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Cost-effectiveness of deep brain stimulation versus treatment as usual for obsessive-compulsive disorder

Pieter Ooms [a, *], Matthijs Blankers [a, b, c], Martijn Figee [a, d], Isidoor O. Bergfeld [a, d], Pepijn van den Munckhof [e], P. Richard Schuurman [e], Damiaan Denys [a, d, f]

[a] Department of Psychiatry, Academic Medical Center, University of Amsterdam, Amsterdam, The Netherlands
[b] Arkin Mental Health Care, Amsterdam, The Netherlands
[c] Trimbos Institute, Utrecht, The Netherlands
[d] Amsterdam Brain and Cognition, Amsterdam, The Netherlands
[e] Department of Neurosurgery, Academic Medical Center, University of Amsterdam, Amsterdam, The Netherlands
[f] Netherlands Institute for Neuroscience, An Institute of the Royal Netherlands Academy of Arts and Sciences, Amsterdam, The Netherlands

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ABSTRACT

Background: Deep Brain Stimulation (DBS) is effective for obsessive-compulsive disorder (OCD), but requires expensive medical procedures. To date, no study has examined the cost-effectiveness of DBS for OCD.
Objective: To perform the first economic evaluation of DBS for therapy refractory OCD.
Methods: We conducted a 2-year prospective, open cost-effectiveness study, comparing DBS (n = 17) with treatment as usual (TAU) (n = 11), with cost per Quality-Adjusted-Life-Year (QALY) as outcome measure. Apart from the base-case, or primary analysis, we conducted two practice-based scenarios: (1) standard care scenario, without research and innovation costs, and (2) rechargeable scenario, in which we assume the use of a rechargeable battery. Base-case and both scenarios were extrapolated to four years to estimate long-term cost-effectiveness.
Results: Compared to TAU, DBS provides an additional 0.26 QALY (SD = 0.16). Median cost per QALY gained is estimated at €141,446 for base-case, €115,916 for standard care and €65,394 for the rechargeable scenario. Extending the time-horizon to four years results in a median cost per QALY of €80,313 for base-case, €69,287 for standard care, and turned out to be cost-saving at €4678 per QALY for the rechargeable scenario. Assuming a willingness to pay threshold of €80,000/QALY, DBS, under base-case and standard care had 25% and 35% probability of being more cost-effective than TAU. With the rechargeable scenario and in all scenarios extrapolated to four years, the probability of cost-effectiveness was equal or higher than TAU.
Conclusions: This study indicates DBS for OCD is cost-effective in the long-term, especially when rechargeable batteries are taken into account.

Introduction

Obsessive-compulsive disorder (OCD) is a psychiatric disorder characterized by intrusive, fear inducing thoughts (obsessions) and repetitive behaviors aimed at reducing anxiety (compulsions). Left untreated, OCD can cause severe harm in functioning and quality of life to patient and relatives [1]. Standard treatment for OCD consists of cognitive behavioral therapy (CBT) and pharmacotherapy. Despite exhaustive treatment, 10% of patients [2] remain refractory, for which Deep Brain Stimulation (DBS) has been suggested. Over the past decade, DBS trials for OCD demonstrate an responder rate (Yale-Brown obsessive compulsive scale (Y-BOCS) reduction of >35%) of 50% with mostly transient side-effects [3]. Given its efficacy, DBS has been accepted by several countries as last resort treatment. Though health insurance companies in various

Abbreviation: CBT, cognitive behavioral therapy; ICER, incremental cost-effectiveness ratio; IPG, implantable pulse generator; OCD, obsessive-compulsive disorder; QALY, Quality adjusted life Year; WTP, willingness to pay.

* Corresponding author. Academic Medical Center, Department of Psychiatry, Room PA1.184, PO Box 22660, 1100 DD Amsterdam, The Netherlands.
E-mail address: p.ooms@amc.nl (P. Ooms).

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countries worldwide reimburse DBS, surprisingly, nothing is known about its actual costs and cost-effectiveness. Clarifying this is crucial for further implementation of DBS for OCD. Because distribution of resources should not be solely based on clinical benefit but should also be supported by efficiency [4].The aim of this study is to investigate the costs involved in the treatment and perform a preliminary economic evaluation comparing costs and effects of DBS versus treatment as usual (TAU).

Methods

Study design and participants

We conducted an open, prospective study in a cohort of therapy refractory OCD patients treated with either DBS or TAU over a period of two years to compare clinical efficacy and cost-effectiveness of the two interventions. During the study, three visits were conducted in the treatment group. Baseline (3 months before DBS surgery); 12 months after baseline and 24 months after baseline. Patients in the TAU group followed the same follow-up evaluations. The study was conducted in the Academic Medical Center (AMC) in Amsterdam, the Netherlands. Patients only received standard care and therefore medical ethical approval was not required by Dutch law [5]. A total of 28 therapy refractory OCD patients who were referred for DBS-OCD between August 2009 and January 2013 were included in the study, of which 17 underwent DBS surgery and 11 received TAU. The in- and exclusion criteria for the DBS group matched those of the standard DBS program [6]: Patients had to be between 18 and 65 years of age, have a non-remitted DSM-IV-TR [7] diagnosis of OCD for $\geq$5 years, and score $\geq$28 on the Y-BOCS, indicating severe OCD symptoms. Patients were therapy refractory to at least two previous treatments with an serotonin reuptake inhibitor at maximum dosage for at least 12 weeks, treatment with clomipramine hydrochloride at maximum dosage, one augmentation trial with atypical antipsychotics for at least 8 weeks, and one CBT trial. Exclusion criteria were 1) comorbid Axis I disorder in the last six months, with exception of major depressive disorder or mild anxiety disorders, 2) primary Axis II (personality) disorders, as assessed with the structured Clinical Interview for DSM-IV [8], or 3) clinically significant and unstable neurologic or medical illnesses. The same in and exclusion criteria applied to the TAU group, except refractoriness which was defined as failure of three of the four medication trials because of feasibility. However, only two of 11 patients in the TAU group did not meet the stringent medication criteria for DBS at inclusion.

Interventions

DBS consists of 3 phases: 1) pre-operative screening to determine suitability for DBS; 2) DBS surgery, in which a neurosurgeon implants bilateral electrodes with 4 adjacent contact points (Medtronic, type 3389) into the ventral part of the anterior internal capsule, which are connected to an internal pulse generator (IPG) delivering electrical current to the target area; 3) a follow-up phase to achieve and maintain optimal effect, in which DBS parameters are adjusted (e.g. voltage, frequency, pulse width) and individual sessions of CBT are added, when an effective stimulation setting is found (on average a Y-BOCS decrease of >6 points) [6].

TAU is the individualized therapeutic strategy which aims to stabilize social, societal, and psychological functioning. It consists of a combination of 1) maintaining pharmacological treatment, 2) psychosocial interventions like home care, sheltered housing or hospital admissions and 3) low frequent CBT (<10 sessions a year).

Effect measures

To measure effectiveness we used quality-adjusted life-years (QALYs), which means that the cost-effectiveness analysis is technically a cost-utility analysis [9]. QALY was chosen as outcome for the cost-utility analysis according to Dutch guidelines [16] and because it is a commonly used outcome in cost-effectiveness research [11]. Utility values were obtained from the 5-dimensional EuroQol (EQ-5D) [12] using the Dutch tariff [13]. The Utility Score (UtS) represents a health state between 0 (death) and 1 (perfect health). One QALY can be regarded as one year in optimal health. QALYs were calculated from UtS using the area under the curve method [9] adjusting for baseline scores [14]: $QALY = (UtS_{12months}\text{-}UtS_{Baseline})/2 + (UtS_{12months} - UtS_{Baseline}) + (UtS_{24months} - UtS_{12months})/2$. QALYs gained in the second year were discounted at an annual rate of 1.5% [16].

Recourse use and costing

The economic evaluation was performed from the societal perspective and included healthcare utilization, productivity, and travel costs. Healthcare utilization within the hospital was measured using patient health care records and invoices to insurance companies. Health care utilization outside the hospital was measured using the Trimbos/iMTA questionnaire for Costs associated with Psychiatric illness (TiC-P) [15]. The TiC-P measures utilization of medical treatment in the last 3 months. The reported healthcare usage was then extrapolated over a period of one year.

Costs were calculated by multiplying health utilization units with standardized unit costs based on Dutch manual for costing research in health care [16]. For resources without standard cost pricing (imaging scans, blood tests, and theatre time), actual cost calculations from the department of finance of the AMC were used. For DBS equipment we used catalogue pricing. Medication was valued based on the Netherlands' pharmaceutical cost listing [17]. Travel costs were calculated as the average distance to the health service (50 km) multiplied by the cost per km (€0.20) [16]. All costs are expressed in euros and indexed to the reference year 2015. Prices from different years are adjusted to the reference year based on the harmonized index of consumer prices. Future costs were discounted at an annual rate of 4%. We assessed productivity changes with the short form health and labor questionnaire (SF-HLQ) [15]. The productivity changes were calculated according to the human capital approach and extrapolated over a period of one year. The costs and gains were based on the average income of the Dutch population according to specific age and gender classification [16].

The design and the reporting is performed according to cost-effectiveness reporting standards [9] and in line with the Consolidated Health Economic Evaluation Reporting Standards (CHEERS) statement [18].

Statistical analysis

Spreadsheet calculations were conducted using Excel 2010 (Microsoft Corp., Redmond, WA, USA). Statistics were conducted using SPSS 20.0 (IBM Corp., Somers, NY, USA) and R version 3.0.3 [19].

Data were analyzed in agreement with the intention to treat principle. Missing observations were imputed using the Expectation Maximization (EM) algorithm [20]. To handle stochastic uncertainty in the cost and effect data, we extracted 5000 nonparametric bootstrapped samples with replacement. For each of these samples, we calculated the incremental costs, incremental effects, and incremental cost effectiveness ratio (ICER). This ICER