If patient preference is for different settings (e.g., well under or over a validated prescription target), consider offering an additional programme with 'optimised settings/set to target' so they can trial the 'optimised settings' in real-world listening situations and try to adapt to the new sound slowly over time (without losing their preferred settings). Discuss as in a case-by-case basis with your local CI team to ensure adults are referred at the earliest opportunity (to increase their opportunity for positive outcomes with CI).

4.3 For advice on CI candidacy, counselling and referral, see the BAA/BCIG CI champions webpage: https://www.baaudiology.org/professional-information/cochlear-implant-champions/

4.4 Record keeping is important for patients where discussion of CI referral has been undertaken to help with continuity of care and to note any deviation in hearing aids prescription settings so that this can be shared with CI centres in the referral.

5. Take home messages

5.1 Hearing aids form only part of aural rehabilitation for adults with severe and profound hearing loss. It is vital that adults are given all the support possible to maximise their ability to manage their hearing loss. This may include help and adjustment with severe and profound hearing loss, alongside signposting/referral for: Implantable devices, Assistive Listening Devices, lip-reading classes, Access to Work, communication training for family/friends/carers, peer support, self-management strategies, self-help groups, Hearing dogs, Deaf-awareness training, and tailored support in the workplace.

5.2 Cochlear implants should always be considered as a possible treatment option for adults with severe-to-profound hearing loss. However, it is important to ensure adults are optimally aided so they can get the best possible outcomes with their hearing aids. Cochlear implants should continue to be reviewed as an option even if they have previously declined but this conversation needs to be managed in a culturally sensitive way. Evidence currently shows that in the UK adults are not routinely offered a cochlear implant assessment when they are near or at the NICE criteria. (Cullington et al. 2024). CI referral is dependent on where the adults live, and how old they are (with older adults are significantly less likely to be considered for CI referral by Audiologists). This postcode lottery needs to be reduced.

5.3 Optimisation is an ongoing process. We need to continually support these patients with ongoing maintenance, reassessments, and self-management strategies.

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BRITISH ACADEMY OF AUDIOLOGY

British Cochlear Implant Group

Hearing Aid Optimisation Checklist

A. For the patient to be optimally aided you should:

1. Have you maximised audibility of speech recognition and minimised distortion to the speech signal? □
2. Do you understand the patients' goals and induvial needs around their hearing loss? □
3. If there is bilateral hearing loss, are they binaurally aided (where appropriate)? □
4. Have you undertaken in-situ Real Ear Measures to a validated prescription (including BC values where there is any air-bone-gap)? □
5. Are the hearing aid's compression ratios under 3:1? □
6. Have you offered or activated any directionality on the hearing aid? □
7. Have you offered or activated any volume control on the hearing aid / app? □
8. Is their custom earmould comfortable, deep, and well-fitted moulds using appropriate materials? □
9. Is the hearing aid free from feedback? □
10. Have you offered or activated any telecoil and / or wireless connectivity? □
11. Have you offered or activated any remote microphones? □
12. Have you considered with the patient their self-reported preferences □ and balanced these with verification (REMs / RECDs) □, validation (self-reported questionnaires □ and aided speech in quiet measurements □)?
13. Have you counselled on realistic expectations about what amplification can deliver for their level of hearing? □
14. Have you provided them with information for ongoing self-management and do they understand when they should return for a reassessment of their hearing to ensure optimisation is an ongoing process? □

B. You may also wish to:

1. Select and verify frequency lowering. □
2. Offer a music programme depending on the patients' goals. □
3. Select and activate noise reduction technology depending on the patients' goals. □
4. Have you discussed and provide relevant information on other technologies which may be of help to the patient connect with people with hearing loss / the Deaf community, for alerting devices, for emergency situations, for perceiving music and for environmental sound awareness? □
5. Have you counselled on the social and emotional wellbeing of the patient linking back to their goals? □
6. Have you offered and provided information on any additional rehabilitation be provided through auditory training / lipreading classes or group rehabilitation or peer support volunteers? □

C. If the patient is at / near the NICE criteria for cochlear implant assessment you should:

1. Have you ensured the hearing aid is optimised (see section A 1-14)? □
2. Have you discussed (or reviewed with the patient if previously discussed) the option of a cochlear implant assessment? □
3. Have you provided them with written literature to consider this with their family and friends? □

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6. Resources to support this document

- For detailed advice and guidance on this topic see *'Guidelines for Best Practice in the Audiological Management of Adults with Severe and Profound Hearing Loss'* by Turton et al. (2020). Thieme E-Journals - Seminars in Hearing / Abstract (thieme-connect.com)
- For access to the BAA / BCIG Cochlear Implant Scheme Cochlear Implant Champions - British Academy of Audiology |British Academy of Audiology (baaudiology.org)
- Resources for conversations as a Cochlear Implant Champion CI Champions Resources - British Academy of Audiology |British Academy of Audiology (baaudiology.org)
- Access to the BCIG website on all things cochlear implant British Cochlear Implant Group (bcig.org.uk)
- For a range of professional resources and patient leaflets to support adults with severe and profound hearing loss, see the *BSA Sound Practice website*: https://www.soundpractice.org.uk/
- For research and evidence in each area, see: *American Speech Language Hearing Association*: https://www.asha.org/practice-portal/professional-issues/hearing-aids-for-adults/
- Henshaw et al. (2021) *The use of hearing aids by adults with hearing loss: How should we define and measure success?* NIHR. Nottingham Biomedical Research Centre. Poster presented at BAA Conference, Manchester. Abstract available here: https://www.baaudiology.org/app/uploads/2021/11/BAA-2021-abstract-book-in-full.pdf

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9. Declaration of interests

None to declare.