HEALTH TECHNOLOGY APPRAISAL

COCHLEAR IMPLANTS FOR SEVERE TO PROFOUND DEAFNESS IN CHILDREN AND ADULTS

To appraise the clinical and cost-effectiveness of cochlear implants for severe to profound deafness in children and adults

THE EAR FOUNDATION

SUBMISSION

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The Ear Foundation submission to NICE: March 2007
The Ear Foundation, Nottingham, UK

The Ear Foundation brought cochlear implants for children to the UK in 1989 and now over half the profoundly deaf children in the UK have an implant. The first child to be implanted with a multi-channel cochlear implant was Michael Batt and he now writes from University:

“I have been a Cochlear Implant user for 18 years. The Cochlear Implant has benefited me greatly over my life; in the workplace it helps me to communicate with the public and I recently completed a month’s work experience in Belgium. I use it to talk on the phone regularly to my family and girlfriend, I enjoy hearing news all the time!! At the moment I am in my final year at university, the CI has let me enjoy the student life by helping me make friends and take part in all activities. It has become part of me now and I’m glad it is there to help me through my life”

Summary

We know that cochlear implantation is safe, effective and reliable. It has changed the linguistic and educational options for born deaf and early deafened children enabling them to:

- Acquire and understand spoken language, speak intelligibly and use the telephone
- Have improved literacy and educational attainments
- Attend mainstream schools

We know that:

- Early implantation is more effective; preferably under the age of two, or shortly after loss of useful hearing
- Parents value implantation for their children: there is no alternative for them
- Parents report increased confidence and communication skills in their children
- Progress continues over a long time-frame
- Young people continue to wear their implants in the long-term and choose to have re-implantation should the device fail
- Parents and young people are concerned about long-term management of their implant systems and ensuring technical problems are managed
- Access to implantation is not consistent in the UK; there are no agreed guidelines and there remains under provision compared with other countries
- Cochlear implant programmes become more cost-effective over time
- Some evidence of benefit in those with severe losses
- Bilateral implantation is increasing elsewhere and evidence shows effectiveness in noise and localising abilities

We need to know:

- Cost-effectiveness for those with less severe losses
- Cost-effectiveness of bilateral implantation
- Who benefits from two implants as opposed to an implant and a hearing aid
- How more sensitive tests can be developed to measure the more subtle benefits
- How the long-term management can be effectively transferred to the community – to parents and teachers
- How access to cochlear implants can be equitable throughout the UK and for differing groups (complex children, those from minority ethnic backgrounds)
- How earlier referral for implantation after Newborn Hearing Screening can be made a reality to maximise benefit and hence cost-effectiveness

The Ear Foundation submission to NICE: March 2007
The Ear Foundation

The Ear Foundation brought cochlear implantation for children to the UK in 1989, and funded the first implants in the UK, before implantation became an NHS funded service. It founded Nottingham Cochlear Implant Programme, now one of the largest and most experienced in the world. The Ear Foundation now bridges the gap between clinic-based services and home and school where implants are used in everyday life by providing Family Support and Information, Education and Training, and Family-centred research. Although our work began with young deaf children, we increasingly work with young people and adults with implants.

We work with many collaborative partners to ensure our work is up-to-date and inclusive, including the other voluntary agencies and user groups, cochlear implant centres, professional organisations, and manufacturers of implant systems. We provide international educational services, gaining first-hand experience of leading provision elsewhere.

In preparing this, we have discussed and shared our submissions with Cochlear Implanted Children’s Support Group (CICS), National Cochlear Implant Users Association (NCIUA), RNID, NDCS and The Link Centre, to avoid duplication. While sending in separate submissions, we would like to make it clear that we support the submissions made to NICE by the afore-mentioned organisations. While focussing our submission on children, we strongly support the needs of adults, well documented in other submissions.

The effect of profound deafness

Although hearing is important in accessing environmental sounds, the primary disability profound deafness from birth causes is the difficulty in learning and using spoken language, the language used by society in general (Marschark and Spencer, 2006). Spoken language is usually acquired through the channel of hearing via interaction with carers in the first months and years of life. When a child is profoundly deaf from birth or early in life, this process is disrupted – the child not only has difficulty in acquiring speech but in acquiring language, essential to participation in everyday communication, in education and later employment. Conrad’s classic study showed that half of deaf children leaving school at 16 had speech difficult to understand, and had a median reading age of nine years (Conrad, 1979). Until the advent of cochlear implantation, there was little to show progress since then, and for families living with children with profound deafness, without the language to join in family conversation and unable to hear it, life can be challenging. Gregory, Bishop and Sheldon (1995) paint a depressing picture of families under stress, where deaf young people, unable to hear the conversation of the family, are not fully participating in society or family life:

“You can’t have a normal conversation….. he doesn’t say he misses anything, but he wouldn’t know if he missed anything.”

Most of our work is with children, and our submission concentrates on this area, but for adults, sudden or gradual loss of hearing has a profound effect on their ability to communicate in everyday situations at home and work, and usually results in loss of speech intelligibility over time. The difficulties of this group are well documented by National Cochlear Implant Users Association, RNID and by The Link Centre submissions.

The Ear Foundation submission to NICE: March 2007
Heterogeneity of group: challenges for research

Research with young profoundly deaf children has long been recognised as being complex because of the range of factors which influence progress: age at onset, aetiology, presence of other disabilities, cognition, parental support, educational support, hearing levels, are just a few. The advent of cochlear implantation has added yet more variables including age at implantation, length of device use, programming strategy, device used, type of follow up care (Thoutenhoofd et al, 2005). Traditional research methods, using comparative groups, are particularly difficult in this field; truly comparative groups are rare, and numbers are inevitably small in an area of low incidence. Research is additionally complicated by the length of time it takes to measure outcomes, particularly in children outcomes should be measured over years rather than months (Beadle et al, 2005), remembering that, in normally hearing children, language development takes about nine years. In addition, while measuring outcomes, the technology used and the groups being implanted have changed, making the results of the research often out-of-date when published. Much published research is therefore on groups using outdated technology and groups with little or no residual hearing. There continues to be the need for ongoing research with latest technologies, and rigorous, qualitative research which taps into the sensitive areas of communication and psychological development, the end result of hearing restoration.

Traditional support for deafness

Studies over the years have shown the marked delays in the language, educational and reading attainments of profoundly deaf children (Conrad, 1979; Blamey et al, 2001; Paul, 1998; Allen, 1986; Traxler, 2000) and many have tried to overcome these delays by differing teaching methods. The education of deaf children has been characterised by controversy about the most effective way of overcoming the effect of profound deafness in early childhood; whether to use sign language or spoken language, whether to attend special or mainstream education.

Over 90% deaf children are born into hearing families, (Mitchell & Karchmer, 2004) who have no knowledge of deafness or of British Sign Language and are therefore unable to interact in an effective way with their infant in sign language. Additionally, British Sign Language is silent, and has a grammar of its own, different to that of English, the language through which our information and the curriculum is delivered. The transition to English grammar for access to literacy is therefore challenging, with no evidence of successful transition. In some places, Sign Supported English has therefore been used, which involves using spoken English with some sign support to give visual information.

Until recently, for profoundly deaf children, conventional amplification provided limited hearing and little or no access to the high frequency sounds of speech, vital to hear to develop spoken language and intelligible speech. If spoken language was acquired by these children with conventional hearing aids, it was likely to be unintelligible to most people, making everyday communication difficult (Blamey, 2006). A child who uses only British Sign Language is likely to need sign interpreters throughout their lives, to have restricted access to community knowledge and employment opportunities are severely limited.
In addition to the arguments about communication mode to be used with deaf children, there have been ongoing arguments about where they are best educated, at special or mainstream schools, or in specialist classes in mainstream schools. In spite of policies towards inclusion of all children with disabilities in mainstream schools, for deaf children, with difficulties in spoken language, access to the curriculum in the poor acoustics of school has proved challenging and has often required the support of educational communication workers or interpreters. This is not what adolescents in mainstream school want.

**The technology: what outcomes matter to patients/parents; what difference the technology makes**

The advent of cochlear implantation has changed the linguistic and educational options for these children and their families in a comparatively short time (Archbold, 2006a; Spencer and Marschark, 2003). Since the early beginning, now the majority of profoundly deaf children have cochlear implants in the UK: the long-term outcomes are now becoming apparent. Cochlear implantation in young children makes the entire speech range available to them, at quiet levels of 25/30dB, and children who were previously unable to hear with the most powerful hearing aids, become able to hear their parents' speech and conversation, to begin to learn the early communication skills of turn-taking; fundamental to the later development of spoken language (Tait et al, 2000). They become able to monitor their environment by listening alone, which increases confidence, as reported by parents (Archbold et al, 2002; Christiansen & Leigh, 2002).

**Changes over time**

We have witnessed enormous changes in the possibilities brought about by implantation over 18 years. Our expectations were very low initially, only that of environmental sound awareness and an aid to lipreading; cochlear implantation has not only provided useful hearing – it has had a huge impact on the spoken language skills of profoundly deaf children (Svirsky et al, 2000; Geers, Nicholas and Sedey, 2003; O'Donoghue et al, 2000; Geers, 2006; review by Blamey, 2003;). Although there is known variation in outcome, with many variables to be considered, (Spencer & Marschark, 2003) to achieve optimal outcomes in terms of spoken language skills, early intervention is vital (Blamey et al, 2006), unless the child has some residual hearing. For those implanted under two, the growing evidence available is showing that spoken language development is close to that of hearing children (Nicholas & Geers, 2003). While we began implanting those children with little or no residual hearing, now children are considered for implantation who:

- Are severely deaf
- Have some hearing in one ear and can wear implant and hearing aid
- Have deteriorating hearing losses
- Have additional needs, and gain other benefits from implantation – eg increased independence
- Are in the first year of life, following newborn hearing screening
In addition to the changes in expectations, candidature, and technology, there is evidence to show that cochlear implant programmes have become more cost-effective over time (Sach et al, 2003).

Parental perspectives

The main goal of implantation for parents is that of the development of spoken language (Archbold et al, 2006; Nikolopoulos et al, 2001; Kluwin and Stewart, 2000). The submission of the Cochlear Implanted Children’s Support Group illustrates parents’ perspectives clearly and their value of cochlear implantation in this respect.

Sach and Whynes (2005) report that of 216 parents interviewed, only 1% reported doubts about their decision, and all the 19 families of children with additional disabilities interviewed by Wiley et al (2005) reported that they would make the same decision again for implantation. Nikolopoulos et al, 2001, report parents’ expectations to have been met or surpassed in the domains of communication, listening to speech and the development of speech and language. In another report, giving an indication of the value that parents put on implantation for their child, Sach et al (2004) reported on the “willingness to pay” of the 216 parents interviewed. These parents saw no alternative to implantation that could improve their child’s quality of life to the same extent and 99% reported that they would choose the implant over having the money to spend another way on their child.

Archbold et al (2002) found that the major changes reported by parents were those of communication and confidence and Archbold et al (2005) reported that 84% of parents agreed their had been a significant improvement in their child’s confidence and 96% reported that their child was more sociable in the family because of their improved language skills and self confidence. That study of 101 unselected families from throughout the UK with children who had been implanted for over three years, found that 89% of parents reported that their child’s use of spoken language had developed greatly and 79% that their children could now chat in situations where they could not see their parents’ face, such as in the dark, or in the car, indicating good use of hearing.

Sach and Whynes (2005) report the most commonly cited outcome is improved hearing and its implications for every day life:

“She turns to her name every time, so I can stop her touching something dangerous”

“He is now a full member of the family, more relaxed and less frustrated. We can have a proper discussion around the kitchen table.”

“Her school reports used to say she lacked confidence and was introverted but now they say she is really confident. She talks at cochlear implant conferences in front of 200-300 people.”

Young people’s perspectives

As yet, there is little evidence from the young people themselves about implantation, either of those who were implanted early and are now teenagers, of those who are choosing to have implants as teenagers. Wheeler et al (in press) interviewed 29 young people and found that the only changes they reported in the use of their implants was they would like changes to be made to be able to wear implants for longer periods – eg
in the shower, or when swimming. Several were experiencing device problems but all intended to have another to replace it. When asked ‘on a scale of 1-5 how much can you hear with your cochlear implant?’ (5 indicating a high level of benefit) the range reported by these young people was from 3 to 5 with the average 4.4. Overall there was feeling that the implant was essential to them, with many of the group reporting that they felt bereft if there was a problem and they could not use it (12, 41%). The following comments illustrate their thoughts on what happened if there was a problem and they could not use their implant:

“I don't like it if it's not working because I don't know what is happening” (female; 13yrs; sign and speech)
“I feel very sad, a bit worried, a bit upset” (female; 14yrs; sign and speech)
“Can't hear anything or understand” (female; 13yrs; sign and speech)
“I hate it so much. Very frustrating because I can't hear” (female; 16yrs; spoken language)

The advantages of the implants to the young people were many and various. Every young person had something positive to say about their cochlear implant and overall positive statements outnumbered negative ones by 9:1.

“when I had hearing aids when I was little (they) didn’t help at all…but cochlear implant – wow! It's amazing to hear everything.” (female; 16yrs; spoken language)

“If I have my hearing aid on it embarrass me. If two people talking if I have my implant I can hear what both saying. I can see what is going on behind me” (female; 13yrs; spoken language)

Other studies by Tooher et al (2001) and Chmiel et al(2000) are equally positive, with no reported psychological or social difficulties.

An indication of the benefit received from implantation is whether implants are being used in the long-term by children and young people. In a study by Archbold et al, (in press) of 138 children implanted for seven years at Nottingham Cochlear Implant Programme, 83% were wearing their implants full-time, 12% most of the time, 2% some of the time, and 3% none of the time, indicating high levels of usage.

Educational implications

The reported improvements in spoken language have led to greater educational attainments, including reading (Stacey et al, 2006; Thoutenhoofd, 2006; Archbold et al, 2006c; Vermeulen in press).

There are also reported changes in educational provision for these children, with more children attending mainstream schools, with potential educational cost-savings (O’Neill et al, 2000). Significantly more children with implants are going to mainstream schools compared with those with hearing aids (Archbold et al, 2002). However, these were young children (aged 5-7) and anecdotal evidence indicates that the trend is not holding up as the children go to secondary school with the challenges of poor acoustics, demanding language and curriculum. While Geers & Brenner (2003) found a trend towards mainstream education, Thoutenhoofd (2006) did not find this trend in their
Scottish study; this may be due to the long recognised difficulty in noise for those with unilateral and/or moderate hearing losses (Bess et al, 1986; Lieu, 2004; Most 2004). The vast majority of those children reported in studies so far have only one implant; schools are noisy environments, and the effect of the equivalent of a unilateral loss is likely to be greater in the increased challenges of secondary educational provision.

The choice of communication mode is also changing for children with implants: those using a visual means of communication prior to implantation are changing to spoken language after implantation, particularly those implanted young (Watson et al, 2005; Spencer, 2003; Tait et al 2007). In the Tait et al 2007 study, before implantation, around 80% of all the three groups were using signed communication rather than oral communication. Twelve months after implantation, the groups implanted at two and three had shown very little change, whereas of the group implanted at one, only 15% were still using signed communication, with the majority having moved to oral communication. Parents report that they are changing to spoken language because their child now has useful hearing, and that they are following the child’s lead, using what the child prefers. (Watson et al, in preparation). This change has significant implications for education – particularly with trend to early implantation, when it is more likely to occur. Those using spoken language can access English in school, with potential gains in literacy skills, and require less specialist support such as provided by sign language interpreters.

The young people report that, while they use spoken language most of the time, for education and for participation in society, they like to use sign language too (Wheeler et al, in press); hence for the first time, these deaf young people are accessing and using the spoken language of society, while also being able to use sign language when they wish, as another language.

In addition to the educational benefits, educational savings have been claimed as a result of implantation (O’Neill et al, 2000; Francis et al, 1999). In personal written communication, a head of a large educational service in England compares the costs for supporting his profoundly deaf children with cochlear implants as being £140,000 as against £630,000 if they had not been implanted – a saving of 450%, in addition to the better spoken language outcomes they are achieving.

Who benefits most?

Controlling for variables is complex, but age at implantation consistently is shown to be the major factor: recent work at The Ear Foundation by Tait et al, 2007, shows that those implanted at the age of one are significantly more likely to show auditory responses most of the time, whereas matched groups implanted at two and three had shown very little change; this difference was highly significant. None of the groups showed auditory response prior to implantation.

Early diagnosis, followed by early implantation is supporting the development of spoken language development – age at implantation remains the most important indicator of spoken language outcome after implantation (Nicholas and Geers, 2006) and although various chronological turning points have been suggested, for example 5 years by Stacey et al, 2006, 2.5 years by Connor et al, 2006, they conclude that current evidence points to the turning point being the age of two. The majority of those children being implanted early are showing language development at similar rates to those of hearing
children and therefore continued delays are due to the gap prior to implantation (Nicholas & Geers, 2006). This emphasises the need to gain early referral, to maximise the benefits of newborn hearing screening followed by early implantation.

Earlier implantation is now increasingly common in other European countries. Increasing evidence, for example Lesinski, 2006, shows that implantation in the first year of life is safe and effective. Following newborn hearing screening, earlier implantation, with the known benefits, is a realistic possibility but in the UK is rarely achieved. In many countries, for example, Sweden, Belgium, Denmark, the average age at implant is in the first year of life. This is not achieved in the UK and there is disparity across the country about access.

Those with deteriorating hearing losses and those implanted later with some useful hearing have been found to have benefited from implantation (Eisenberg et al, 2000; Rubenstein et al, 1999); having the auditory pathway already stimulated and using spoken language in education provides an excellent basis for good implant benefit (Osberger & Fisher, 2000). As one girl, implanted at 16, reported after her implant: “It has been the most exciting year of my life”. She was able to follow class lessons without being dependent on lipreading or relying on her friends.

Although initially cautious about implanting children with complex needs, when the benefits may not be quantifiable on standard measures, implantation may make tremendous differences to families and parents’ and child quality of life. All the children in the study of Wiley et al (2005) were reported to have improved their communication abilities and all parents reported that they would choose an implant again for their child. Edwards (in press) provides a review of current evidence in this group.

Using the technology

Although the technology of cochlear implantation is increasingly used with very young children, it is not always found to be suitable. Parents report problems with keeping the coil on infants’ heads, on the size of the processor for small ears (De Raeve, 2007) and teachers report difficulty in monitoring implant functioning. Trouble-shooting days at The Ear Foundation are well attended; teachers and parents are committed to ensuring the technology works at home and school as well as it did in the clinic, but need further hands-on training in this, and practical support. Fitting implants to FM systems adds an additional challenge and again the demand for training in this area grows for us at The Ear Foundation.

Availability of spare parts and batteries is also reported as a problem for parents; differing guidelines pertain in differing areas of the country.

The safety guidelines from the British Cochlear Implant Group are widely available and provide useful information about safety and restrictions in using implants for parents and teachers.

Disadvantages of Implantation

Wheeler et al (in press) asked the young people about possible disadvantages of cochlear implants; 11 (38%) of the group failed to come up with anything negative about their implant. The teenagers suggested that there were situations where it could be
difficult to use the implant. Problems were experienced when noises were at the extremes, either very loud or very quiet and 11 (38%) mentioned difficulties where there was a lot of background noise:

“In noisy situations it is hard to hear people talking” (male; 15y10m; spoken language)  
“In noisy environment, a crowded place like the town also in the train station” (female; 16yrs; spoken language)  
“In a noisy environment. At parties, sometimes ladies talk to me and ‘sorry I didn’t get that’” (female; 14yrs; spoken language)  
“It is hard outside because the traffic is very loud” (female; 13yrs sign and speech)

Both parents (Archbold et al 2002) and young people (Wheeler et al, in press) expressed concerns about the technology (10, 35%). The consequence of their positive experience of implantation was that the young people felt dependent on it and thus there were fears and worries about it going wrong. Some young people (9, 31%) described how much they hated to have it not working, even for a brief period.

“The fact it can break down and the fact that some time in your life have to have another operation to replace it” (female; 14yrs; spoken language)  
“I just worry and get a bit upset because I don’t like it when cochlear is gone. I like it to work all the time and I was a bit worried if no sound. Nothing” (female;14yrs sign and speech)

These young people have often become reliant on their implant systems to access the curriculum – if they only have one implant, if there is a technical problem they are in real difficulties in the classroom, socially, and often psychologically. Bilateral implantation makes this situation unlikely.

The three young people in this group who were facing possible re-implantation due to failed electrodes said they would not hesitate to have the operation repeated when the time was right. The implant systems are largely reliable, but in every case of device failure at Nottingham Cochlear Implant Programme, the child and parent decided to proceed with another implant operation, an indication of the value put on the device.

Groups having difficulty in accessing implant services

There is clear evidence that the deaf population is not accessing implant services in consistent ways, and adult implant services in particular are not meeting demand – see the figures of National Cochlear Implant Users Association. The lack of consistent guidelines and practice across the country leads to frustration on behalf of parents and inconsistent delivery of implantation. Lack of knowledge of the latest research in this fast changing field can lead to inappropriate clinical decisions and guidelines established. The Ear Foundation provided the commentary and summary for the National Library for Health literature review (annually) and provides a link from its website (www.earfoundation.org.uk) to make keeping up-to-date as easy as possible, and improve consistency of the evidence-base for practice. We also produced the cochlear implant care pathways for DO ONCE AND SHARE, now being put on map of medicine, again to endeavour to improve consistency of access.
Cochlear implantation involves complex technology and has traditionally been fitted in cochlear implant centres which may be at a distance from patients' homes. The current models of service delivery in the UK in specialist centres, requiring return to the centre for follow up care, involves parents and adults in travel and in time off work. For parents, organising child care and these issues can restrict access for some families and be stressful (Sach and Whynes, 2006). Sach et al (2006) found that travel costs were the greatest out-of-pocket expenses for families and this may restrict access to implantation: Fortnum et al (2006) found that children with implants were more likely to come from more affluent families.

In addition, those using sign language and those from minority ethnic families may have difficulty in accessing information about implantation. Parents of children with complex needs may also have difficulty in obtaining referral to implant centres, because of the emphasis on speech and language outcomes, the lack of sensitive measures for this group, which, combined with a lack of experience in managing these children, gives rise to a reluctance to proceed.

**Bilateral Implantation**

We know that two ears are more effective in the adverse listening conditions which exist in real-life situations and that there are benefits from binaural hearing, with implant and hearing aid (for example, Ching et al, 2006). Tyler et al (2006) suggest that we need more sensitive measures to evaluate fully the benefits of binaural implantation, but the evidence of bilateral implantation in the profoundly deaf (Litovsky et al, 2006; Litovsky, 2004; Khun-Inacker et al, 2004; Verschuur et al, 2005) has been enough to convince the Blue Cross insurance company in the US to state: “recent literature and developments in clinical practice are sufficient to support treating bilateral cochlear implants as medically necessary for some patients”.

In terms of cost-effectiveness, simultaneous bilateral is likely to be more effective, as current evidence shows that the shorter the time delay between the two implants the better the outcome, and the more similar the sound of both ears the better (McKay, 2007). Additionally it involves only one assessment, surgery, tuning and programme of follow up care, giving better outcomes, with limited additional costs.

We urgently need up-to-date evidence in the UK and we are beginning a research project using Tait video analysis of early communication skills, comparing those with early bilateral implants with matched unilateral children. We have also just completed a review of parents of children with bilateral implants in the UK (funded by RNID); parents report increased ability in background noise, and appreciate the fact that their child is never without hearing. Some parents commented on the advantages of having a ‘back up’ system.

*If the battery on one runs out he is no longer suddenly deaf- he can carry on until the batteries on one are replaced.* (18)

*But important to me is the fact that should anything happen to one implant, she will never again have to go without listening with at least one ear. D is 110% reliant on listening!* (7)
He has ‘taken off’, totally accepted it. It seemed the most natural thing for him to have. We have peace of mind he has a ‘back up’ now. (18)

They comment also on listening in noise:

(He) responds to voices in large noisy environments e.g. playgroups. (22)

We really notice the difference if one magnet has fallen off e.g. in noisy environments. (23)

Immediate preference for two in background noise.

On the occasions that our child has only been wearing one processor (i.e. due to ear infection) we have noted a significant deterioration in her hearing and sound locating ability. Moreover our child prefers wearing both – she is unhappy when one is turned off (e.g. at hearing tests) (9)

Two parents commented on their problems with funding their child’s second implant:

In terms of benefits we are very pleased. We were turned down for funding and then had to plough our way through the maze of going private (which implant centre, costs, post implant care), it was a minefield and very stressful. The time he was in surgery was hard – what if something goes wrong? when already has one, will it be worth it? will his cochlea have ossified etc..we now have huge costs BUT DON’T regret it for a second.(22)

PCT refused to fund. Due to ossification we could not wait and fight so paid for it. The whole experience has been and continues to be stressful and a financial strain. However....early results that he is showing prove that it is worth it and we would do it again. T likes both his ‘ears’ and this is enough to know he is benefiting. (2)

In many areas in Europe, the situation is different: in Stockholm, for example, over 100 children have been bilaterally implanted while the number of implanted children in the whole country is about 500. When we provide parental training courses in Denmark, we can see the differences in early communication in the children with bilateral implants, particularly their confident responses in noise. Colleagues in Flanders (De Raeve, 2007), giving initial data on the Belgian Government of Health Care multi-centre study (2003-2006) of 42 children with bilateral implants, on pure-tone audiometry and speech recognition in quiet and noise, report that:

"Bilateral cochlear implantation offers advantages to all children in comparison with the first implant, even for the children who received a second implant after the age of 6, a progress is determined after 18 months. However, the data appear to show a beneficial performance for those children who received their second implant before the age of 6, especially in the more challenging conditions."

With regard to education; we have commented on the effect of a unilateral hearing loss; Bess (1986) showed that children with a unilateral hearing loss were ten times more likely to fail a grade, and twice as likely to have behavioural difficulties in the classroom. In the noisy classroom environment, the benefits of bilateral implantation are likely to become more apparent over time. Where bilateral implantation is more widely available,
in Belgium, De Raeve (2007) reported that 100% of children with bilateral implants were in mainstream schools, compared with 54% of those with unilateral implants thus greatly increasing the potential for mainstream education, and hence for further educational cost savings, maximising the benefit of implantation for these children.

At our recent international conference on bilateral cochlear implantation (The Ear Foundation, 2007) led by key international players in the field, the consensus was summed up by Rich Tyler (IOWA) that current evidence shows:

- Clear benefit of two ears in noise and in localisation abilities; in the adverse conditions in which deaf children find themselves learning language and accessing the demanding curriculum
- Two implants are better than one for those profoundly deaf
- For those severely deaf, the question remains which patient should have two implants, and which a hearing aid and an implant.

Comment:

“Spoken language development of deaf children may be more possible today than ever before. We are poised on a threshold of what often seem like unlimited possibilities.” Marschark and Spencer, p17, (2006)

This comment, by two rigorous deaf educators and researchers, seems apt. For those of us working with deaf children for many years, cochlear implants have provided unthought-of possibilities in terms of ease of communication, spoken language and access to education for children; “revolutionised the experiences of spoken language acquisition for deaf children” (Geers, 2006). There is no alternative which can provide this. However, basing judgements and clinical practice entirely on published research evidence means that it is likely to be based on out-of-date evidence for reasons given above. In the UK the level of provision is below what is expected on current evidence (Taylor & Hine, 2006) and below that of other European countries.

The clinical and cost-effective evidence for unilateral implants in profoundly deaf children is there, (for example Stacey et al, 2006; Barton et al, 2006): the evidence of benefit in those with severe losses and for bilateral implantation will take more time to obtain. However, our early evidence and experience shows that we appear to be on the same pathway as we were for unilateral implantation eighteen years ago. Continued rigorous evaluation using sensitive tools is necessary, to enable continuing review of the evidence.

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