Cochlear implants and electroacoustic checks

Stuart Whyte discusses the new Quality Standards and Good Practice Guides from the UK Children’s Radio Aid Working Group

The 2017 BATOD conference included practical workshops following the launch of the Radio Aid Working Group’s ‘Quality Standards for the use of personal radio aids: Promoting easier listening for deaf children’ kindly published by the National Deaf Children’s Society (NDCS, 2017). BATOD’s 2018 conference focused on evidence and this article expands on my contribution to the joint workshop with Joyce Sewell-Rutter and Trish Cope of the Ewing Foundation.

The presentation by Joyce and Trish focused on evaluation: gathering evidence with speech in noise tests to demonstrate the advantage of the radio aid when combined with hearing devices. My presentation was on the prior setup of the radio aid with the device and focused on validation with new evidence and guidance. The key document discussed was ‘Electroacoustic checks with auditory implant systems’. This and other Quality Standards Good Practice Guides are available at www.fmworkinggroup.org.uk. It is the intention of the UK Children’s Radio Aid Working Group (which I have the privilege of chairing) to update guidance as new research, technology and equipment becomes available.

Quality Standards of particular relevance to the workshop:

**Fitting and setting up of personal radio aids**
- QS3: The personal radio aid must be set up with the child’s individual hearing aids or implants to ensure that the radio signal provides the desired advantage.
- QS4: The child’s listening response must be checked with the complete system in place.
- QS5: Training and written information about the personal radio aid system, its settings and its appropriate use must be agreed and shared with the child, parents, teachers and all those involved in supporting the child.

**Management and use of personal radio aids**
- QS7: Subjective checks of personal radio aids must take place regularly.
- QS8: Electroacoustic checks must be performed regularly and whenever a part of the system is changed.
- QS10: Subjective and objective evaluation of a personal radio aid system to determine its benefit must be carried out.
- QS11: There must be close liaison between health and education teams, including the exchange of written information relating to the use of the child’s personal radio aid system.

In the UK, as well as taking account of relevant Quality Standards, Teachers of the Deaf work in line with their specialist Mandatory Qualification (NCTL, 2016) to achieve best practice and maximise achievement for deaf learners.

**Communication is the key**
It is important to explain the setup of the radio aid and any settings required, to describe the benefit it provides and show evidence of this. Collaborative working, the exchange of information and valuing each other’s specialist knowledge and expertise is part of the everyday practice of Teachers of the Deaf and Educational Audiologists. Ofsted exemplified such practice as one of the key factors fundamental to delivering high quality well-coordinated support to deaf children and their families (Ofsted, 2012).

**Rationale**
As part of the usual setting up procedures for personal radio aid systems, a check of the whole system is recommended (see also Good Practice Guides for QS4 and QS7.) To support timely and appropriate provision, regular electroacoustic (test box) checks and speech testing should be carried out:
- to review frequency responses (QS 8)
- to ensure that the radio aid signal provides the desired advantage (QS3) and
- to determine benefit (QS10).

Only the user can truly monitor their perception of the output of the combination of their sound processor and assistive listening device. For this reason, behavioural testing is recommended when fitting radio aid systems to individuals with auditory implants.

The electroacoustic checks and their development are described more fully in the QS8 Good Practice Guide: Electroacoustic checks with auditory implant systems. The document is still considered to be in draft status as further evidence is being collected to review the interim guidance.

**Background**
It is important to ensure that the appropriate settings of the sound processor (e.g. programs, telecoil function and audio mixing ratio) are enabled by the Implant Service and that the radio aid transmitter and receiver are available from the education service (and its connection adapters or direct audio leads if required.)

Separate listening checks of the sound processor(s) and radio aid and the whole system combined should be carried out. Electroacoustic testing can then be carried out in quiet conditions with an appropriately calibrated test box.
Which SPL values do I need with Cochlear Implants?

Initial UK studies with cochlear implants used test signals of equal intensity in line with MCHAS FM Advantage procedures with non-linear amplification [www.connevans.info/image/connevans/fmadvantage.pdf]. Following feedback from users with technology of the period (circa 2008) the intensity of the radio aid signal was reduced by delivering a signal of 5dB less to the CI sound processor and matching the radio aid to this lower response ie in line with the procedure for linear amplification. However, new technology (in particular dynamic radio aid systems and updated implant processors) has led to new research by the University of Southampton Auditory Implant Centre (work ongoing) and practitioners in the United States of America (Schafer et al. 2013, Nair et al 2017).

The original transparency procedures utilised the initial ‘front-end’ processing of the signal – which was linear in early sound processors. That signal was subsequently adapted by the non-linear compression of the automatic gain control (AGC) circuits of the processor and delivered to the user as an electrical sensation of sound.

Cochlear introduced some compression to the front-end processing to the Nucleus 6 series of processors (and in subsequent generations, eg Nucleus 7 or CP1000). This auto-sensitivity (ASC) engages at 57dB SPL and results in compression of the input signal (Wolfe and Schafer, 2015). For this reason lower signal levels are required for the N6 and N7 processors (see procedure below).

Schafer et al (2013) proposed using signals of equal intensity to the processor and to the radio aid with transparency or balance achieved if the responses were within 3dB. This value was quoted in last year’s article ‘Cochlear Implants and Radio Aids Workshop’ (BATOD Magazine May 2017); however, the standard ‘within 2dB’ has been adhered to.

So, the interim guidance recommends running three curves: two frequency response curves for the implant processor and one via the radio aid transmitter. The first processor curve is at a less intense level (5dB lower as per the original radio aid protocol) and then a second response curve is run at the same level as the subsequent radio aid curve.

Electroacoustic checks: cochlear implants and radio aids

As per the original protocol – ensure that the appropriate settings of the sound processor, radio aid and test box are employed, listening checks have been carried out and that measures are recorded in SPL.

- Connect the appropriate test lead (CPG QS 8 Appendix 1) to the sound processor and test box (test chamber levelled as necessary).
- Turn the sound processor on and check it is on the default everyday listening program.
- Place the sound processor in the test box chamber (eg in the test or target area and within 2mm of a reference microphone, if used) and close the lid.

For Cochlear™ implant processors Nucleus® 6 and Nucleus® 7 present:
- to the processor:
  1) a frequency response curve with a digital speech signal or speech-weighted signal at 50dB input.
  2) a frequency response curve with a digital speech signal or speech-weighted signal at 55dB input.
- to the radio aid:
  a frequency response curve with a digital speech signal or speech-weighted signal at 55dB input.

For Advanced Bionics, MED-EL and RONDO processors, and for Nucleus® 5 present:
- to the processor:
  1) a frequency response curve with a digital speech signal or speech-weighted signal at 60dB input.
  2) a frequency response curve with a digital speech signal or speech-weighted signal at 65dB input.
- to the radio aid:
  a frequency response curve with a digital speech signal or speech-weighted signal at 65dB input.

In either case:
- Adjust the volume ‘FM advantage’ or ‘EasyGain’ level of the receiver radio aid curve so that the radio aid response curve matches a sound processor response curve* to within 2dB for ‘transparency’ or ‘balance’.

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eg an average of the response values at 750Hz, 1kHz and 2kHz or RMS values are within 2dB. Adjusting the receiver should be done preferably by starting at a low volume/gain and then increasing.

* Signals of equal intensity may provide a match, or as per the original protocol, you may decide to opt for a match to the 5dB lower curve, or between the two. If possible, discuss with the users their preference of set-up; ie whether the radio aid response is matched to the lower or higher response of the sound processor. But most importantly consider behavioural responses and validate with speech in noise testing with and without the radio aid to assess benefit.

- Save, print and share the information (QS11).

By design, sounds will always be presented at comfortable levels for the cochlear implant user. It is important to note that if the radio aid gain is too high then both the sound processor signal and the radio aid signal will be compressed into the dynamic range of the user. Too high a radio aid gain will make environmental sounds softer by comparison and the user may not find this acceptable.

The next article related to the workshop, which looks specifically at the Roger dynamic radio aid system available from Phonak, will appear in the September issue.

References:

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