

Fuel for the processor: Our experience

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Abstract

Introduction: Cochlear implant centers providing audiological and habilitation support to their implantees are also obligated to offer prompt and accessible equipment maintenance. **Aim of the Study:** To evaluate and compare the number of accessories requiring replacement by the different processors of the three major cochlear implant manufacturers: Advanced Bionics, Cochlear, and MED-EL. **Type of Study:** Retrospective. **Materials and Methods:** An analysis of the inventory of accessories required and used by 218 recipients supported by our center for a period of 3 years from 2010 to 2013 was done. These data were statistically analyzed for each manufacturer. **Results:** Eleven accessories provided by the manufacturer were replaced regularly by implantees over 3 years. Cables were the most frequently replaced accessory. Magnets were the least commonly replaced accessory. MED-EL implantees needed the maximum replacements as compared to implantees of the other two companies. **Conclusion:** Preimplant counseling regarding choice of any device usually includes technical details, esthetics, cost of the device, and expected outcomes. Maintenance of the device is often overlooked and becomes a major challenge for patients of lower socioeconomic strata of society. This study will enable clinics to give information regarding the sustainability of the device to the implantee, and the family which will definitely have an impact on better utilization of the device and better outcomes.

Key words: Accessories, cochlear implant, manufacturers

Introduction

In India, approximately 63 million people suffer from significant auditory loss. This is more frequent in rural India where around 70% of the population resides.^[1] There is a large discrepancy between the number of hearing-impaired individuals and treatment providers in India. The audiologist to population ratio is 1:500,000 and that of the speech therapist to the deaf population are 1:200. Most of these professionals are based in urban areas.^[1]

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Most cochlear implant clinics offer a choice of devices manufactured by different vendors to the implantees and the family. This choice is influenced by various personal, social, cultural factors, and most importantly those related to the device itself.^[2] Reliability and maintenance of the device are the major concerns for most parents for making the final decision regarding the implant.^[3] The most important aspect of maintenance is the replacement of various accessories needed by the processor.

Audiologists at cochlear implant centers in India look after diagnostic audiology, hearing aid dispensing, and services related to cochlear implantation, that is, candidacy, postoperative mapping, and troubleshooting. Considering that there is limited manpower available

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for troubleshooting in cochlear implantees, it creates one of the biggest challenges faced by centers providing support to implantees.

The fact that a majority of implantees stay far away from the center leads to additional travel costs, invariably borne by the families, and mental stress every time there is an issue with the implant. In developed countries, numerous counseling sessions regarding troubleshooting along with guidelines provided by the companies are usually sufficient for problem solving.^[4] However, in developing countries due to the educational status of the parents, many are unable to comprehend and follow the basic troubleshooting tips.

Most revisits to the cochlear implant center after the surgery are for replacement of accessories. A considerable amount of the professional's time is utilized in addressing accessory-related issues. In countries like India and those with similar demographics and health care systems patients either fund their own implants or are funded through various charitable trusts and nongovernment organizations. However, they have to bear the costs of maintenance and postoperative habilitation. Only 10% of Indians have health insurance. Therefore, the cost of surgery and maintenance is borne by the families.^[5]

The decision regarding the implant is taken jointly by the team and the prospective implantees' family. Involving patients and parents in the choice of the cochlear implant encourages an active role in the process.^[6] It is observed that pediatric candidates are influenced by the experience of other implantees and the professionals at the cochlear implant clinic.^[2] Recipients and their families are constantly comparing not only each other's progress in terms of auditory and expressive skills but also accessory replacements. This can sometimes raise doubt in a recipient's/parent's mind about the quality of the implant. The educational background of these families provides an additional challenge as they are unable to comprehend the issues that may arise after implantation.

On reviewing English literature, the authors were unable to find any data regarding the number of accessories needed by implantees using devices of the three major cochlear implant manufacturers, that is, Advanced Bionics, Cochlear and MED-EL.

An analysis of this data would enable clinics counsel prospective implantees and their families regarding postimplant maintenance issues. This information

will enable families to make device choices based on sustainability of the device, leading to better use of the device, and thereby better outcomes rather than esthetics.

Aim of the study

To evaluate and compare the number of accessories needing replacement by the different processors of the three major cochlear implant manufacturers: Advanced Bionics, Cochlear and MED-EL.

Materials and Methods

Study design

A retrospective review of the inventory of accessories required by implantees from our center, Big Ears, KEM Hospital, Pune, India was performed for a period of 3 years from 2010 to 2013.

Participants

The inventory data of 218 implantees was analyzed. This data were analyzed for the accessories needing a replacement for the different processors of the three main implant manufacturers.

Statistical analysis

The values on the quantity of accessories used have been shown as user weighted average along with median (minimum–maximum) values across the several processors for each company. The inter-processor and inter-companies group comparisons were done using univariate generalized linear models procedure through one-way analysis of variance with Tukey's *post-hoc* test for multiple group comparisons. The number of users was used as a weighting criterion to process the entire data statistically. $p < 0.05$ was considered to be statistically significant. The entire data were statistically analyzed using Statistical Package for Social Sciences (SPSS Inc., Chicago IL, USA) version 11.5 for MS windows.

Results

Patient details

Of the 218 implantees who were included in this study, 105 were male and 113 female patients. The majority of the implantees were under the age of 10 years at implantation [Table 1].

Implant details

Sixty-three patients were using the Advanced Bionics device, 87 patients were using Cochlear devices, and 68 patients were using MED-EL devices. The Advanced

Bionics processors used were PSP by 24 patients, Auria by 12 patients, Harmony by 20 patients, and Neptune by 7 patients. The Cochlear processors used were Sprint by 35 patients, Freedom 35 by patients, CP 802 by 10 patients, and CP 810 by 7 patients. The MED-EL processors used were Tempo plus by 28 patients, Opus 1 by 30 patients and Opus 2 by 10 patients. Table 2 displays the different processors used by the recipients every year.

Table 1: Gender demographics and age at implantation

CI company	Gender		Age at implantation (years)			
	Male	Female	<5	5-10	10-15	>15
Advanced Bionics (63)	35	28	37	25	0	1
Cochlear (87)	37	50	38	33	11	5
MED-EL (68)	33	35	23	30	7	8

Table 2: Year-wise distribution of processors used by the recipients

	2010-2011	2011-2012	2012-2013
Advanced Bionics processor types			
PSP	6	10	8
Auria	5	4	3
Harmony	1	7	12
Neptune	0	2	5
Cochlear Ltd., processor types			
Sprint	10	14	11
Freedom	12	10	13
CP802	0	3	7
CP810	2	2	3
MED-EL processor types			
Tempo+	16	8	4
Opus 1	11	7	12
Opus 2	4	1	5

Accessory details

Table 3 displays the various accessories which needed to be replaced for the different processors of Advanced Bionics, Cochlear and MED-EL.

Table 4 shows which of the accessories needed replacement within and after the warranty period of the accessory.

The accessories requiring most replacement were the cables.

Cables

A total of 505 cables needed to be replaced for 218 implantees. Sixty-three implantees using the Advanced Bionics device needed 106 cables replaced all of them after the warranty period. The PSP processor needed the maximum cables replaced. One hundred twenty-three cables needed to be replaced for the 87 Cochlear implantees and all of these were after the warranty period. The Sprint processor needed the maximum cables replaced, that is, 94 cables. For the 68 implantees using the MED-EL device, 276 cables needed to be replaced. All of these were after the warranty period as MED-EL does not offer any warranty with their cables. The Tempo plus processor needed the maximum number of cables replaced [Table 3].

Dry bricks

Dry bricks used in the anti-humidity kit were the second most commonly needed accessory. Two hundred of these needed to be purchased by the recipients. No dry bricks were needed by Advanced Bionic implantees. Cochlear recipients needed 173 dry bricks replaced. The Freedom processor needed 127 whereas CP 802 needed 21 and CP 810 needed 25 dry bricks replaced. For MED-EL recipients, 27 bricks needed a replacement for the Opus 2 processor.

Table 3: List of accessories replaced for the different processors of the three manufacturers

Accessories	Advanced Bionics (63)				Cochlear (87)				MED-EL (68)		
	PSP	Auria	Harmony	Neptune	Sprint	Freedom	CP802	CP810	Tempo	Opus 1	Opus 2
Cables	78	11	14	3	94	23	2	4	208	42	26
Processor	3	6	2	1	10	5	0	4	33	11	2
Battery	8	2	11	0	18	4	1	3	58	34	9
Magnet	0	0	1	0	2	1	0	0	0	2	0
Coil	14	11	5	0	11	6	0	2	3	1	0
Microphone	3	1	1	0	20	NA	NA	NA	NA	NA	NA
Charger	3	4	4	0	5	2	0	0	28	16	6
Power cable	1	1	1	0	2	0	0	0	NA	NA	NA
Battery frame	NA	NA	NA	NA	5	7	1	1	36	5	2
Microphone locks	NA	NA	NA	NA	9	NA	NA	NA	NA	NA	NA
Dry bricks	NA	NA	NA	NA	0	127	21	25	NA	NA	27

NA: Not available

Table 4: List of accessories replaced within/after warranty of the manufacturers

Accessories	Advanced Bionics			Cochlear			MED-EL		
	In warranty	Out of warranty	Warranty period	In warranty	Out of warranty	Warranty period	In warranty	Out of warranty	Warranty period
Cables		106	1 year		123	1 year		276	No
Processor	11	1	3 years	15	4	3 years	43	3	3 years
Battery	2	19	3 months	4	22	1 year	93	8	1 year
Magnet	0	1	NA	0	3	1 year	0	2	No
Coil	23	7	3 years	4	15	1 year	0	4	3 years
Microphone	0	5	1 year	0	20	3 years	0	0	3 years
Charger	10	1	3 years	2	5	1 year	48	2	1 year
Power cable	0	3	1 year	0	2	1 year	NA	NA	NA
Battery frame	NA	NA	NA	5	9	1 year	41	2	3 years
Microphone locks	NA	NA	NA	0	9	90 days	NA	NA	NA
Dry bricks	NA	NA	NA	NA	173	NA	NA	27	NA

NA: Not available

Batteries

A total of 158 rechargeable batteries had to be replaced. Twenty-one Advanced Bionics batteries needed to be replaced, 19 of these were after the warranty period. Eight were for the PSP processor, 2 for the Auria, 11 for Harmony, and none for the Neptune processor. Twenty-six rechargeable batteries had to be replaced for the Cochlear devices, and 22 of these were not within the warranty period. The Sprint processor needed 18 batteries replaced compared to 4 for Freedom, 1 for CP 802, and 3 for CP 810. For the MED-EL implantees, 101 rechargeable DeCapo batteries needed to be replaced; however, 93 occurred within the warranty period and 8 after the warranty period. Fifty-eight were for the Tempo plus processor, 34 for the Opus 1, and 9 for Opus 2.

Battery chargers

Eleven Advanced Bionic battery chargers had to be replaced. Three of these were for the PSP processor and four each for Auria and Harmony. Ten of these were within warranty period. Seven battery chargers of Cochlear needed to be replaced, two were within warranty period. All these were required by Sprint users. Fifty MED-EL DeCapo battery chargers needed to be replaced, 48 of these were within the warranty period. The majority of these were for the Tempo plus users.

Battery frames

Fourteen battery frames provided by Cochlear developed breakages. Seven Freedom users, 5 Sprint users and 1 each of CP 802 and CP 810 needed replacement. Nine of these were replaced after the warranty period. Forty-three battery frames of the rechargeable unit provided by MED-EL developed cracks. Thirty-six were replaced for Tempo plus users, 5 for Opus 1 and 2 for Opus 2. Forty-one of these were replaced within the warranty period.

Head coil

The Advanced Bionic head coil had to be replaced in 30 patients, 23 of them during the warranty period. Fourteen PSP, 11 Auria, and 5 Harmony head coils needed replacement. Nineteen Cochlear implantees needed their head coils replaced. Fifteen of these were after the warranty period was over. Eleven were needed for Sprint, 6 for Freedom and 2 for CP 810. Four patients with the MED-EL device needed the head coil replaced. Three were for the Tempo plus processor and 1 for the Opus 1 processor.

Microphones

Five Advanced Bionic implantees needed their microphones replaced, all after the warranty period. Three of these were for PSP users and one each for Auria and Harmony. Twenty-nine Cochlear processors had problems with their microphone. Twenty of these had defective microphones that needed replacement, all after the warranty period. All of these were for the Sprint processor. Nine had issues with the microphone locks. None of the MED-EL processors had microphone issues.

Processors

Of 218 implantees, 77 needed their processors replaced. Twelve Advanced Bionic processors were sent back to the parent company for a replacement. Eleven of these were within the warranty period. Six Auria processors, 3 PSP, 2 Harmony, and 1 Neptune processor needed replacement. Nineteen Cochlear processors needed to be replaced. Fifteen of them needed replacement within the warranty period. Ten Sprint processors, 5 Freedom and 4 CP 810 processors were replaced. Forty-six MED-EL processors needed to be replaced; however, only 3 were after the warranty period. Thirty-three Tempo plus processors, 11 Opus 1, and 2 Opus 2 processors needed replacement.

Table 5 shows the comparison of the use of accessories across the different Advanced Bionics processors. The average number of accessories needed was significantly higher for PSP processors compared to Auria, Harmony and Neptune processors ($p < 0.01$). The average number of accessories did not differ significantly between Auria and Harmony processors ($p > 0.05$). The average number of accessories did not differ significantly between Auria and Neptune processors ($p > 0.05$). The average number of use of accessories did not differ significantly between Harmony and Neptune processors ($p > 0.05$).

Table 6 shows the comparison of the use of accessories across the various Cochlear processors. The average number of accessories needed was significantly higher

for Freedom processor compared to Sprint, CP802, and CP810 processors ($p < 0.05$) for all. The average number of accessories was significantly higher for Sprint processors compared to CP802 and CP810 processors ($p < 0.001$) for both. The average number of accessories did not differ significantly between CP802 and CP810 processors ($p > 0.05$).

Table 7 shows the comparison of the use of accessories across the various MED-EL processors. The average number of accessories needed was significantly higher for Tempo processor compared to Opus 1 and Opus 2 processors ($p < 0.001$) for both. The average number of accessories did not differ significantly between Opus 1 and Opus 2 processors ($p > 0.05$).

Table 5: Comparison of use of accessories across various Advanced Bionics processors

Company	Advanced Bionics (n=63 users)	Number of accessories			
		User weighted mean	Median	Minimum	Maximum
Processors	PSP (n=24)	13.8	3	0	78
	Auria (n=12)	4.5	3	0	11
	Harmony (n=20)	4.9	3	1	14
	Neptune (n=7)	0.5	0	0	3
P	PSP versus Auria	0.003			
	PSP versus Harmony	0.001			
	PSP versus Neptune	0.001			
	Auria versus Harmony	0.765			
	Auria versus Neptune	0.148			
	Harmony versus Neptune	0.310			

Table 6: Comparison of use of accessories across various Cochlear Ltd. processors

Company	Cochlear Ltd., (n=87 users)	Number of accessories			
		User weighted mean	Median	Minimum	Maximum
Processors	Sprint (n=35)	16.0	9	0	94
	Freedom (n=35)	19.4	5	0	127
	CP802 (n=10)	2.8	0	0	21
	CP810 (n=7)	4.3	2	0	25
P	Sprint versus freedom	0.034			
	Sprint versus CP802	0.001			
	Sprint versus CP810	0.001			
	Freedom versus CP802	0.001			
	Freedom versus CP810	0.011			
	CP802 versus CP810	0.539			

Table 7: Comparison of use of accessories across the various MED-EL processors

Company	MED-EL (n=68 users)	Number of accessories			
		User weighted mean	Median	Minimum	Maximum
Processors	Tempo (n=28)	52.3	33	0	208
	Opus 1 (n=30)	15.9	11	1	42
	Opus 2 (n=10)	9.0	4	0	27
P	Tempo versus Opus 1	0.001			
	Tempo versus Opus 2	0.001			
	Opus 1 versus Opus 2	0.801			

Table 8 shows the comparison of the accessories used across the three companies. The average number of accessories used is significantly higher for MED-EL compared to Advanced Bionics and Cochlear ($p < 0.001$) for both. The average number of accessories used is significantly higher for cochlear compared to Advanced Bionics ($p < 0.001$).

Discussion

Cables were the most common accessory requiring replacement for all the companies, and they all came at a cost to the family as they were after the warranty period. Although Advanced Bionics and Cochlear gave a warranty of 1 year for their cables, MED-EL gave no warranty for the same. MED-EL implantees had more cable-related issues than Cochlear and Advanced Bionics implantees. In June 2013, MED-EL changed their cables and since then there has been a dramatic decrease in cable-related issues.

Dry bricks/drying capsules were another constantly needed accessory. This is a use and throw accessory which means that it has to be purchased and is not replaced by the manufacturers. This is a recurrent expenditure as it has to be replaced every 3 months. MED-EL provides an electrical dry kit as an accessory only for the Opus 2 processor. For the remaining processors drying capsules have to be purchased. For the Advanced Bionics devices, dry bricks are needed only for users of Naida or Neptune processors. Implantees using the Harmony processor are provided silica granules that do not need to be replaced.

Many recipients have problems with rechargeable batteries and their chargers. These were noticed in patients from geographical areas where the power supply is irregular and fluctuating. The use of voltage stabilizers by these recipients greatly reduced this issue. The addition of a voltage stabilizer as a standard accessory in developing countries where the power supply in rural areas is an issue would be a great help to recipients.

MED-EL implantees had the most accessory-related issues as compared to the other two manufacturers. The one redeeming point was that other than the cables for which the MED-EL company offers no warranty, most of the others were within the warranty period. However, this did cause more emotional trauma to the parents and took up a lot of time and manpower at the center. Since June 2013, the MED-EL cables seem to be sturdier, and parents are not reporting to the center with as many cable-related issues as before.

The comparison of the various processors within each manufacturer reveals that the newer generation processors need fewer replacements than the older generation processors. This data should help in convincing families to upgrade their devices.

The comparison of the use of accessories across the three companies revealed that the MED-EL processors needed maximal replacements followed by those of cochlear.

Conclusion

Cables are the accessories that needed maximum replacement followed by dry kits and batteries for all the three companies.

The accessories needed by the older generation processors were more than the newer generation processors except for Cochlear. The Freedom processor of Cochlear needed more accessories replaced than the Sprint processor that is an older generation processor.

MED-EL implantees needed the maximum accessories replaced compared to the other two companies.

The newer generation processors of all the three companies needed fewer replacements than the older generation processors.

Table 8: The comparison of use of accessories across various companies

Company	Number of accessories			
	User weighted mean	Median	Minimum	Maximum
Cochlear Ltd., (n=87)	15.0	5	0	127
MED-EL (n=68)	29.4	16	0	208
Advance Bionics (n=63)	7.7	5	0	78
<i>P</i>				
Cochlear Ltd., versus MED-EL	0.001			
Cochlear Ltd., versus advance Bionics	0.001			
MED-EL versus advance Bionics	0.001			

The authors feel that the above data should be stressed upon during preimplant counseling so that the caregivers have a realistic idea about the recurring financial expenses related to maintenance of the device.

In developing countries where the cost of cochlear implantation is overwhelming for most families, the initial euphoria of getting the device is replaced at times by a feeling of inadequacy in many caregivers regarding the sustainability of the device. This may in the future lead to limited use or nonusers of the device. Appropriate and realistic counseling during preimplant visits will deliver better device use and better outcomes.

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Conflicts of interest

There are no conflicts of interest.

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