

## **Brief Assessment of Parental Perception (BAPP): Development and Validation of a New Measure for Assessing Paediatric Outcomes after Bilateral Cochlear Implantation**

### **Abstract**

#### Objective

In contrast to previous clinical practice, current guidelines recommend bilateral cochlear implantation in children, resulting in a cohort of children who initially received one implant, but have subsequently had a second, contralateral implant. This study aimed to explore satisfaction and quality of life in children implanted simultaneously or sequentially.

#### Design

A novel measure of satisfaction and quality of life following paediatric bilateral cochlear implantation (the Brief Assessment of Parental Perception; BAPP) was developed and preliminary validation undertaken as part of a large, national project of bilateral implantation. Children's parents completed the measure yearly for up to three years following implantation.

#### Study Sample

Children from 14 UK implant centres were recruited into the study; data were available for 410 children one year post-implantation.

#### Results

The BAPP was found to have good face and convergent validity, and internal consistency. Results indicated very high levels of satisfaction with the devices, and improvements in quality of life. However there was evidence that children implanted sequentially were less willing to wear their second implant in the first two years than those children receiving simultaneous implants.

#### Conclusion

Simultaneous and sequential cochlear implants have a positive impact on the quality of life of deaf children.

## Introduction

In 2009, the United Kingdom National Institute for Health and Care Excellence (NICE) recommended that all suitable children be offered simultaneous *bilateral* cochlear implants (NICE, 2009). NICE also advised that children who were unilaterally implanted prior to the guidance should be offered a second implant if appropriate. When the guidance was published, NICE recommended that an audit of bilateral cochlear implantation be conducted. A consortium of 14 cochlear implant centres in the United Kingdom was formed to identify appropriate assessment measures to assess the benefit children receive from bilateral cochlear implants. This National Paediatric Bilateral Project (NPBP) consortium identified a number of clinical outcomes to be assessed: localisation of sound, speech recognition in quiet and background noise, speech production, listening, vocabulary, surgical data including complications, and parental perceptions of quality of life (Cullington, Bele, Brinton et al, 2013). One existing measure of quality of life (QoL), the Paediatric Cochlear Implantation: Parent Outcome Profile (POP; O'Neill, Lutman, Archbold, et al, 2004) was adopted for the project, the results of which, along with the clinical outcomes, are reported elsewhere. However, the need for an additional, brief, QoL of life measure was identified, and the development of this, along with selected results obtained from the project, form the focus of this paper.

### *Quality of Life Assessment*

Quality of life measures take two primary forms; generic and condition specific. Although there are a range of generic paediatric QoL measures available, they may not be suitable for assessing QoL in children with cochlear implants because they focus on physical health-related function (e.g. mobility, pain) which usually have little relevance for deaf children. In addition, such measures often include measurement of self-care behaviours in older children (e.g. washing and dressing) which may not be applicable given that children who have cochlear implants are increasingly implanted around their first birthday. For example, Sach and Barton (2007) assessed QoL in children with cochlear implants (mean age 9.2 years) using a generic QoL measure, the EuroQol (Rabin & deCharro, 2001). The authors found no significant changes on the measure

from pre- to post-implantation, and therefore inferred that “parents rejected the notion that deafness was a HRQL [health related quality of life] issue” (Sach & Barton, 2007, p.443).

Research assessing quality of life (QoL) in children with cochlear implants has also been conducted using another generic measure, the KINDL<sup>R</sup>, which assesses health related QoL in children and adolescents (Huber, 2005; Warner-Czyz, Loy, Royland, et al, 2009). However it is only suited for children age 3 years and over, and many of the children in the NPBP would be below this age at the time of their first, and possibly second annual review following implantation.

Within the area of cochlear implantation, at the time of this study only one published measure existed to assess QoL of life specifically for children with cochlear implants: the Paediatric Cochlear Implantation: Parent Outcome Profile (POP). The POP is a 74-item questionnaire designed to assess parents’ perceptions regarding their child’s experience with cochlear implant(s). The POP was adopted as one measure of QoL for the NPBP but it has significant short-comings when used in this type of large-scale study. The POP is very lengthy and requires a level of literacy that a significant proportion of parents may not have. As around 16 per cent of adults in England have literacy levels at or below those expected of an 11-year-old (National Literacy Trust, 2014) there was concern that: i) the length of the questionnaire ii) the length of individual questions and iii) the ambiguity in question wording would exclude a significant percentage of parents from being able to complete it, especially for parents for whom English was not their first language.

Therefore a need was identified to develop a brief, psychometrically valid and reliable measure of QoL following cochlear implantation, that was accessible to as many parents as possible and covered the full age range of children being implanted.

For the NPBP, when considering aspects specific to cochlear implantation, in addition to traditional domains assessed by existing QoL measures, it was also important to measure the children’s usage and willingness to wear the speech processors. This was particularly important amongst children and teenagers receiving a sequential implant, often many years after their first. Usage and willingness to wear implants was not included in any existing measures.

This paper will therefore describe the development and validation of a new parent-completed measure to assess cochlear implant usage, satisfaction with the implants and QoL for children following bilateral cochlear implantation (simultaneous and sequential). The paper will then describe the QoL outcomes identified with this measure for children who took part in the National Paediatric Bilateral Project (Cullington et al, in preparation).

## **Part 1. Development and Validation of the Brief Assessment of Parental Perception (BAPP)**

### **Method**

#### *Background*

The aim of this project was to develop a brief, concise, clinically useful measure of quality of life and satisfaction for children post-cochlear implantation. Clinical Psychologists working in paediatric cochlear implant teams identified key factors and devised questions for the measure based on their collective clinical experience in the programmes within the UK, taking into account: i) factors commonly mentioned in clinical assessment and review by parents and children as key desired outcomes / or achieved outcomes from cochlear implantation that are valued and ii) the specific aspects of psychosocial development that have been found within the literature to be relevant for deaf children or that may change after implantation. The factors were also chosen bearing in mind the domains typically included in well-established generic measures of QoL.

Given the young age at which the majority of deaf children now undergo cochlear implantation, a parent-reported measure was developed (rather than self-report), so that all children could be included in the study. The final questionnaire consisted of 4 questions on one side of paper, including one five-item question to measure QoL. Due to the context of the measure development, that is being required to measure change in QoL from the time point of implantation onwards, the QoL question was designed to be retrospective, with the question worded as follows: “compared to when your child had one implant, to what extent has the second implant made a difference to your child in terms of the following factors?”. For

those receiving simultaneous implants, the equivalent question read “compared to before your child had bilateral cochlear implants, have the cochlear implants made a difference to your child in terms of the following factors?”. Thus two different versions of the questionnaire were produced, in order to differentiate between simultaneously and sequentially implanted children (see Appendix A).

Summary of items included and rationale:

#### *Usage & Willingness to wear*

These two questions were included based on clinical experience that adherence to usage is a useful proxy for satisfaction (either parental or child).

#### *Recommend to friends*

The ‘family and friends test’ (NHS England, 2013) is a commonly used Patient Reported Outcome Measure to evaluate satisfaction with services or treatment.

#### *Quality of Life Items*

Consistent with recommendations in the QoL literature (Davis et al., 2007) items were selected which assessed well-being rather than ill-being. For example, an item was worded “getting on with friends and family” as opposed to “problems with relationships with friends and family”.

The following factors were included within this section: behaviour; communication; contentment (emotional well-being); learning; getting on with friends. These items were selected as they reflected areas reported by parents and children, clinically and in research studies, as being important in deaf children and/or improving after cochlear implantation (e.g. Edwards, Khan, Broxholme and Langdon, 2006; Huttunen & Välimaa, 2010; Anmyr, Larsson, Olsson and Freijd, 2012; Van-Gent, Goedhart & Treffers, 2012; Shin, Kim, Kim et al, 2007; Bat-Chava, Martin & Kosciw, 2005). Each of these factors was presented within a table and respondents were asked to tick the box to show how things have changed, indicating degree of change using the following scale: much worse; slightly worse; no change; slightly better; much better.

It is important to note that parents were being asked to reflect on different circumstances depending on whether their child had received simultaneous or sequential implants. The parents of simultaneously implanted children were asked to rate change in their child's QoL, with the time frame being pre-bilateral implantation to the point of measure completion (i.e. one-, two-, or three-years post-implant). The parents of sequentially implanted children, however, were asked to rate change in the child's QoL, with the time frame being unilateral implantation to the point of measure completion, by which time they were bilaterally implanted. To clarify, parents of sequentially implanted children were rating the additional impact of the *second* cochlear implant, rather than the impact of cochlear implantation in a child who previously had no cochlear implants.

### *Scoring the Measure*

As the four questions within the BAPP were designed to measure distinct concepts (usage, willingness to wear, quality of life, and satisfaction), each question was scored separately. The scoring for the items can be seen in Appendix A. For question 3, the overall quality of life score was computed by summing the scores on the five items, giving a possible range of -10 (worst deterioration) to 10 (optimal improvement). Due to the relatively small number of items within this scale, an overall score was only computed if the respondent had answered all five items. It should be noted that throughout the results sections below, the numbers of children in the analyses varies both due to the overall number of BAPPs completed at a particular time point, and the completion rate for individual BAPP questions and items.

### **Results - Validity and Reliability**

Data collection for the NPBP occurred from 1<sup>st</sup> January 2010 to 31<sup>st</sup> December 2012. In the years 2010 and 2011 all children pre-implant, 1 year and 2 years post-implant were invited to participate. In 2012 the pre-implant interval was discarded (as these children would not reach the 1 year follow-up before the end of the study) and an additional 3 year interval was added. Thus all children receiving simultaneous bilateral or

a sequential bilateral cochlear implant from 2008 to 2011 were eligible to be included. This protocol resulted in significantly more data for all outcome measures at the 1 year time point and the decrease in numbers of children over the three years does not therefore constitute drop-outs from the study or missing data. With regards to the BAPP data there were 380, 170, and 45 fully-completed BAPPs for the 1, 2, and 3 year post-implantation time points respectively. For this reason, the reliability and validity statistics were primarily computed using the 1-year post-implantation data. Data from children implanted simultaneously and sequentially were combined.

### *Convergent Validity*

Convergent validity refers to the extent to which a measure correlates with other measures designed to measure the same construct. Ideally, a gold-standard, well-validated measure should be used for such analysis. Due to the lack of a suitable measure, however, and the necessity to use the data collected within the project, the POP was used to assess convergent validity. Given the poor reliability of the original sub-sections of the POP (Cronbach's alphas 0.2-0.61, Nunes, Pretzlik, & Ilicak, 2005), the factor structures and resultant scales identified during the NPBP project data analysis of the POP were utilised as the comparison variables (Cullington et al., in preparation): Well-being and Behaviour. The internal consistency of each of these scales was good, with Cronbach's alpha coefficients of 0.885 and 0.743 respectively.

Spearman's rho correlations were used to measure the relationship between the QoL scores derived from question 3 of the BAPP and the POP Well-being and Behaviour scales. Non-parametric Spearman's correlations were used as not all of the data met the assumptions of normality necessary to use parametric tests. The POP Well-being scale was normally-distributed, but the Behaviour scale was not; BAPP quality of life was positively skewed, due to the majority of parents rating at least some improvement in their child's QoL (Kolmogorov-Smirnov tests:  $p = 0.200$ ,  $0.001$  and  $0.000$  respectively). The BAPP total QoL score was significantly correlated with both POP Well-being and Behaviour (Spearman's rho correlation coefficients: POP Well-being  $r_s = 0.287$ ,  $p=0.000$ ; POP Behaviour  $r_s = 0.688$ ,  $p = 0.000$ ). These correlations indicate that the BAPP has acceptable convergent validity.

### *Face Validity*

Face validity relates to the extent to which a measure appears to respondents to measure what it is intended to measure.

Throughout the course of data collection, clinicians administering the questionnaire often commented on how parents were able to relate to the items within the measure through informal feedback, and how easy it was for parents to complete.

### *Internal consistency*

Internal consistency of Question 3 was assessed to ascertain whether the five items measure the same underlying construct. Cronbach's alpha coefficient of 0.864 at the 1-year post-implantation time point indicated that this question has excellent internal consistency, based on a sample size of 380. Despite smaller sample sizes at years two and three post-implant, strong alpha coefficients of 0.892 (n=170) and 0.786 (n=45) respectively were obtained.

## **Part 2. Quality of life and satisfaction following bilateral cochlear implants (results from the BAPP)**

### **Method**

#### *Participants*

All children receiving simultaneous or a sequential bilateral cochlear implant within the study period at the 14 centres were eligible to be enrolled. As described earlier data collection occurred between January 2010 and December 2012. Children newly implanted or at one or two years post-implant in 2010 and 2011 were included; for 2012 the three-year data collection interval was added. Based on figures from the British Cochlear Implant Group (BCIG, 2012), it can be estimated that 1032 children received simultaneous bilateral implants and 828 children received sequential bilateral implants in the UK between 2008 and 2011. One thousand and one children were included in the project representing 54% of the total eligible



population (bearing in mind that four paediatric implant centres chose not to participate in the consortium for unknown reasons ).

The sample characteristics for children whose parents completed the BAPP one year post-implant can be seen in Table 1. Data from the simultaneous and sequential groups is presented separately, due to the considerable differences between these two groups.

### *Procedure*

When children attended the consortium centres for their standard annual review appointments, their parents were asked to complete the BAPP (along with the other project measures). Parents were typically able to complete the questionnaire independently in less than five minutes, but support was available for those who required it. However it was not always possible for it to be translated into languages other than English as the availability of interpreters could not be guaranteed. Each centre collated their own raw data and periodically sent it to the University of Southampton Auditory Implant Service (USAIS) for analysis.

As the BAPP was designed as a measure of change, it was not included in the pre-implant protocol, but was included in the protocol at all three annual post-implant time-points.

### **Results**

The amount of data available at each of the post-implant time-points decreased every year. This was because routine bilateral implantation in the UK had only recently begun, so few children had reached the three year time point by the end of the project. In addition, not all of the participants completed all of the measures at each time-point, and individuals dropped both in and out of the project; the number of children included in the analysis of each of the constructs therefore varied and the N values are presented within each section separately. Thus there was considerably more data available 1 year post-implantation than later in the project, and the results will focus primarily on this time-point.

### *Usage*

Figures 1 and 2 show the wearing patterns of children with simultaneous and sequential bilateral cochlear implants respectively. For those that answered the question, at one year post-implant 153 of 167 children (91.6%) in the simultaneous group, and 203 of 238 children (85.3%) in the sequential group, were reported to be wearing both of their implants/second implant all the time. There was no significant association between whether the child was implanted simultaneously or sequentially and their wearing characteristics  $\chi^2 (2)=4.765$ ,  $p = 0.092$ .

At two years post-implant, data were available for 67 simultaneously implanted children and 115 sequentially implanted children; at three years post-implant, data were available for 18 simultaneously implanted children and 31 sequentially implanted children. The percentages of children wearing both of their implants all of the time remained consistently high (at 2 years simultaneous = 94.0%, sequential = 88.7%; at 3 years simultaneous = 100%; sequential = 87.1%), and there were no significant differences between the wearing characteristics of the two groups (simultaneous versus sequential) at either of these time-points (2 years:  $\chi^2 (1)=1.422$ ,  $p = 0.233$ ; 3 years  $\chi^2 (2)=2.529$ ,  $p = 0.282$ ).

#### *Willingness to wear*

Figures 3 and 4 show the willingness to wear both/the second cochlear implant in children with simultaneous and sequential bilateral cochlear implants respectively. For those that answered the question, at one year post-implant 149 of 167 children (89.2%) in the simultaneous group and 196 of 240 children (81.7%) in the sequential group were reported to be either 'Keen' or 'Very keen' to wear both implants (simultaneous) or the second implant (sequential). Recoding this question into a three-point scale comprising Keen (made up of Keen and Very keen), Neutral, and Reluctant (made up of Reluctant and Very reluctant), there was a significant difference in the willingness to wear characteristics of the two groups (simultaneous and sequential);  $\chi^2 (2)=6.338$ ,  $p = 0.042$ . This difference between the groups persisted at the 2 years post-implant interval, where 66 of 70 children (94.3%) in the simultaneous group and 95 out of 117 (81.2%) in the sequential group were Keen or Very keen to wear both implants/their second implant ( $\chi^2 (2)=6.591$ ,  $p = 0.037$ ). A significant difference did not remain at the 3 year time interval, where 16 out of 18

(88.9%) in the simultaneous group and 28 out of 32 (87.5%) in the sequential group were Keen or Very keen to wear both implants/their second implant ( $\chi^2 (2)=5.808, p = 0.055$ ).

### *Satisfaction*

At one year post-implant, 165 of 170 (97.1%) parents of simultaneously implanted children and 222 of 236 (94.1%) parents of sequentially implanted children reported that they would recommend bilateral implants or a sequential implant to families in a similar situation. These figures remained consistently high at two years (simultaneous: 68 of 69 [98.6%]; sequential: 172 of 181 [92.9%]) and three years post-implant (simultaneous: 18 of 18 (100%); sequential: 32 of 32 (100%). There were no statistically significant differences between the groups (simultaneous and sequential) at any of the time points (1 year:  $\chi^2 (2)=2.618, p = 0.270$ ; 2 years:  $\chi^2 (2)=2.988, p = 0.224$ ).

### *Quality of Life*

The BAPP total QoL scores for the simultaneous and sequential groups at each time point can be seen in Table 2 and Figure 5. The potential range of QoL scores is -10 to 10, with a positive score representing an improvement in parent-reported QoL.

The results displayed in Table 2 and Figure 5 indicate that both simultaneously and sequentially implanted children generally showed improvements in their overall QoL of life at all three time-points, with at least 87% of parents reporting some improvement regardless of group membership or number of years post-implant. Data plotted in Figure 5 are presented as boxplots in order to illustrate a measure of the range of scores. Although most children showed an improvement in QoL after implantation there were some children whose parents reported a decline. Encouragingly, almost all families reported positive scores by three years after implantation. Spearman rho correlations were calculated between QoL scores and the duration between implants for the sequentially implanted children. Significant negative correlations were found for years one ( $r_s=-0.425, p=0.000, n=220$ ), and two ( $r_s=-0.381, p=0.000, n= 112$ ) post implant. This

indicates that the longer the gap between the first and second implant, the smaller the improvement in QoL.

One of the outcome measures of the NPBP was the Categories of Auditory Perception- Second Edition questionnaire (CAP-II; Gilmour, 2010). This clinician-rated scale is designed to measure the child's ability to interpret and respond to their auditory environment. It comprises a hierarchical scale of auditory perceptive ability ranging from 0 "no awareness of environmental sounds or voice" to 9 "use of telephone with an unknown speaker in unpredictable context". In order to explore whether improvement in QoL is associated with changes in a measure of listening ability, the Spearman rho correlation was calculated between QoL and CAP-II scores at one year, for simultaneously and sequentially implanted children together (n=301). A significant positive correlation was found such that greater improvement in QoL was associated with greater improvement in auditory perceptive ability; Spearman  $r_s=0.463$ ,  $p=0.000$ .

## **Discussion**

### *Development and Validation of the Brief Assessment of Parental Perception (BAPP)*

The results presented in the current paper indicate that the BAPP, a brief and simple questionnaire measure, has excellent internal consistency and good convergent validity. The measure also has good face validity and was well-received by clinicians and parents alike.

Providing the measure is reliable and valid, brief measures have a number of advantages; they are less onerous for patients and minimise missing data through higher completion rates (Phillips, Absolom, Stark & Glaser, 2010). They are also less costly in terms of administration required for data entry and scoring (Zimmerman et al. 2010) and they are more acceptable for clinicians (Mitchell, Kaar, Coggan, & Herdman, 2008).

A strength of this project was that the recruitment of participants was done with minimal bias. Many similar projects in this field include only subjects who are sufficiently motivated to take part in research, are performing well, have no additional difficulties, and so on. The inclusive nature of this project and the ease of completion of the BAPP is likely to have ensured better representation of the population of children with

two cochlear implants. Nevertheless, not all participants completed the BAPP when they attended review appointments, possibly due to the significant number of participants who spoke or read no English and for whom no interpreter was available. Also, it is possible that there was variability between the participating implant centres in the reliability of their data collection that cannot be accounted for in our results.

Despite the fact that the BAPP has been shown to be a valid and reliable measure for assessing usage, satisfaction, and QoL of life after bilateral implantation the limitations of the measure should also be considered. Firstly, the BAPP combines both snapshot questions regarding the time of completion (e.g. usage) and some retrospective questions assessing change from a prior time-point (QoL). Ideally PROMS measures should ask participants to rate current perceptions of a variable and measure change by comparing rates at different time points, rather than asking for retrospective reports which may be subject to biases in memory. Second, the measure may be limited in that some of the wording may not be familiar to respondents in other English-speaking countries. For example, the word “keen”, meaning enthusiastic (with reference to using processors), is not used in American English.

An additional limitation worth noting is that the BAPP QoL section refers to change in QoL from either having no implants to two implants (simultaneous implantation) or one implant to two implants (sequential), rather than an overall current quality of life. It is therefore not possible to draw conclusions about differences between simultaneously and sequentially implanted children’s overall QoL. Finally, the brevity of the BAPP could also be seen as a weakness. Zimmerman et al (2010) has highlighted how short measures may be less reliable (stable) than longer multi-domain questionnaires and less appropriate for assessing non-discrete concepts such as QoL. Thus the BAPP’s short format precludes a richer understanding about parent’s perceptions of their child’s implant related QoL. For example, the BAPP does not include questions regarding reasons for usage and willingness to wear the implant, potentially valuable clinical information. However, despite its brevity the BAPP was found to correlate significantly with the 24 items comprising the POP Well-being and Behaviour subsections.

*Part 2. Quality of life and satisfaction following bilateral cochlear implants (results from the BAPP)*

The results obtained from the NPBP presented in the current paper indicate that the majority of children wear their implants consistently and are willing to do so, whether implanted sequentially or simultaneously. However, at one and two years post-implant there was a significant difference in the willingness to wear characteristics of the simultaneous and sequential groups; children who had received simultaneous implants were more keen to wear their processors than those receiving a second implant some time after the first. The significant difference did not remain at the 3 year time interval. It is possible that there was no longer a difference at the 3 year time due to the smaller sample size at this time-point. An alternative interpretation is that the sequential group took longer to realise the benefits of their second implant and therefore they gradually became more enthusiastic about wearing it. This is consistent with anecdotal clinical experience.

Findings indicate that the majority of children showed positive improvements in QoL after receiving cochlear implants, with those who were simultaneously bilaterally implanted showing the greatest improvements. This is unsurprising given that parents in the simultaneous group were being asked to rate the value of their child having two implants, having previously had none, rather than the added value of one additional implant (sequential group). For simultaneously implanted children, the QoL impact in terms of hearing status change, and the opportunities that this brings with regards to developing listening skills, communication and social inclusion, is likely to be more striking compared to the more subtle gains, such as directional identification and hearing in background noise, for existing unilateral implant users receiving an additional implant.

The final valuable finding is that the vast majority of parents would recommend cochlear implants (both simultaneously or sequentially implanted) to other parents in a similar position, suggesting very high rates of satisfaction amongst parents of children using these devices. However, this was not the case for

everyone, and the finding that some parents reported a decline in QoL in the early years after implantation and would not recommend an implant needs further investigation. Almost all the cases were children who were sequentially implanted, suggesting that some children and their families may require additional support in the period after the child receives their second implant.

### **Conclusion**

A brief parent-report outcome measure developed to assess cochlear implant-related QoL and implant usage was found to be internally consistent and valid. The vast majority of parents perceived an improvement in their child's QoL particularly if their child received two implants simultaneously, and would recommend cochlear implants for others. Thus the BAPP provides a useful measure of Quality of Life and Satisfaction following bilateral Cochlear Implantation in Children.

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St Thomas' Hospital Hearing Implant Centre, London

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Figure 1. BAPP measure of child's wearing of both CIs at each interval (simultaneously-implanted children).

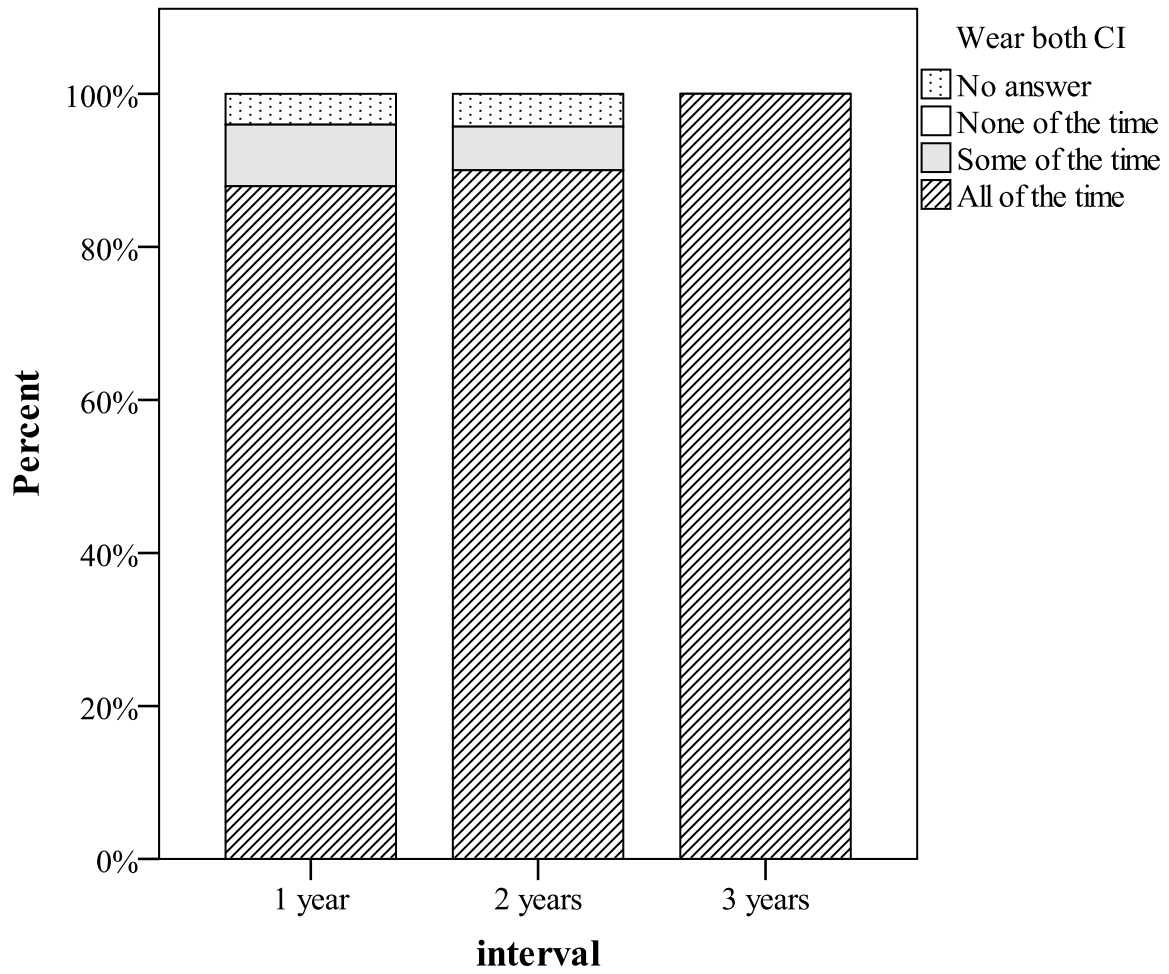


Figure 2. BAPP measure of child's wearing of second CI at each interval (sequentially-implanted children).

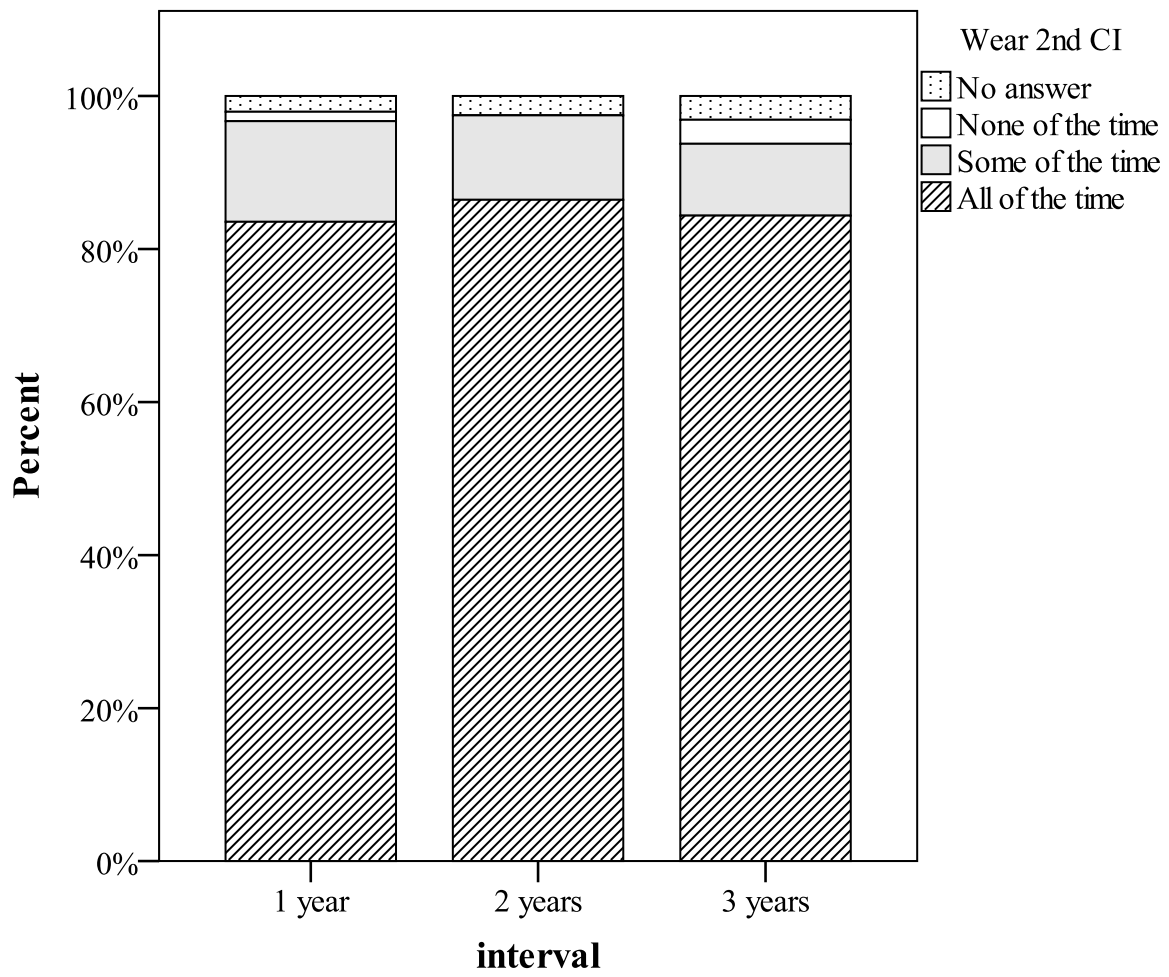


Figure 3. BAPP measure of willingness to wear both CIs at each interval (simultaneously-implanted children).

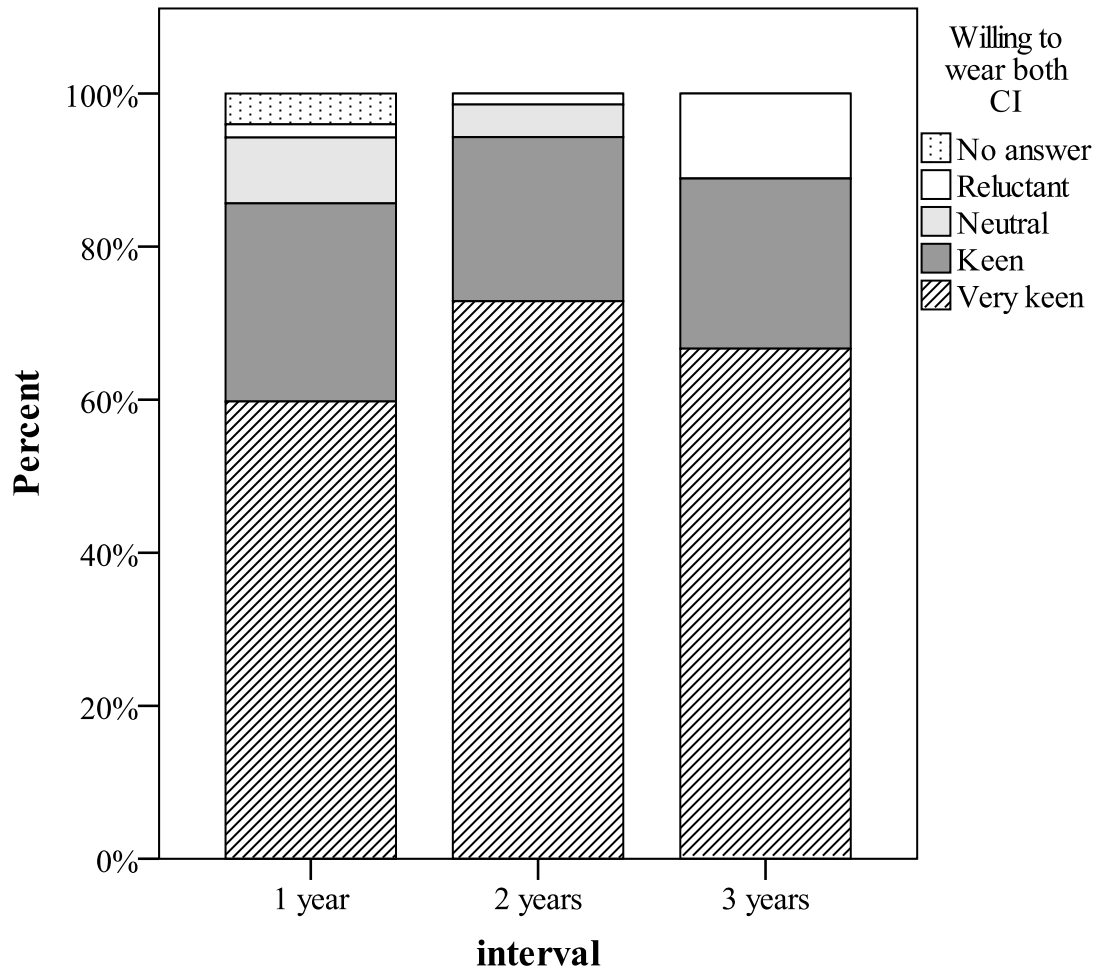


Figure 4. BAPP measure of willingness to wear the second CI at each interval (sequentially-implanted children).

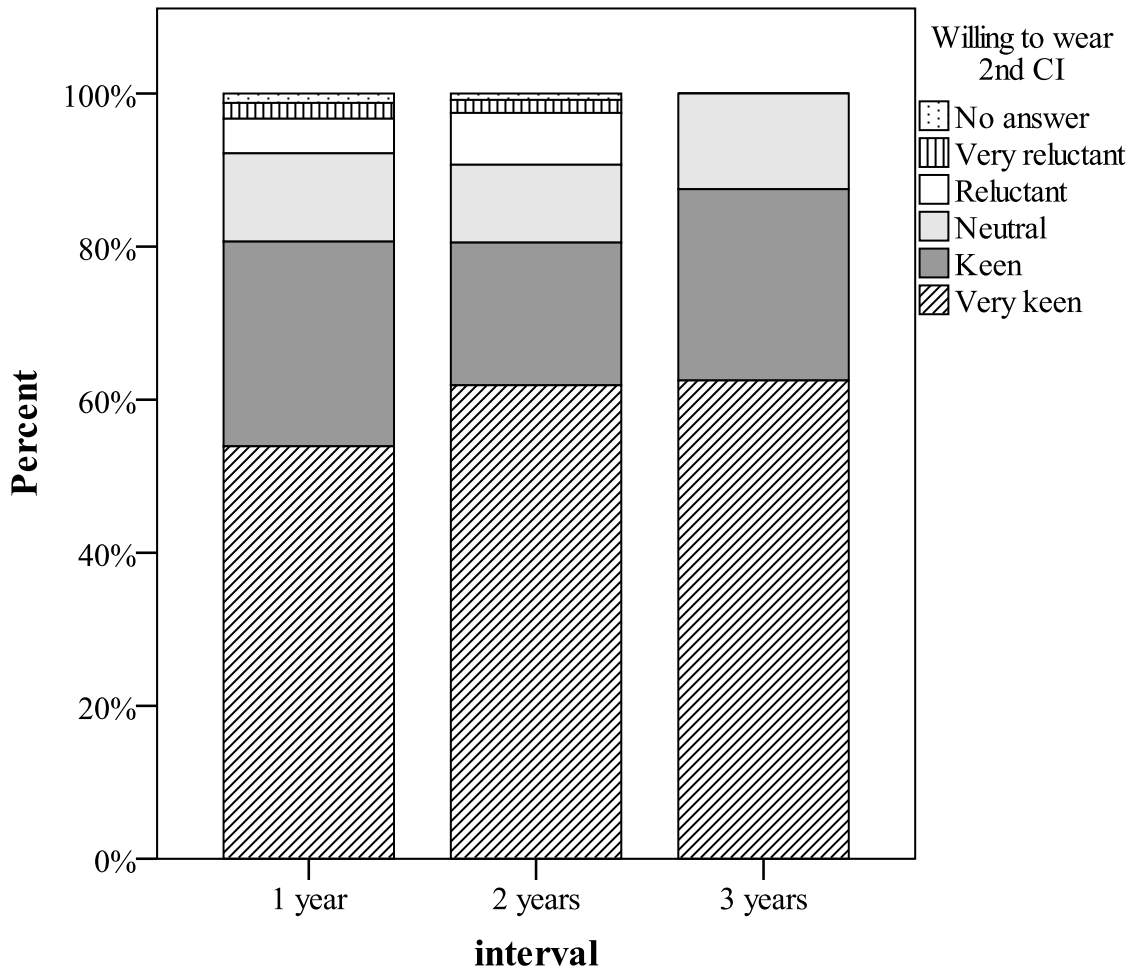


Figure 5. Boxplot of BAPP overall Quality of Life score against interval in simultaneously- and sequentially-implanted children. The solid line in the box represents the median; the bottom of the box is the 25th percentile and the top of the box is the 75<sup>th</sup> percentile. The whiskers represent the minimum and maximum observed values that are not statistically outlying. Outliers (greater than 1.5 times the height of the box) are shown as circles. The numbers by the outlier markers represent individual case identifiers. (Simultaneous n=160, 58, 15; sequential n=220, 112, 30).

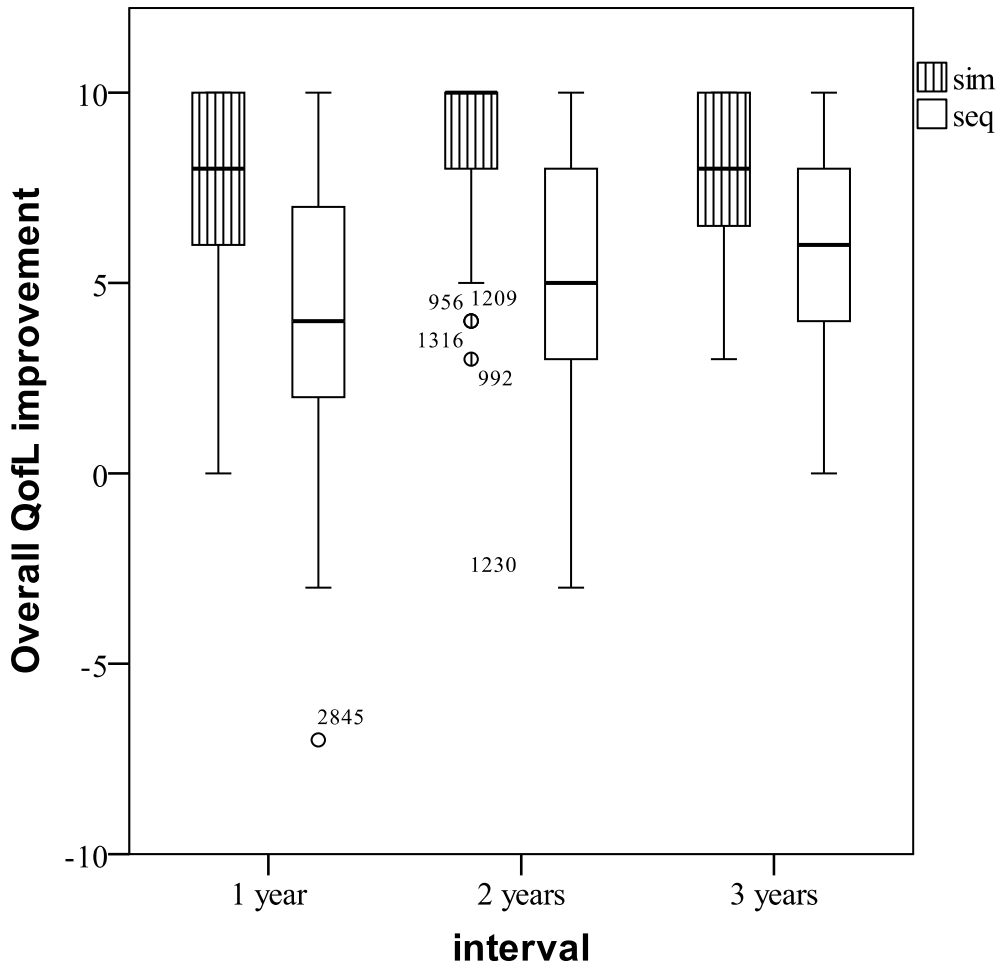


Table 1. Characteristics of children assessed one year post-implantation\*

	<b>Simultaneous (N=170)</b>	<b>Sequential (N=240)</b>
<b>Mean age at implant for 1<sup>st</sup> implant(s) in years (range; SD)</b>	3.17 (0.7-15.3y; 2.88y)	
<b>Mean age at implant for 2<sup>nd</sup> implant in years (range; SD)</b>	-	8.65 (1.2-17.6y; 3.50y)
<b>Mean duration between implants in years (range, SD)</b>	-	5.46 (0.1-13.5y; 3.00y)
<b>% Male</b>	55	48
<b>% Female</b>	45	52

\*Data relating to those children for whom the BAPP was at least partially completed



Table 2. Quality of life (question 3 of the BAPP)

	Mean (SD)	Range	% of positive scores (+1 or higher)
<b>1 year post-implant</b>			
Simultaneous (n=160)	7.63 (2.35)	0 to 10	98.7%
Sequential (n=220)	4.53 (3.32)	-7 to 10	87.3%
<b>2 years post-implant</b>			
Simultaneous (n=58)	8.53 (2.44)	-3 to 10	98.3%
Sequential (n= 112)	5.23 (3.34)	-3 to 10	89.3%
<b>3 years post-implant</b>			
Simultaneous (n=15)	7.80 (2.27)	3 to 10	100%
Sequential (n=30)	6.17 (2.74)	0 to 10	96.7%