

Article

Factors Affecting Patient Compliance with Rechargeable Implantable Pulse Generators for Deep Brain Stimulation

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Abstract

Deep brain stimulation (DBS) with implantable pulse generators (IPGs) is widely used in the treatment of movement disorders. Rechargeable IPGs (RC-IPGs) were developed to extend device longevity and address the limitations of battery life in non-rechargeable IPGs. However, data regarding patient compliance and device-related complications remain limited. Therefore, this retrospective observational study evaluated compliance, satisfaction, and complications in patients with RC-IPGs. Compliance in 42 patients with RC-IPGs was evaluated using the Timmermann questionnaire together with additional questions regarding device preference, complaints, and complications. Statistical analyses were performed using NCSS software (Number Cruncher Statistical System, version 2020; NCSS LLC, Kaysville, UT, USA). Although a substantial percentage (42.9%) of patients needed help during recharging, the overall satisfaction score was high (96% of the maximum possible score), and 95.2% of patients preferred RC-IPGs if a repeat DBS would be required, and the rate of RC-IPG complications (7.1%) was low. The patients rated the display screen with the lowest scores (54.05%), mainly those who underwent two or more DBS surgeries. The training subscore showed a statistically significant negative correlation with age ($r = -0.531$, $p = 0.001$), and dystonia patients, constituting the youngest group in the cohort, rated training with higher points. This study provides additional data on patient compliance and safety of RC-IPGs. These findings may contribute to a better understanding of patient experience and factors affecting compliance with rechargeable systems.

Keywords: deep brain stimulation; rechargeable pulse generator; patient satisfaction; patient compliance; complication



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1. Introduction

In clinical practice, deep brain stimulation (DBS) has been used for movement disorders for the last three decades. In DBS, the stimulation applied depends on the type and severity of the underlying disease. Therefore, the power consumed by the device and the life of the implantable pulse generator (IPG) vary from patient to patient. The service life of an IPG is also model-dependent and influenced by device-specific characteristics. Fixed-life non-rechargeable (nonRC) IPGs that provide regular electrical activity in the brain were the first devices implanted for DBS, and their predicted life ranged from 3 to 5

years but could vary between 1 year and 7 years depending on the stimulation parameters and device usage [1–5].

In 2008, RC-IPGs with a proposed service life of >10 years were introduced, and their use was shown to be associated with a high satisfaction rate [3,4,6]. Although RC-IPGs have been associated with high satisfaction rates and lower long-term costs, patient or caregiver compliance with recharging procedures must also be considered [4,7–16]. Many additional factors may also influence patient compliance, but studies that investigated these factors are limited. At present, the choice between RC-IPGs and non-rechargeable IPGs largely depends on surgeon and patient preference. However, both surgeons and patients still need adequate information regarding long-term compliance and device-related problems associated with RC-IPGs. Reports from different centers may provide a broader and more generalizable view of the feasibility of these devices, as suggested in previous studies [7]. In addition, such data may contribute to the development of RC-IPGs with improved usability. Therefore, the present study aimed to evaluate patient compliance, satisfaction in several domains, complaints, and device-associated side effects in detail.

This study provides a domain-based analysis of patient compliance, satisfaction, and device-related difficulties using a standardized questionnaire, while also exploring the impact of age, surgical history, and clinical characteristics on device usability. This approach aims to better define the practical challenges associated with RC-IPGs and to identify factors influencing patient experience and compliance. Despite previous studies reporting patient satisfaction and general outcomes of rechargeable systems, there is still limited evidence providing a comprehensive domain-based evaluation of compliance, usability, and device-related challenges within a single, well-characterized cohort. Therefore, this study aims to address this gap by systematically analyzing multiple dimensions of patient experience and identifying factors influencing compliance in real-world clinical practice.

2. Materials and Methods

2.1. Inclusion Criteria, Cohort Features and Utilized IPG Devices

Patients who underwent DBS with an RC-IPG between April 2016 and April 2021, or who had undergone an exchange operation with an RC-IPG, and who were followed up for at least 6 months were eligible for participation in the survey conducted during the period 2019–2021. Exclusion criteria included patients with incomplete clinical data, insufficient follow-up (<6 months), severe cognitive impairment precluding questionnaire participation, and those unwilling to participate in the survey. Forty-two out of the 87 DBS-implanted patients qualified for these criteria and were included in the study. RC-IPGs were applied to 25 patients during the first DBS operation and 17 during IPG replacement. The mean follow-up was 42.5 months (range 6–76). Thirteen of the patients who applied for the exchange and accepted the questionnaire application were switched from Activa® PC (Medtronic, Minneapolis, MN, USA) to Vercise™ and Gevia™ RC-IPG (Boston Scientific, Marlborough, MA, USA), 2 patients were switched from nonRC-IPG Abbott to RC Abbott, and 2 patients were switched from Vercise PC nonRC-IPG to Vercise RC-IPG (Boston Scientific). These switches were primarily performed due to battery depletion, patient preference for rechargeable systems, and the aim to reduce the need for future replacement surgeries. In addition, device selection and switching decisions were influenced by the availability of rechargeable options, clinician experience, and patient-specific clinical considerations. These factors were taken into account when interpreting compliance and satisfaction outcomes. All procedures were performed using standard stereotactic techniques under local or general anesthesia. The implantable pulse generator (IPG) was placed in the subclavicular region and connected to intracranial electrodes via extension leads.

2.2. Questionnaires

A Timmermann questionnaire, including 24 questions, was employed (see Appendix A) [4]. The patients gave scores on a 5-point Likert scale from 1 (completely disagree) to 5 (completely agree) for several aspects regarding the devices and their education process related to device use. Patients were also asked whether they would prefer a DBS surgery and an RC-IPG device again if required. The patients were also asked about specific complaints, accidental device closure, instances of forgetting to recharge, and seeking help to deal with device-related issues. Lastly, data about recharging periods per week, duration of recharging, and complications were determined. Given the questionnaire-based design, potential response bias was considered. Cognitive status was evaluated during routine neurological follow-up visits based on clinical judgment and the patient's ability to complete the questionnaire independently. Caregiver assistance during questionnaire completion was recorded when applicable to improve the reliability of patient-reported outcomes.

2.3. Statistical Analysis

Statistical analyses were performed using NCSS software (Number Cruncher Statistical System, version 2020; NCSS LLC, Kaysville, UT, USA). The normality of the distribution of variables was assessed using the Shapiro–Wilk test and boxplots. Student's *t* test was used to compare normally distributed variables between groups; the Mann–Whitney *U* test was utilized for the intergroup comparisons of non-normally distributed parameters. The Pearson correlation analysis was employed to determine the relationships between the variables. The Pearson Chi-Square, Fisher's Exact, and Fisher-Freeman Halton tests were used to compare qualitative data. A *p* value of < 0.05 was considered statistically significant. Due to the relatively small sample size and heterogeneity of the cohort, multivariate analyses were not performed; therefore, findings should be interpreted as exploratory. Potential selection bias and cohort heterogeneity were considered during data interpretation.

2.4. Study Ethics

This observational cohort study was conducted in accordance with the principles of the Declaration of Helsinki and its latest amendments. Patient consent was waived due to the retrospective nature of the study and the use of anonymized data. The study was approved by the Memorial Hospital Ethics Committee, Istanbul, Türkiye, dated 5 October 2022 and numbered 53.

3. Results

The study included 18 male and 24 female patients with a median age of 60.5 years (range: 24–78) and a median follow-up of 42.5 months (range: 6–76). The cohort comprised 25 patients who underwent their first surgery and 17 who were operated on twice or more. 25, 11, 4, and 2 patients were operated once, twice, three times, and four times, respectively. Seven patients in the cohort had cerebral atrophy, while 35 patients did not show radiological signs of atrophy. Patients with cerebral atrophy were significantly older than patients without atrophy ($p = 0.038$). Patients with dystonia were significantly younger than Parkinson's disease patients ($p = 0.001$). There was no difference in percentages of cerebral atrophy when analyzed according to diagnosis ($p = 0.747$). In this cohort, all patients with cerebral atrophy underwent a single DBS surgery, whereas 51.4% of patients without atrophy underwent two or more procedures. This difference may be related to patient characteristics such as age and comorbidity profile. These diverging ratios were also significantly different ($p = 0.030$). (Table 1).

Table 1. Demographic and Clinical Characteristics According to Cerebral Atrophy.

Variable	Atrophy Absent	Atrophy Present	<i>p</i> Value
Age	55.71 ± 15.01	67.57 ± 9.12	0.038
Parkinson's disease	26 (74.3)	7 (100)	0.747
Dystonia	6 (17.1)	0	—
Essential tremor	2 (5.7)	0	—
Tardive dyskinesia	1 (2.9)	0	—
Single surgery	18 (51.4)	7 (100)	0.030
Two or more surgeries	17 (48.6)	0	—

The overall satisfaction score was considerably high (average: 14.14 out of 15 maximum points). When the subscore results were proportioned according to their uppermost limits, higher percentages correlating with more satisfaction were 88.2%, 87.6%, 80.35%, 71.33%, and 54.05% for the fit-comfort, recharging, programmer, training, and display domains, respectively. The overall satisfaction score did not differ among patients with different diagnoses. Yet, patients with dystonia gave higher points for the programmer and training subscales than those with Parkinson's Disease ($p = 0.002$ and $p = 0.001$, respectively). (Table 2) (Figure 1).

Table 2. Timmermann Satisfaction Scale Subscores According to Diagnosis.

Subscale	Dystonia Mean ± SD	PD Mean ± SD	<i>p</i>
Fit-Comfort	14.66 ± 0.81	13.03 ± 3.10	0.198
Recharging	19.16 ± 2.04	17.33 ± 2.93	0.099
Display	12.16 ± 2.99	10.51 ± 3.61	0.108
Programmer	28.50 ± 2.07	20.24 ± 5.84	0.002
Training	20.00 ± 0.00	15.15 ± 2.59	0.001
Overall satisfaction	15.00 ± 0.00	14.03 ± 1.55	0.086

Essential tremor ($n = 2$) and tardive dyskinesia ($n = 1$) were excluded from statistical comparisons because of insufficient sample size.

Patients who were dissatisfied with the device frequently reported that the charging duration was excessively long. A statistically significant negative correlation was observed between age and training subscore ($r = -0.531$, $p = 0.001$) (Table 3).

Table 3. Timmermann Subscore Correlations with Age.

Subscale	<i>r</i>	<i>p</i> Value
Fit-Comfort	−0.049	0.758
Recharging	−0.183	0.245
Display	−0.125	0.431
Programmer	−0.268	0.086
Training	−0.531	0.001
Overall Satisfaction	−0.225	0.151

r: Pearson correlation coefficient.

Of note, patients who were operated on twice or more gave significantly lower points for the display subscore ($p = 0.001$). Nonetheless, there was no difference among other subscores according to the number of surgeries. Patients who found the recharging duration long and were therefore discontented with recharging gave lower points for the fit-comfort and display subscores than those who were okay with the charging duration ($p = 0.007$ and $p = 0.001$, respectively). (Table 4).

Table 4. Device-Related Complaints, Recharging Characteristics, and Complications.

Variable	n (%) / Mean $\pm$ SD
Complaints present	9 (21.4)
Accidental device closure	9 (21.4)
Forgetting to recharge	6 (14.3)
Need for assistance during charging	18 (42.9)
Recharging frequency (per week)	3.66 $\pm$ 1.60
Charging duration (minutes)	30.95 $\pm$ 8.98
Complications	3 (7.1)
Skin dehiscence behind ear	1 (2.4)
Burn over cable	1 (2.4)
Skin dehiscence over cable	1 (2.4)

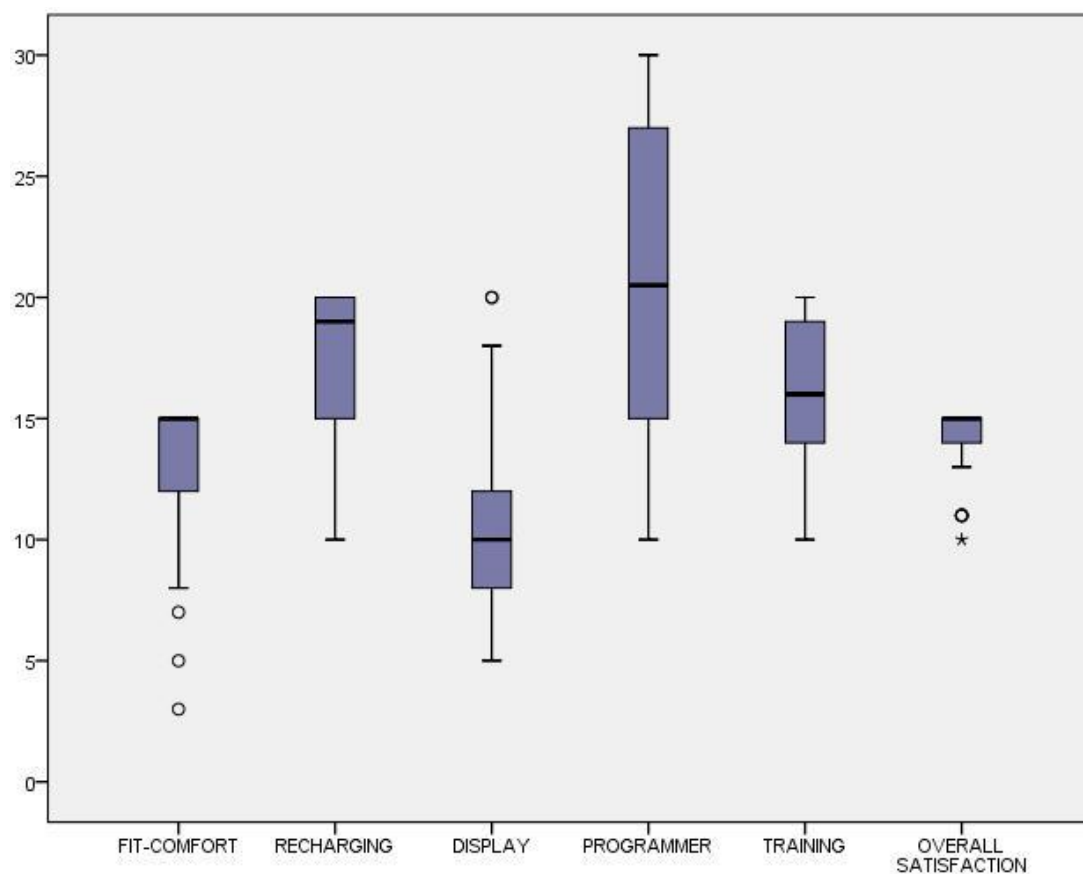


Figure 1. Distribution of Timmermann Satisfaction Scale Scores Box-plot distribution of the Timmermann survey subscores (Fit-Comfort, Recharging, Display, Programmer, Training, and Overall Satisfaction). The programmer and training domains demonstrated higher median scores, whereas the display domain showed the lowest satisfaction scores among patients. Circles indicate outliers, and asterisks indicate extreme outliers.

4. Discussion

Overall satisfaction in the present cohort was high; all patients reported that they would undergo DBS again if necessary, and approximately 95% stated that they would prefer a rechargeable IPG for a future procedure. These findings indicate that rechargeable systems are generally well accepted by patients. Although training scores negatively correlated with age, both younger and older patients were generally able to adapt to RC-IPG technology. Moreover, there was no significant difference between the fit-comfort, recharging, display, and overall satisfaction scores of patients with different diagnoses, suggesting that the perceived benefits of RC-IPGs were largely independent of the underlying disease.

Nonetheless, because several patients had some degree of complaints and some subscore points (mainly regarding the display score) were relatively lower, it should also be kept in mind that the general satisfaction of the patients relates more to the chronicity of their disease, their awareness about DBS surgeries could be more efficient than pharmacotherapy, and their desire to minimize the requirement of repeat surgeries. Lower scores in display-related domains suggest that certain device-related usability issues remain.

Rechargeable systems provide longer service life and reduce the need for replacement surgeries, although they require active patient participation during routine charging. In this context, the relatively high rate of accidental device closure (21.4%) is clinically relevant, as unintended interruption of stimulation may lead to rapid symptom worsening. These findings underscore the importance of user-friendly programmer interfaces and structured patient (and caregiver) education programs. Moreover, given that 42.9% of patients required assistance during charging, caregiver involvement appears to be an important determinant of successful long-term device management.

When the subscores of the Timmermann scale were proportioned to their maximum values, the lowest satisfaction was related to the display features of the RC-IPG. Patients who had undergone multiple DBS procedures and those dissatisfied with recharging duration tended to report lower display scores. These findings suggest that the user interface of RC-IPGs may require further improvement. A simplified display system could improve usability, particularly in patients with neurodegenerative disorders who may have cognitive limitations.

When the Timmermann subscores were analyzed according to diagnosis, dystonia patients gave higher scores for the programmer and training domains than patients with Parkinson's disease. This difference is likely related to the younger age of dystonia patients and their potentially greater familiarity with technology. Previous studies have also reported high satisfaction rates among dystonia patients treated with rechargeable systems [7]. However, some reports describe difficulties such as challenges in positioning the charger or the need for frequent charging [7]. In addition, dystonia-related trunk or cervical posturing may occasionally complicate access to the implanted device during recharging [4].

Several studies have reported that the recharging process may be perceived as burdensome by some patients [7,15,16]. In the present cohort, the mean charging time was 30.95 ± 8.98 min, which is within the range reported in previous studies. Interestingly, patient satisfaction with charging duration was not directly associated with the actual charging time or diagnosis. Instead, subjective perception of time and personal tolerance for routine device maintenance may play a role.

The overall rate of complaints in this cohort was relatively low (21.4%), and device-related complications were even lower (7.1%). However, the proportion of patients reporting accidental device closure (21.4%) deserves attention because sudden interruption of DBS may lead to rapid worsening of symptoms. Similar findings have been reported previously and were attributed to difficulties using the patient programmer [14]. The relatively high rate of patients requiring assistance during charging (42.9%) highlights the potential value of periodic retraining and caregiver support.

The relationship between cerebral atrophy, age, and training scores observed in this study is also noteworthy. Older patients and those with cerebral atrophy tended to report lower training scores, which may reflect age-related cognitive decline. Nevertheless, the rates of seeking assistance or forgetting to recharge did not differ significantly between patients with and without cerebral atrophy. This finding suggests that although older patients may initially experience difficulties during training, many are ultimately able to manage device maintenance adequately.

This study has several limitations. The relatively small sample size and retrospective design may introduce selection bias, while the use of a subjective questionnaire may have been influenced by individual perception and potential response bias. In addition, the absence of a control group and the heterogeneous cohort limit direct comparisons and subgroup analyses. Although the single-center design and standardized follow-up protocol provide internal consistency, the findings should be interpreted cautiously. Further prospective multicenter studies are needed to validate these results.

5. Conclusions

Rechargeable IPGs may represent a feasible and generally well-tolerated option for selected patients undergoing deep brain stimulation. However, patient compliance may be influenced by age, cognitive factors, and the need for caregiver support. Given the retrospective design and limited sample size, these findings should be interpreted with caution, and further prospective studies are warranted.

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Informed Consent Statement: Written informed consent was obtained from all participants prior to enrollment.

Data Availability Statement: The data supporting the findings of this study are available from the corresponding author upon reasonable request.

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Abbreviations

DBS	Deep Brain Stimulation
IPG	Implantable Pulse Generator
RC-IPG	Rechargeable Implantable Pulse Generator
PD	Parkinson's Disease
SD	Standard Deviation

Appendix A

Table A1. Timmermann Questionnaire.

Item	Completely Agree	Mostly Agree	Not Sure	Mostly Disagree	Completely Disagree
1 I am pleased with the fit of the battery	5	4	3	2	1
2 The battery bothers me	1	2	3	4	5
3 The size of the battery is no concern for me	5	4	3	2	1
4 I have no problem with wearing the shoulder or waist belt for recharging	5	4	3	2	1

Table A1. Cont.

Item	Completely Agree	Mostly Agree	Not Sure	Mostly Disagree	Completely Disagree
5 The shoulder or waist belt that I wear for recharging is uncomfortable	1	2	3	4	5
6 I find it difficult to understand the recharging process	1	2	3	4	5
7 The need to keep recharging the device is inconvenient	1	2	3	4	5
8 Recharging the device is no bother to me	5	4	3	2	1
9 I am comfortable with the need to recharge this device	5	4	3	2	1
10 I find the display on the patient programmer clear and easy to understand	5	4	3	2	1
11 The display screen is not clear to me at all	1	2	3	4	5
12 The patient programmer gives me a real sense of control over my disease	5	4	3	2	1
13 The sound alerts that are produced by the patient programmer are not very useful	1	2	3	4	5
14 I find it difficult to understand how to check the status of my battery	1	2	3	4	5
15 The patient programmer gives me confidence	5	4	3	2	1
16 I don't value the patient programmer	1	2	3	4	5
17 I rely on the patient programmer to check my battery levels	5	4	3	2	1
18 The training materials left me a little confused	1	2	3	4	5
19 The training I received from the nurses and doctors was excellent	5	4	3	2	1
20 I needed help understanding the training materials	1	2	3	4	5
21 The training materials and DVD clearly explained everything I needed to know	5	4	3	2	1
22 Deep brain stimulation controls the symptoms of my disease	5	4	3	2	1
23 I think the rechargeable DBS device suits my needs better than other therapies I have used	5	4	3	2	1
24 Overall I am very satisfied with the rechargeable DBS device	5	4	3	2	1

Reproduced from Timmermann et al. [4].

References

1. Paff, M.; Loh, A.; Sarica, C.; Lozano, A.M.; Fasano, A. Update on current technologies for deep brain stimulation in Parkinson's disease. *J. Mov. Disord.* **2020**, *13*, 185–198. [[CrossRef](#)] [[PubMed](#)]
2. Niemann, M.; Schneider, G.H.; Kuhn, A.; Vajkoczy, P.; Faust, K. Longevity of implantable pulse generators in bilateral deep brain stimulation for movement disorders. *Neuromodulation* **2018**, *21*, 597–603, Erratum in *Neuromodulation* **2019**, *22*, 122–123. [[CrossRef](#)] [[PubMed](#)]
3. Yazdani, F.; Enriquez-Marulanda, A.; Dehmamy, A.; Hassan, T.; Shils, J.; Alterman, R. Battery longevity in deep brain stimulation for Parkinson's disease. *Stereotact. Funct. Neurosurg.* **2025**, *103*, 227–235. [[CrossRef](#)] [[PubMed](#)]
4. Timmermann, L.; Schüpbach, M.; Hertel, F.; Wolf, E.; Eleopra, R.; Franzini, A.; Servello, D.; Skogseid, I.-M.; Rumia, J.; Aliaga, A.S.; et al. A new rechargeable device for deep brain stimulation: A prospective patient satisfaction survey. *Eur. Neurol.* **2013**, *69*, 193–199. [[CrossRef](#)] [[PubMed](#)]
5. Lumsden, D.E.; Kaminska, M.; Tustin, K.; Gimeno, H.; Baker, L.; Ashkan, K.; Selway, R.; Lin, J.-P. Battery life following pallidal deep brain stimulation in children and young people with severe primary and secondary dystonia. *Childs Nerv. Syst.* **2012**, *28*, 1091–1097. [[CrossRef](#)] [[PubMed](#)]
6. van Riesen, C.; Tsironis, G.; Gruber, D.; Klostermann, F.; Krause, P.; Schneider, G.H.; Kupsch, A. Disease-specific longevity of impulse generators in deep brain stimulation and review of the literature. *J. Neural Transm.* **2016**, *123*, 621–630. [[CrossRef](#)] [[PubMed](#)]
7. Antenucci, P.; Colucci, F.; Gozzi, A.; Angelini, C.; Cavallo, M.A.; Scerrati, A.; Casetta, I.; Sensi, M. Rechargeable and nonrechargeable implantable pulse generators for deep brain stimulation in Parkinson's disease: Long-term experience. *Acta Neurol. Scand.* **2025**, *2025*, 6097313. [[CrossRef](#)]

8. Kaminska, M.; Lumsden, D.E.; Ashkan, K.; Malik, I.; Selway, R.; Lin, J.P. Rechargeable deep brain stimulators in the management of paediatric dystonia: Well tolerated with a low complication rate. *Stereotact. Funct. Neurosurg.* **2012**, *90*, 233–239. [[CrossRef](#)] [[PubMed](#)]
9. Okun, M.; Foote, K.; Zesiewicz, T.; Bezchlibnyk, Y.; Papanastassiou, A.; Carlson, J.; Aldred, J.; Krishna, V.; Merola, A.; Luca, C.; et al. Real-world outcomes in USA using DBS systems with directionality and multiple independent current control. *Neurology* **2023**, *100*, 17. [[CrossRef](#)]
10. Swinnen, B.; Fuentes, M.; Volz, M.; Heath, S.; Starr, P.A.; Little, S.J.; Ostrem, J.L. Clinically implemented sensing-based initial programming of deep brain stimulation for Parkinson’s disease: A retrospective study. *Neuromodulation* **2024**, *28*, 501–510. [[CrossRef](#)] [[PubMed](#)]
11. Walsh, G.; Shah-Zamora, D.; Laxton, A.; Tatter, S.; Siddiqui, M. Infection rates in rechargeable cell implantable pulse generators compared to primary cell implantable pulse generators in patients undergoing deep brain stimulation. *Neurology* **2024**, *102*, 7. [[CrossRef](#)]
12. Wasilewski, D.; Hoffmann, A.; Braun, F.; Bozkurt, S.G.; Mertens, R.; Ferdowssian, K.; Truckenmüller, P.; Schneider, G.-H.; Faust, K.; Vajkoczy, P.; et al. The risk of bacterial colonization increases with multiple replacements of implanted pulse generators for deep brain stimulation. *Neuromodulation* **2025**, *Online ahead of print*. [[CrossRef](#)]
13. Jia, F.; Hao, H.; Meng, F.; Guo, Y.; Zhang, S.; Zhang, J.; Li, L. Patient perspectives on the efficacy of a new kind of rechargeable deep brain stimulators. *Int. J. Neurosci.* **2016**, *126*, 996–1001. [[CrossRef](#)] [[PubMed](#)]
14. Jakobs, M.; Kloss, M.; Unterberg, A.; Kiening, K. Rechargeable internal pulse generators as initial neurostimulators for deep brain stimulation in patients with movement disorders. *Neuromodulation* **2008**, *21*, 604–610. [[CrossRef](#)] [[PubMed](#)]
15. Gillies, M.J.; Joint, C.; Forrow, B.; Fletcher, C.; Green, A.L.; Aziz, T.Z. Rechargeable vs. nonrechargeable internal pulse generators in the management of dystonia. *Neuromodulation* **2013**, *16*, 226–229. [[CrossRef](#)] [[PubMed](#)]
16. Harries, A.M.; Major, S.; Sandhu, M.; Honey, C.R. Rechargeable internal neural stimulators: Is there a problem with efficacy? *Neuromodulation* **2012**, *15*, 214–217. [[CrossRef](#)] [[PubMed](#)]

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