Unilateral deep brain stimulation of the thalamus may be considered medically necessary in patients with disabling, medically unresponsive tremor (see policy guidelines) due to essential tremor or Parkinson’s disease.

Bilateral deep brain stimulation of the thalamus may be considered medically necessary in patients with disabling, medically unresponsive (see policy guidelines) tremor in both upper limbs due to essential tremor or Parkinson disease.

Unilateral or bilateral deep brain stimulation of the globus pallidus or subthalamic nucleus may be considered medically necessary in the following patients:

- Those with Parkinson’s disease with all of the following:
  - A good response to levodopa; AND
  - A minimal score of thirty (30) points on the motor portion of the Unified Parkinson Disease Rating Scale when the patient has been without medication for approximately twelve (12) hours; AND
  - Motor complications not controlled by drug therapy.

- Patients age greater than seven (7) years with chronic, intractable (drug refractory) primary dystonia, including generalized and/or segmental dystonia, hemidystonia and cervical dystonia (torticollis).

Deep brain stimulation is considered investigational for the following, as there is insufficient evidence to support a conclusion concerning the health outcomes or benefits associated with these procedures:

- Other movement disorders including, but not limited to, multiple sclerosis and post-traumatic dyskinesia and tardive dyskinesia;
- Treatment of chronic cluster headaches;
• Psychiatric disorders or neurologic disorders including, but not limited to Tourette syndrome, depression and obsessive-compulsive disorder anorexia nervosa, alcohol addiction, chronic pain, and epilepsy.

Deep brain stimulation is **contraindicated** in patients with the following conditions:

• Patients who are not good surgical risks because of unstable medical problems or because of cardiac pacemakers;

• Patients who have medical conditions that require repeated magnetic resonance imaging (MRI);

• Patients who have dementia that may interfere with the ability to cooperate;

• Patients who have had botulinum toxin injections within the last six months.

**Policy Guidelines**

Disabling, medically unresponsive tremor is defined as all of the following:

• tremor causing significant limitation in daily activities

• inadequate control by maximal dosage of medication for at least 3 months before implant.

**Cross-reference:**

MP-1.069 Spinal Cord Stimulation

**II. PRODUCT VARIATIONS**

This policy is applicable to all programs and products administered by Capital BlueCross unless otherwise indicated below.

BlueJourney HMO*            BlueJourney PPO*            FEP PPO**


** Refer to FEP Medical Policy Manual MP-7.01.63, Deep Brain Stimulation. The FEP Medical Policy Manual can be found at: [www.fepblue.org](http://www.fepblue.org)
Deep brain stimulation (DBS) involves the stereotactic placement of an electrode into the brain (i.e., hypothalamus, thalamus, globus pallidus, or subthalamic nucleus). DBS is used as an alternative to permanent neuroablative procedures for control of essential tremor (ET) and Parkinson's disease (PD). DBS is also being evaluated for the treatment of a variety of other neurologic and psychiatric disorders, including epilepsy, dystonia, cluster headache, Tourette syndrome, depression and obsessive-compulsive disorder (OCD).

Deep brain stimulation has been investigated as an alternative to permanent neuroablative procedures, such as thalamotomy and pallidotomy. The technique has been most thoroughly investigated as an alternative to thalamotomy for unilateral control of essential tremor and tremor associated with Parkinson's disease (PD). More recently, there has been research interest in the use of deep brain stimulation of the globus pallidus or subthalamic nucleus as a treatment of other parkinsonian symptoms, such as rigidity, bradykinesia, or akinesia. Another common morbidity associated with PD is the occurrence of motor fluctuations, referred to as "on and off" phenomena, related to the maximum effectiveness of drugs (i.e., the “on” state) and the nadir response during drug troughs (i.e., the “off” state). In addition, levodopa, the most commonly used anti-Parkinson's drug, may be associated with disabling drug-induced dyskinesias.

Deep brain stimulation has been investigated in patients with primary and secondary dystonia, defined as a neurological movement disorder characterized by involuntary muscle contractions, which force certain parts of the body into abnormal, contorted, and painful movements or postures. Dystonia can be classified according to age of onset, bodily distribution of symptoms, and cause. Age of onset can occur during childhood or during adulthood. Dystonia can affect certain portions of the body (focal dystonia and multifocal dystonia) or the entire body (generalized dystonia). Torticollis is an example of a focal dystonia. Primary dystonia is defined when dystonia is the only symptom unassociated with other pathology. Treatment options for dystonia include oral or injectable medications (i.e., botulinum toxin) and destructive surgical or neurosurgical interventions (i.e., thalamotomies or pallidotomies) when conservative therapies fail. Secondary Dystonia is a dystonia brought on by an inciting event, such as a stroke, trauma, or drugs. Tardive dystonia is a form of drug-induced secondary dystonia.

Deep brain stimulation has been investigated in patients with chronic cluster headaches. Cluster headaches occur as episodic attacks of severe pain lasting from 30 minutes to several hours. The pain is usually unilateral and localized to the eye, temple, forehead, and side of the face. Autonomic symptoms that occur with cluster headaches include ipsilateral facial sweating, flushing, tearing, and rhinorrhea. Cluster headaches occur primarily in men and have been classified as vascular headaches that have been associated with high blood pressure, smoking, alcohol use, etc. However, the exact pathogenesis of cluster headaches is uncertain. Positron emission tomography (PET) scanning and magnetic resonance imaging (MRI) have shown the
hypothalamic region may be important in the pathogenesis of cluster headaches. Alterations in hormonal/serotonergic function may also play a role. Treatment of cluster headaches includes pharmacologic interventions for acute episodes and prophylaxis, sphenopalatine ganglion (SPG) blockade, and surgical procedures such as percutaneous SPG radiofrequency rhizotomy and gamma knife radiosurgery of the trigeminal nerve.

The role of DBS in treatment of other treatment-resistant neurologic and psychiatric disorders, particularly Tourette syndrome, epilepsy, obsessive-compulsive disorder (OCD) and major depressive disorders, is also being investigated. Ablative procedures are irreversible and, though they have been refined, remain controversial treatments for intractable illness. Interest has shifted to neuromodulation through DBS of nodes or targets within neural circuits involved in these disorders. Currently, a variety of target areas are studied.

DBS involves the stereotactic placement of an electrode into the brain (i.e., hypothalamus, thalamus, globus pallidus, or subthalamic nucleus). The electrode is initially attached to a temporary transcutaneous cable for short-term stimulation to validate treatment effectiveness. Several days later, the patient returns to surgery for permanent subcutaneous implantation of the cable and a radiofrequency-coupled or battery-powered programmable stimulator. The electrode is typically implanted unilaterally on the side corresponding to the most severe symptoms. However, the use of bilateral stimulation using 2 electrode arrays has also been investigated in patients with bilateral, severe symptoms. After implantation, noninvasive programming of the neurostimulator can be adjusted to the patient's symptoms. This feature may be important for patients with PD, whose disease may progress over time, requiring different neurostimulation parameters. Setting the optimal neurostimulation parameters may involve the balance between optimal symptom control and appearance of side effects of neurostimulation, such as dysarthria, disequilibrium, or involuntary movements.

**Regulatory Status**

The U.S. Food and Drug Administration (FDA) has approved the Activa Tremor Control System, manufactured by Medtronic Corp, MN for deep brain stimulation. While the original 1997 FDA-labeled indications were limited to unilateral implantation of the device for the treatment of tremor, in January 2002, the FDA-labeled indications were expanded to include bilateral implantation as a treatment to decrease the symptoms of advanced Parkinson’s that are not controlled by medication. In April 2003, the labeled indications were expanded to include “unilateral or bilateral stimulation of the internal globus pallidus or subthalamic nucleus to aid in the management of chronic, intractable (drug refractory) primary dystonia, including generalized and/or segmental dystonia, hemidystonia and cervical dystonia (torticollis) in patients seven years of age or above.” This latter indication received FDA approval through the Humanitarian Device Exemption process. The Activa Tremor Control System consists of the following components: the implantable pulse generator, the deep brain stimulator lead, an extension that connects the lead to the power source, a console programmer, a software cartridge to set electrical parameters for simulation, and a patient control magnet, which allows the patient to turn the pulse generator on and off, or change between high and low settings.
The Vercise™ Deep Brain Stimulation system (Boston Scientific) is currently available in Europe, Israel, and Australia. Completion of a large U.S. multicenter trial (INTREPID) is expected in 2021.

In February 2009, the FDA approved deep brain stimulation with the Reclaim device (Medtronic, Inc.) via the Humanitarian Device Exemption (HDE) process for the treatment of severe obsessive-compulsive disorder (OCD).

IV. RATIONALE

This evidence review was created in 1998 with a review of the MEDLINE database. Updated literature searches have been conducted regularly, most recently through February 11, 2016.

Essential Tremor and Tremor in Parkinson Disease

Unilateral Stimulation of the Thalamus

This section was originally based on a 1997 TEC Assessment that focused on unilateral deep brain stimulation (DBS) of the thalamus as a treatment of tremor. The Assessment concluded:

- Tremor suppression was total or clinically significant in 82% to 91% of operated sides in 179 patients who underwent implantation of thalamic stimulation devices. Results were durable for up to 8 years, and adverse effects of stimulation were reported as mild and largely reversible.
- These results are at least as good as those associated with thalamotomy. An additional benefit of DBS is that recurrence of tremor may be managed by changes in stimulation parameters.

Studies identified in subsequent literature searches supported the conclusions of the TEC Assessment. For example, in 2008, Schuurman et al reported 5-year follow-up of 68 patients comparing thalamic stimulation and thalamotomy for treatment of tremor due to Parkinson disease (PD; 45 patients), essential tremor (ET; 13 patients), and multiple sclerosis (MS; 10 patients). Forty-eight (71%) patients were assessed at 5 years: 32 with PD, 10 with ET, and 6 with MS. The Frenchay Activities Index (FAI), the primary study outcome measure, was used to assess change in functional status; secondary measures included tremor severity, complication frequency, and patient-assessed outcomes. The mean difference between interventions, as measured on the FAI, favored thalamic stimulation at all time points: 4.4 (95% confidence interval [CI], 1.1 to 7.7) at 6 months, 3.3 (95% CI, -0.03 to 6.6) at 2 years, and 4.0 (95% CI, 0.3 to 7.7) at 5 years. The procedures had similar efficacy for suppressing tremors. The effect of thalamic stimulation diminished in half of the patients with ET and MS. Neurologic adverse effects were higher after thalamotomy. Subjective assessments favored stimulation.

Hariz et al evaluated outcomes of thalamic DBS in patients with tremor-predominant PD who participated in a multicenter European study and reported that at 6 years postsurgery, tremor was...
still effectively controlled and appendicular rigidity and akinesia remained stable when compared with baseline.³

**Bilateral Stimulation of the Thalamus**

In 2005, Putzke et al reported on a series of 25 patients with ET treated with bilateral DBS for management of midline tremor (head, voice, tongue, trunk).⁴ Three patients died of unrelated causes, 1 patient was lost to follow-up due to transfer of care, and 1 patient did not have baseline evaluation; these patients were not included in the analysis. Patients were evaluated at baseline (before implantation of second stimulator), and at 1, 3, 6, 12, 24, and 36 months. At 12 months, evaluations were obtained from 76% of patients; at 36 months, 50% of patients were evaluated. The most consistent improvement on the tremor rating scale during both unilateral and bilateral stimulation was found for head and voice tremor. The incremental improvement over unilateral stimulation through the first 12 months of bilateral stimulation was significant (p<0.01). Bilateral stimulation at months 3 and 12 was significantly better than unilateral stimulation at month 3 (p<0.05). Small sample size limited analysis at months 24 and 36. Dysarthria was reported in 6 (27%) patients and disequilibrium in 5 patients after bilateral stimulation in staged implantations. No patient reported dysarthria and 2 reported disequilibrium before bilateral stimulation.

In 2006, Pahwa et al reported on long-term follow-up of 45 patients who underwent thalamic DBS, 26 of whom had ET; of these patients, 18 had unilateral and 8 had bilateral implantation.⁵ Sixteen patients with unilateral and 7 with bilateral stimulators completed at least part of the 5-year follow-up evaluations. Patients with bilateral stimulation had a 78% improvement in mean motor tremor scores in the stimulation on state compared with baseline at 5-year follow-up (p=0.02) and 36% improvement in activities of daily living (ADL) scores. Patients with unilateral stimulation improved 46% on motor tremor scores and 51% on ADLs (p<0.01). Stimulation-related adverse events were reported in more than 10% of patients with unilateral and bilateral thalamic stimulators. Most were mild and were reduced with changes in stimulation parameters. Adverse events in patients with bilateral stimulation (eg, dysarthria and other speech difficulties, disequilibrium or balance difficulties, abnormal gait) persisted, despite optimization of the stimulation parameters.

**Advanced Parkinson Disease**

**Stimulation of the Globus Pallidus and Subthalamic Nucleus**

This section was based on a 2001 TEC Assessment that focused on the use of DBS of the globus pallidus and subthalamic nucleus for a broader range of PD symptoms.⁶ The Assessment concluded:

- A wide variety of studies consistently demonstrate that DBS of the globus pallidus interna (GPI) or subthalamic nucleus (STN) results in significant improvements, as measured by standardized rating scales of neurologic function. The most frequently observed improvements consist of increased waking hours spent in a state of mobility without dyskinesia, improved motor function during “off” periods when levodopa is not effective, reduction in frequency and severity of levodopa-induced dyskinesia during
periods when levodopa is working (“on” periods), improvement in cardinal symptoms of PD during periods when medication is not working, and in the case of bilateral DBS of the STN, reduction in the required daily dosage of levodopa and/or its equivalents. The magnitude of these changes is both statistically significant and clinically meaningful.

- The beneficial treatment effect lasts at least for the 6 to 12 months observed in most trials. While there is not a great deal of long-term follow-up, the available data are generally positive.
- Adverse effects and morbidity are similar to those known to occur with thalamic stimulation.
- DBS possesses advantages to other treatment options. In comparison to pallidotomy, DBS can be performed bilaterally. The procedure is nonablative and reversible.

A 2014 systematic review of randomized controlled trials (RCTs) by Perestelo-Perez et al evaluated the impact of DBS plus medication to medication alone (or plus sham DBS) on PD outcomes. Six RCTs (total N=1184 patients) were included in the review. Five of the studies exclusively involved bilateral stimulation to the STN and, in the sixth trial, half of the patients received stimulation to the STN and the other half had stimulation to the GPi. Motor function assessment was blinded in 2 studies and randomization method was described in 4 studies. Five studies reported motor function, measured by the Unified Parkinson’s Disease Rating Scale–III (UPDRS). In the off-medication phase, motor function was significantly higher with DBS versus control (weighted mean difference [WMD], 15.20; 95% CI, 12.23 to 18.18; standard mean difference [SMD], 1.35). In the on-medication phase, there was also significantly greater motor function with DBS versus control (WMD=4.36; 95% CI, 2.80 to 5.92; SMD=0.53). Meta-analyses of other outcomes (eg, ADLs, quality of life, dementia, depression), also favored the DBS group.

An earlier (2006) systematic review included both RCTs and observational studies; this review examined the literature on subthalamic stimulation for patients with PD who had failed medical management. Twenty studies, primarily uncontrolled cohorts or case series, were included in the meta-analysis. Subthalamic stimulation was found to improve ADL by 50% over baseline, as measured by the UPDRS-II (decrease of 13.35 points out of 52). There was a 28-point decrease in the UPDRS-III score (out of 108), indicating a 52% improvement in the severity of motor symptoms that occurred while the patient was not taking medication. A strong relationship was found between the preoperative dose response to levodopa and improvements in both the UPDRS-II and -III. The analysis found a 56% reduction in medication use, a 69% reduction in dyskinesia, and a 35% improvement in quality of life with subthalamic stimulation.

In 2007, a meta-analysis by Appleby et al found that the rate of suicidal ideation/suicide attempt associated with DBS for PD was 0.3% to 0.7%. The completed suicide rate was 0.16% to 0.32%. In light of the rate of suicide in patients treated with DBS, the authors argued for prescreening patients for suicide risk.
Globus Pallidus Versus Subthalamic Nucleus Stimulation

RCTs and meta-analyses have compared the efficacy of GPi and STN stimulation in PD patients. In 2014, Sako et al reported a meta-analysis of studies directly comparing these 2 targets and identified 4 trials.10 In a pooled analysis of scores on the UPDRS-III in the off-medication phase, there was not a statistically significant difference in outcomes after GPi or STN stimulation (SMD=0.19; 95% CI, -0.2 to 0.58). However, a pooled analysis of 3 trials found a significantly lower rate of depression after stimulation to the GPi rather than the STN (risk ratio [RR], 0.53; 95% CI, 0.31 to 0.90).

In 2015, Combs et al published a meta-analysis of cognition and depression outcomes in PD patients after GPi or STN stimulation.11 Thirty-eight articles suitable for meta-analysis were identified. Five reported on stimulation to the GPi only, 3 compared GPi to STN stimulation and the other 30 reported on STN stimulation only. Following STN stimulation, there were statistically significant declines in a number of outcomes, including learning and memory, language, and attention/concentration. However, effect sizes tended to be low; the largest were for semantic fluency (effect size [ES], -0.475; SE=0.054), verbal fluency (ES=0.0398; SE=0.047), and phonemic fluency (ES = -0.363; SE=0.047). There were fewer statistically significant declines in outcomes after GPi stimulation and effect sizes tended to be smaller compared with STN stimulation. Due to the small effect sizes overall, the authors concluded that both GPi and STN stimulation in PD patients appear to be well-tolerated.

Primary Dystonia

DBS for the treatment of primary dystonia received U.S. Food and Drug Administration (FDA) approval through the humanitarian device exemption (HDE) process in 2003. The HDE approval process is available for conditions that affect fewer than 4000 Americans per year. According to this approval process, the manufacturer is not required to provide definitive evidence of efficacy, but only probable benefit. The approval was based on the results of DBS in 201 patients represented in 34 manuscripts.12 There were 3 studies that reported at least 10 cases of primary dystonia. In these studies, clinical improvement with DBS ranged from 50% to 88%. A total of 21 pediatric patients were studied; 81% were older than age 7 years. Among these patients, there was an approximate 60% improvement in clinical scores. As noted in the analysis of risk and probable benefit, the only other treatment options for chronic refractory primary dystonia are neurodestructive procedures. DBS provides a reversible alternative.

Since FDA approval, there have been additional published trials of DBS for dystonia, which also reported positive results.13-16 For example, in 2006, the Deep-Brain Stimulation for Dystonia Study Group compared bilateral pallidal neurostimulation with sham stimulation in 40 patients with dystonia who had failed medical management (3-month randomized trial with a 6-month open-label extension).17 Blinded assessment with the Burke-Fahn-Marsden Dystonia Rating Scale (BFMDRS) found greater improvements in the movement score with active treatment (16 points vs 1.6 points in sham controls), which corresponded to a 39% reduction in symptoms. Disability scores improved by 4 points in the neurostimulation group (38% improvement) compared with an 0.8-point improvement in the control subjects. There were 21 serious adverse events that required hospitalization. Almost all serious adverse events were device-related,
including subcutaneous infection, lead dislodgement/lead breakage, and stimulator malfunction. The most common nonserious adverse event was dysarthria. Moreover, in 2007, Egidi et al retrospectively reviewed records of 69 patients from multiple Italian centers who were treated with DBS implanted in the globus pallidus; 37 patients had primary and 32 had secondary dystonia. Improvement of at least 50% on the BFMDRS was reached by 45% of primary and 37% of secondary dystonia patients at 3 to 84 months of follow-up (>24 months in half the patients).14

An industry-sponsored patient- and observer-blinded RCT of pallidal neurostimulation in patients with refractory cervical dystonia was published by Volkmann et al in 2014.18 The study included 62 adult patients with cervical dystonia of at least 3 years in duration, a severity score of at least 15 on the Toronto Western Spasmodic Torticollis Rating Scale (TWSTRS), and an unsatisfactory response to botulinum toxin injection and oral medication. Patients were randomly assigned to DBS (n=32) or sham stimulation (n=30). The primary outcome was change in the TWSTRS severity at 3 months at the end of the blinded study period; thereafter, all patients received open-label active stimulation. After 3 months, mean TWSTRS improved by 5.1 points (95% CI, 3.5 to 7.0) in the neurostimulation group and by 1.3 (95% CI, 0.4 to 2.2) in the sham group. The between-group difference was 3.8 points (95% CI, 1.8 to 5.8; p=0.024). Findings were mixed on the prespecified secondary outcomes. There was significantly greater improvement in the neurostimulation than in the sham group on the TWSTRS disability subscore and the Bain Tremor Scale, but not on the TWSTRS pain score or the Craniocervical Dystonia Questionnaire‒24 score. During the 3-month blinded study period, 22 adverse events were reported in 20 (63%) patients in the neurostimulation group and 13 adverse events were reported in 12 (40%) patients in the sham group. Of these 35 adverse events, 11 (31%) were rated as serious. Additionally, 40 adverse events, 5 of which were considered serious, occurred during 9 months of the open-label extension period. During the study, 7 patients experienced dysarthria (ie, slightly slurred speech), which was not reversible in 6 of the patients.

**Tardive Dyskinesia and Tardive Dystonia**

Stimulation of the globus pallidus was examined as a treatment of tardive dyskinesia in a 2007 multicenter case series, with a double-blind evaluation at 6 months (comparison of symptoms in the on and off positions).19 The trial was stopped early due to successful treatment (>40% improvement at 6 months) in the first 10 patients. In the double-blind evaluation of these patients, stimulation was associated with a mean decrease of 50% in the symptom score when the device was on versus off.

Outcomes on motor function, quality of life, and mood in a series 9 patients treated with DBS of the globus pallidus internus for tardive dystonia were reported by Gruber et al in 2009.20 One week and 3 to 6 months after surgery, BFMDRS motor scores were improved by 56.4%±26.7% and 74.1%±15.8%, BFMDRS disability scores by 62.5%±21% and 88.9%±10.3%, and Abnormal Involuntary Movement Scale (AIMS) scores by 52.3%±24.1% and 69.5%±27.6%, respectively. At last follow-up (mean, 41 months; range, 18-90 months), BFMDRS motor scores were reduced compared with presurgical assessment by 83%±12.2%, BFMDRS disability score by 67.7%±28%, and AIMS scores by 78.7%±19.9%.
### Epilepsy

In 2010, Fisher et al reported a U.S. multicenter, double-blind, randomized trial of bilateral stimulation of the anterior nuclei of the thalamus for epilepsy (SANTE).\(^{21}\) Included were 110 patients, ages 18 to 65 years, who experienced at least 6 partial seizures (including secondarily generalized seizures) per month, but no more than 10 per day. (An additional 47 patients were enrolled in the study but did not undergo implantation). At least 3 antiepileptic drugs must have failed to produce adequate seizure control before baseline, with 1 to 4 antiepileptic drugs used at the time of study entry. Patients were asked to keep a daily seizure diary during treatment. Half the patients were randomized to stimulation during a 3-month blinded phase; then all patients received unblinded stimulation.

The baseline monthly median seizure frequency was 19.5. During the first and second months of the blinded phase, the difference in seizure reduction between stimulation on and stimulation off (-42.1% vs -28.7%, respectively) was not significantly different. In the last month of the blinded phase, the stimulated group had a greater reduction in seizures compared with the control group (-40.4% vs -14.5% in controls).

Long-term outcomes of the SANTE trial were reported by Salanova et al in 2015.\(^{22}\) The uncontrolled open-label portion of the trial began after 3 months and, beginning at 13 months, stimulation parameters could be adjusted at the clinician’s discretion. Of the 110 implanted patients, 105 (95%) completed the 13-month follow-up, 98 (89%) completed the 3-year follow-up, and 83 (75%) completed 5 years. Among patients with at least 70 days of diary entries, the median change in seizure frequency from baseline was 41% at 1 year and 69% at 5 years (p<0.001 for both). During the study, 39 (35%) of 110 patients had a device-related serious adverse event, most of which occurred in the first several months after implantation. These included implant site infection (10% of patients) and lead(s) not within target (8.2% of patients). Seven deaths occurred during the study and none were considered to be device-related. Depression was reported in 41 (37%) patients following implant; in 3 cases, it was considered device-related. Memory impairment (nonserious) was reported in 30 (27%) patients during the study, half of whom had a history of the condition. Although some patients appear to have benefited from treatment during the extended follow-up phase, the difference between groups in the blinded portion of the study, while significant, was modest overall.

### Multiple Sclerosis

In 2008, Schuurman et al reported 5-year follow-up of 68 patients comparing thalamic stimulation and thalamotomy for treatment of MS (10 patients) plus PD and ET.\(^{2}\) Trial detailed are discussed above in the section on Unilateral Stimulation of the Thalamus. The small numbers of patients with MS in this trial limits conclusions that can be drawn.

### Tourette Syndrome

Several systematic reviews of the literature on DBS for Tourette syndrome have been published, including 4 identified in the 2016 literature search.\(^{23-26}\) Most recent systematic reviews (ie, those published in 2015 or 2016) qualitatively described the literature. Only Baldermann et al (2015) conducted pooled analyses of study data. The review identified 57 studies on DBS for Tourette
syndrome, 4 of which were randomized crossover studies. The studies included a total of 156 cases. Twenty-four studies included a single patient each and 4 had sample sizes of 10 or more (maximum, 18). Half of the patients (n=78) were stimulated in the thalamus and the next most common areas of stimulation were the GPi anteromedial part (n=44) and post ventrolateral part (n=20). Two of the RCTs used thalamic stimulation, 1 used bilateral globus pallidus stimulation, and 1 used both. The primary outcome was the Yale Global Tic Severity Scale (YGTSS). In a pooled analysis of within subject pre-post data, there was a median improvement of 53% in the YGTSS, a decline from a median score of 83 to 35 at last follow-up. Moreover, 81% of patients showed at least a 25% reduction in the YGTSS and 54% showed an improvement of 50% or more. In addition, data were pooled from the 4 crossover RCTs; there were a total of 27 patients receiving DBS and 27 receiving a control intervention. Targets included the thalamus and the globus pallidus. In the pooled analysis, there was a statistically significant between-group difference, favoring DBS (SMD=0.96; 95% CI, 0.36 to 1.56). The authors noted that the effect size of 0.96 is considered to be a large effect.

Another systematic review from 2012 examined patient and target selection for DBS of Tourette syndrome. Most clinical trials for DBS in Tourette syndrome have targeted the medial thalamus at the crosspoint of the centromedian nucleus, substantia periventricularis, and nucleus ventro-oralis internus. Other targets that have been investigated include the subthalamic nucleus, caudate nucleus, GPi, and the anterior limb of the internal capsule and nucleus accumbens. The review found no clear consensus in the literature for which patients should be treated and what the best target is. Additional study is needed to clarify these issues.

The crossover RCT with the largest sample size was published by Kefalopoulou et al (2015). The double-blind trial included 15 patients with severe medically refractory Tourette syndrome; all received surgery for bilateral GPi DBS and were randomized to the off-stimulation phase first or the on-stimulation phase first for 3 months, followed by the opposite phase for the next 3 months. Of the 15 receiving surgery, 14 were randomized and 13 completed assessments after both on and off phases. For the 13 study completers, the mean YGTSS scores were 80.7 (SD=12.0) in the off-stimulation phase and 68.3 (SD=18.6) in the on-stimulation phase. The mean difference in YGTSS scores was an improvement of 12.4 points (95% CI, 0.1 to 24.7), which was statistically significant (p=0.048) after Bonferroni correction. There was no significant between-group difference in YGTSS scores in patients who were randomized to the on-stimulation phase first or second. Three serious adverse events were reported, 2 related to surgery and 1 related to stimulation. The authors noted that the most effective target for DBS in patients with Tourette syndrome needs additional study.

Cluster Headaches and Facial Pain

DBS of the posterior hypothalamus for the treatment of chronic cluster headaches has been investigated, because functional studies have suggested cluster headaches have a central hypothalamic pathogenesis.

In 2010, Fontaine et al published results from a prospective crossover, double-blind, multicenter study in 11 patients with DBS of the posterior hypothalamus for severe refractory chronic cluster
headache. The randomized phase compared active and sham stimulation during 1-month periods and was followed by a 1-year open phase. Severity of cluster headache was assessed by the weekly attacks frequency (primary outcome), pain intensity, sumatriptan injections, emotional impact, and quality of life (12-Item Short-Form Health Survey). During the randomized phase, no significant change in primary and secondary outcome measures was observed between active and sham stimulation. At the end of the open phase, 6 of 11 patients reported a greater than 50% reduction in the weekly frequency of attacks.

Another research group from Europe has published several case series (potentially overlapping) on DBS of the ipsilateral posterior hypothalamus in patients with chronic cluster headache. Stimulation was reported to result in long-term pain relief (1-26 months of follow-up) without significant adverse effects in 16 patients with chronic cluster headaches and in 1 patient with neuralgiform headache; treatment failed in 3 of 3 patients who had atypical facial pain. Controlled studies are needed to evaluate the long-term safety and effectiveness of DBS for chronic cluster headaches.

**Treatment-Resistant Depression**

A variety of target areas are being investigated for DBS of treatment-resistant depression. A systematic review from 2014 identified 22 published reports with 6 different approaches/targets including the nucleus accumbens, ventral capsule/ventral striatum, subgenual cingulate cortex, lateral habenula, inferior thalamic nucleus, and medial forebrain bundle. Only 3 of the studies identified were controlled with sham stimulation periods, and at least 2 multicenter RCTs evaluating subgenual cingulate cortex and ventral striatum/ventral capsule DBS had been terminated due to futility (interim analysis demonstrating very low probability of success if trial was completed as planned). A 2015 systematic review identified a single published RCT on DBS for depression; this trial is described next.

An industry-sponsored, double-blind RCT evaluating DBS of the ventral capsule/ventral striatum in patients with chronic treatment-resistant depression was published by Dougherty et al (2015). The study included 30 patients with a major depressive episode lasting at least 2 years and inadequate response to at least 4 trials of antidepressant therapy. Participants were randomized to 16 weeks of active (n=16) versus sham (n=14) DBS, followed by an open-label continuation phase. One patient, who was assigned to active treatment, dropped out of the study during the blinded treatment phase. The primary outcome was clinical response at 16 weeks, defined as 50% or greater improvement from baseline on the Montgomery-Asberg Depression Rating Scale (MADRS). A response was identified in 3 (20%) of 15 patients in the active treatment group and 2 (14%) of 14 patients in the sham control group. The between-group difference in response was not statistically significant (p=0.53). During the blinded treatment phase, psychiatric adverse events occurring more frequently in the active treatment group included worsening depression, insomnia, irritability, suicidal ideation, hypomania, disinhibition, and mania. Psychiatric adverse events occurring more frequently in the sham control group were early morning awakening and purging. Findings of this study do not support the conclusion that DBS is effective for treating treatment-resistant depression.
Obsessive-Compulsive Disorder

Several systematic reviews evaluating DBS for obsessive-compulsive disorder (OCD) have been published.\textsuperscript{35-38} Two of these reviews included meta-analyses pooling study findings. Kisely et al (2014) included only double-blind RCTs of active versus sham DBS.\textsuperscript{38} Five trials (total N=50 patients) met eligibility criteria and data on 44 patients were available for meta-analysis. Three were parallel group RCTs with or without a crossover phase and 2 were only crossover trials. The site of stimulation was the anterior limb of the internal capsule (3 studies), the nucleus accumbens (1 study) and the STN (1 study). Duration of treatment ranged from 2 to 12 weeks. All studies reported scores on the Yale-Brown Obsessive Compulsive Scale (Y-BOCS). This is a 10-item clinician-rated scale, in which higher ratings reflect more intense symptoms, and a score of 24 or more (of a possible 40) indicates severe illness. Most studies designate a therapeutic response as a Y-BOCS reduction of 35\% or more from the pretreatment baseline, with a reduction of 25\% to 35\% considered a partial response. Only 1 of the 5 studies compared the proportion of responders on Y-BOCS as an outcome measure and that study did not find a statistically significant difference between active and sham stimulation groups. All studies reported the outcome measure, mean reduction in Y-BOCS. When data from the 5 studies were pooled, there was a statistically significantly greater reduction in the mean Y-BOCS in the active versus sham group (mean difference, -8.49; 95\% CI, -12.18 to -4.80). The outcome measure, however, does not allow conclusions on whether the difference between groups is clinically meaningful. Trial authors reported 16 serious adverse events including 1 cerebral hemorrhage and 2 infections requiring electrode removal. Additionally, nonserious transient adverse events were reported including 13 reports of hypomania, 6 of increase in depressive or anxious symptoms, and 6 of headaches.

A 2015 systematic review and meta-analysis by Alonso et al included studies of any type (including case reports) evaluating DBS for OCD and reporting changes on the Y-BOCS.\textsuperscript{37} The authors identified 31 studies (total N=116 patients). They did not report study type (ie, controlled vs uncontrolled); however, the meta-analysis was only of patients who received active treatment. Twenty-four (77\%) studies included 10 or fewer patients. Most studies (24, including 83 patients) involved DBS of striatal areas including the anterior limb of the internal capsule, the ventral capsule and ventral striatum, the nucleus accumbens or the ventral caudate nucleus. Of the remaining studies, 5 (27 patients) addressed STN stimulation and 2 (6 patients) addressed stimulation of the inferior thalamic peduncle. Twelve studies provided patient-level data and 4 provided pooled data on percentage of responders (ie, >35\% reduction in posttreatment Y-BOCS scores). A pooled analysis yielded a global percentage of responders of 60\% (95\% CI, 49\% to 69\%). The most frequent adverse events reported were worsening anxiety (25 patients) and hypomanic symptoms (23 patients). The study reported benefits and risks of DBS stimulation but conclusions cannot be drawn about stimulation to any particular region or about the safety or efficacy of DBS for OCD compared with sham stimulation or an alternative therapy.

Section Summary: Obsessive-Compulsive Disorder

The literature on DBS for OCD consists of several RCTs and a number of uncontrolled studies. Most studies had small sample sizes. Only 1 of the 5 RCTs identified in a 2015 meta-analysis
reported the outcome measure of greatest interest, clinically significant change in the Y-BOCS. Uncontrolled data suggest improvement in OCD symptoms after DBS treatment, but also identify a substantial number of adverse events. Additional blinded controlled studies are needed to draw conclusions about the impact of DBS on the net health benefit.

**Other**

The evidence on DBS for anorexia nervosa, alcohol addiction, Alzheimer disease, Huntington disease, and chronic pain consists of small case series. These are not adequate to make a determination of efficacy.

**Ongoing and Unpublished Clinical Trials**

Some currently unpublished trials that might influence this review are listed in Table 1.

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<th>Completion Date</th>
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<td>NCT02480803</td>
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<td>NCT02076698</td>
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<td>Dec 2019</td>
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<tr>
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<td>NCT01973478</td>
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<td></td>
<td>NCT01839396a</td>
<td>Implantable Neurostimulator for the Treatment of Parkinson's Disease</td>
<td>310</td>
<td>Jul 2021</td>
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</table>

NCT: national clinical trial.

a Denotes industry-sponsored or cosponsored trial.

### Summary of Evidence

The evidence for deep brain stimulation (DBS) of the thalamus in individuals who have essential tremor or tremor in Parkinson disease includes a systematic review and case series. Relevant outcomes are symptoms, functional outcomes, quality of life, and treatment-related morbidity. The systematic review, a TEC Assessment, concluded that there was sufficient evidence that DBS of the thalamus resulted in clinically significant tremor suppression and that outcomes after DBS were at least as good as thalamotomy. Subsequent studies reporting long-term follow-up supported the conclusions of the Assessment and found that tremors were effectively controlled 5 to 6 years after DBS. The evidence is sufficient to determine qualitatively that the technology results in a meaningful improvement in the net health outcome.

The evidence for DBS of the globus pallidus or subthalamic nucleus in individuals who have symptoms (eg, speech, motor fluctuations) associated with advanced Parkinson disease includes randomized controlled trials (RCTs) and systematic reviews. Relevant outcomes are symptoms, functional outcomes, quality of life, and treatment-related morbidity. One of the systematic reviews was a TEC Assessment, which concluded that studies on DBS of the globus pallidus or
subthalamic nucleus consistently demonstrated clinically significant improvements in outcomes (eg, neurologic function). Other systematic reviews also found significantly better outcomes after DBS versus a control intervention. The evidence is sufficient to determine qualitatively that the technology results in a meaningful improvement in the net health outcome.

The evidence for DBS of the globus pallidus or subthalamic nucleus in individuals who have primary dystonia includes RCTs and case series. Relevant outcomes are symptoms, functional outcomes, quality of life, and treatment-related morbidity. Double-blind, sham-controlled studies generally found significantly better outcomes with active stimulation. The treatment was associated with adverse events, the most common of which was nonserious dysarthria. The evidence is sufficient to determine qualitatively that the technology results in a meaningful improvement in the net health outcome.

The evidence for DBS in individuals who have tardive dyskinesia or tardive dystonia includes case series, 1 of which included a double-blind comparison of outcomes when the device was on versus off. Relevant outcomes are symptoms, functional outcomes, quality of life, and treatment-related morbidity. Few studies were identified and they had small sample sizes (≤10 patients). Additional studies, especially RCTs or other controlled studies, are needed. The evidence is insufficient to determine the effects of the technology on health outcomes.

The evidence for DBS in individuals who have epilepsy or multiple sclerosis includes RCTs. Relevant outcomes are symptoms, functional outcomes, quality of life, and treatment-related morbidity. Only 1 RCT was identified for each condition; DBS had a positive impact on some outcomes but not others, and adverse events were reported. Additional trials are required to determine the impact of DBS on the net health outcome. The evidence is insufficient to determine the effects of the technology on health outcomes.

The evidence for DBS in individuals who have Tourette syndrome includes crossover RCTs and systematic reviews. Several small (≤15 patients) crossover studies and a 2015 metaanalysis have suggested that DBS may improve outcomes in patients with Tourette syndrome. However, the optimal target for DBS is not known and additional controlled studies in larger numbers of patients are needed. The evidence is insufficient to determine the effects of the technology on health outcomes.

The evidence for DBS in individuals who have cluster headaches or facial pain includes a randomized crossover study and case series. Relevant outcomes are symptoms, functional outcomes, quality of life, and treatment-related morbidity. In the randomized study, the between-group difference in response did not differ significantly between active and sham stimulation phases. Additional RCTs or controlled studies are needed. The evidence is insufficient to determine the effects of the technology on health outcomes.

The evidence for DBS in individuals who have treatment-resistant depression or obsessive-compulsive disorder includes RCTs and systematic reviews. Relevant outcomes are symptoms, functional outcomes, quality of life, and treatment-related morbidity. The only double-blind RCT in patients with depression did not find that DBS significantly increased the response rate versus
sham. Among the RCTs on DBS for obsessive-compulsive disorder, only 1 reported the outcome of greatest clinical interest, therapeutic response rate, and that study did not find a statistically significant benefit for DBS compared to sham treatment. The evidence is insufficient to determine the effects of the technology on health outcomes.

The evidence for DBS in individuals who have anorexia nervosa, alcohol addiction, Alzheimer disease, Huntington disease, or chronic pain includes case series. Relevant outcomes are symptoms, functional outcomes, quality of life, and treatment-related morbidity. RCTs are needed. The evidence is insufficient to determine the effects of the technology on health outcomes.

**SUPPLEMENTAL INFORMATION**

**Clinical Input Received From Physician Specialty Societies and Academic Medical Centers**

While the various physician specialty societies and academic medical centers may collaborate with and make recommendations during this process, through the provision of appropriate reviewers, input received does not represent an endorsement or position statement by the physician specialty societies or academic medical centers, unless otherwise noted.

In response to requests, input was received from 2 academic medical centers and 2 physician specialty societies while this policy was under review in 2014. The input supported the use of bilateral DBS in patients with medically unresponsive tremor in both limbs.

**Practice Guidelines and Position Statements**

**American Academy of Neurology**

The American Academy of Neurology (AAN) published an updated guideline on the treatment of essential tremor (ET) in 2011. There were no changes from the conclusions and recommendations of the 2005 practice parameters regarding DBS for ET. The guidelines stated that bilateral DBS of the thalamic nucleus may be used to treat medically refractory limb tremor in both upper limbs (level C, possibly effective), but that there were insufficient data regarding the risk/benefit ratio of bilateral versus unilateral DBS in the treatment of limb tremor. There was insufficient evidence to make recommendations regarding the use of thalamic DBS for head or voice tremor (level U, treatment is unproven).

The 2006 guidelines from AAN on the treatment of Parkinson disease (PD) with motor fluctuations and dyskinesia found that although the criteria are evolving, patients with PD who are considered candidates for DBS include levodopa-responsive, nondemented, and neuropsychiatrically intact patients who have intractable motor fluctuations, dyskinesia, or tremor. AAN concluded that DBS of the subthalamic nucleus (STN) may be considered as a treatment option in PD patients to improve motor function and to reduce motor fluctuations, dyskinesia, and medication usage (Level C, possibly effective), but found insufficient evidence to make any recommendations about the effectiveness of DBS of the globus pallidus or the ventral intermediate nucleus of the thalamus in reducing motor complications or medication usage, or in improving motor function in PD patients.
The 2010 guidelines from AAN on the treatment of nonmotor symptoms of PD found insufficient evidence for the treatment of urinary incontinence with DBS of the STN.\textsuperscript{42} AAN found that DBS of the STN possibly improves sleep quality in patients with advanced PD. However, none of the studies performed DBS to treat insomnia as a primary symptom, and DBS of the STN is not currently used to treat sleep disorders.

The 2013 guidelines from AAN on the treatment of tardive syndromes states that the available evidence, which consists of Class IV studies comprising case reports or small case series, is insufficient to support or refute pallidal DBS for tardive syndromes.\textsuperscript{43}

**American Society for Stereotactic and Functional Neurosurgery et al**
The American Society for Stereotactic and Functional Neurosurgery and the Congress of Neurological Surgeons published a systematic review and guideline on DBS for obsessive-compulsive disorder (OCD) in 2014.\textsuperscript{36} The document concluded that there is a single level I study supporting the use of bilateral STN DBS for medically refractory OCD and a single level II study supporting bilateral nucleus accumbens DBS for medically refractory OCD. It also concluded that the evidence on unilateral DBS is insufficient.

**American Psychiatric Association**
In their 2007 guideline on treatment of patients with OCD, the American Psychiatric Association states that DBS may be recommended on the basis of individual circumstances.\textsuperscript{44}

**Canadian Network for Mood and Anxiety Treatments**
The Canadian Network for Mood and Anxiety Treatments’ 2009 clinical guideline for management of major depressive disorder in adults states that there is emerging evidence to support DBS as an experimental intervention for patients with treatment-refractory depression.\textsuperscript{45} There is no consensus on the most effective target brain region for implantation, although 3 regions have been explored (subcallosal cingulated gyrus, nucleus accumbens, ventral caudate/ventral striatum region).

**European Society for the Study of Tourette Syndrome**
The European Society for the Study of Tourette Syndrome published guidelines on DBS in 2011.\textsuperscript{46} The guidelines state that DBS for Tourette syndrome is still in its infancy and that there are no randomized controlled trials available that include a sufficiently large number of patients. There was general agreement among the workgroup members that DBS should only be used in adult, treatment-resistant, and severely affected patients, and it was highly recommended that DBS be performed in the context of controlled and double-blind trials including larger and carefully characterized groups of patients.

**National Institute for Health and Care Excellence**
The U.K.’s National Institute for Health and Care Excellence (NICE; previously the National Institute for Clinical Excellence) has published interventional procedure guidance documents on DBS, as discussed in the following subsections.
**Tremor and Dystonia**
In 2006, NICE made the same statement for use of DBS for treatment of both tremor and dystonia. Unilateral and bilateral stimulation of structures responsible for modifying movements, such as the thalamus, globus pallidus, and the STN, which interact functionally with the substantia nigra, are included in both guidance statements. The guidance states: “Current evidence on the safety and efficacy of deep brain stimulation for tremor and dystonia (excluding Parkinson’s disease) appears adequate to support the use of this procedure, provided that the normal arrangements are in place for consent, audit and clinical governance.”

**Refractory Chronic Pain Syndromes (Excluding Headache)**
The 2011 guidance from NICE states that there is evidence that DBS for refractory chronic pain (excluding headache) is associated with serious risks. However, the procedure is “efficacious in some patients” refractory to other treatments and, therefore, it may be used provided “normal arrangements are in place for consent, audit and clinical governance.” Patients should be informed that DBS may not control their chronic pain symptoms and that possible risks associated with this procedure include the small risk of death.

**Intractable Trigeminal Autonomic Cephalalgias**
The 2011 guidance from NICE states that the evidence on the efficacy of DBS for intractable trigeminal autonomic cephalalgias (e.g., cluster headaches) is limited and inconsistent, and the evidence on safety shows that there are serious but well-known adverse effects. Therefore, this procedure should only be used with special arrangements for clinical governance, consent, and audit or research.

**Refractory Epilepsy**
The 2012 guidance from NICE states that the evidence on the efficacy of DBS for refractory epilepsy is limited in both quantity and quality. The evidence on safety shows that there are serious but well-known adverse effects. Therefore, this procedure should only be used with special arrangements for clinical governance, consent, and audit or research.

**Parkinson Disease**
In 2003, NICE stated that the evidence on the safety and efficacy of DBS for treatment of PD appears adequate to support the use of the procedure, provided that normal arrangements are in place for consent, audit, and clinical governance.

In 2006, NICE published a clinical guideline on the diagnosis and management of PD in primary and secondary care. With the evidence at that time, it was not possible to decide if the STN or globus pallidus interna (GPI) is the preferred target for DBS for people with PD, or whether 1 form of surgery is more effective or safer than the other. Based on level 3 or 4 evidence, NICE concluded that thalamic DBS may be considered as an option in people with PD who predominantly have severe disabling tremor and where STN stimulation cannot be performed.

**U.S. Preventive Services Task Force Recommendations**
Not applicable.
Medicare National Coverage

Effective for services furnished on or after April 1, 2003, Medicare will cover unilateral or bilateral thalamic ventralis intermedius nucleus (VIM) DBS for the treatment of ET and/or parkinsonian tremor and unilateral or bilateral STN or GPi DBS for the treatment of PD when the following conditions are met:

1. DBS devices must be FDA-approved devices for DBS or devices used in accordance with FDA-approved protocols governing Category B Investigational Device Exemption DBS clinical trials.

2. For thalamic VIM DBS, patients must meet all of the following criteria:
   a. “Diagnosis of ET based on postural or kinetic tremors of hand(s) without other neurologic signs, or diagnosis of idiopathic PD (presence of at least 2 cardinal PD features (tremor, rigidity or bradykinesia)) which is of a tremor-dominant form.
   b. Marked disabling tremor of at least level 3 or 4 on the Fahn-Tolosa-Marin Clinical Tremor Rating Scale (or equivalent scale) in the extremity intended for treatment, causing significant limitation in daily activities despite optimal medical therapy.
   c. Willingness and ability to cooperate during conscious operative procedure, as well as during postsurgical evaluations, adjustments of medications and stimulator settings.”

3. For STN or GPi DBS, patients must meet all of the following criteria:
   a. “Diagnosis of PD based on the presence of at least 2 cardinal PD features (tremor, rigidity or bradykinesia).
   b. Advanced idiopathic PD as determined by the use of Hoehn and Yahr stage or Unified Parkinson's Disease Rating Scale (UPDRS) part III motor subscale.
   c. L-dopa responsive with clearly defined "on" periods.
   d. Persistent disabling Parkinson's symptoms or drug side effects (eg, dyskinesias, motor fluctuations, or disabling "off" periods) despite optimal medical therapy.
   e. Willingness and ability to cooperate during conscious operative procedure, as well as during postsurgical evaluations, adjustments of medications and stimulator settings.”

DBS is not covered for ET or PD patients with any of the following:

2. Cognitive impairment, dementia or depression, which would be worsened by or would interfere with the patient’s ability to benefit from DBS.
3. Current psychosis, alcohol abuse or other drug abuse.
4. Structural lesions such as basal ganglionic stroke, tumor or vascular malformation as etiology of the movement disorder.
5. Previous movement disorder surgery within the affected basal ganglion.
6. Significant medical, surgical, neurologic or orthopedic co-morbidities contraindicating DBS surgery or stimulation.”
V. DEFINITIONS

**DYSARTHRIA** is difficult, poorly articulated speech, resulting from interference in the control and execution over the muscles of speech, usually caused by damage to a central or peripheral motor neuron.

**GLOBUS PALLIDUS** is the smaller and more medial part of the lentiform nucleus of the brain, separated from the putamen by the lateral medullary lamina and divided into external and internal portions closely connected to the thalamus and mesencephalon.

**HYPOTHALAMUS** is a part of the diencephalon that serves as the chief region for integration of sympathetic and parasympathetic activities.

**SUBCUTANEOUS** refers to beneath the skin.

**SUBTHALAMUS** is a part of the diencephalon that serves as a correlation center for optic and vestibular impulses relayed to the globus pallidus.

**THALAMUS** is one of a pair of large oval structures made of gray matter and forming most of the lateral walls of the third ventricle of the brain. It relays sensory and motor information, excluding smell, to the cerebral cortex.

**UNIFIED PARKINSON DISEASE RATING SCALE (UPDRS)** - is a rating tool to follow the longitudinal course of Parkinson's disease.

VI. BENEFIT VARIATIONS

The existence of this medical policy does not mean that this service is a covered benefit under the member’s contract. Benefit determinations should be based in all cases on the applicable contract language. Medical policies do not constitute a description of benefits. A member’s individual or group customer benefits govern which services are covered, which are excluded, and which are subject to benefit limits and which require preauthorization. Members and providers should consult the member’s benefit information or contact Capital for benefit information.

VII. DISCLAIMER

Capital’s medical policies are developed to assist in administering a member’s benefits, do not constitute medical advice and are subject to change. Treating providers are solely responsible for medical advice and treatment of members. Members should discuss any medical policy related to their coverage or condition with their provider and consult their benefit information to determine if the service is covered. If there is a discrepancy between this medical policy and a member’s benefit information, the benefit information will govern. Capital considers the information contained in this medical policy to be proprietary and it may only be disseminated as permitted by law.
VIII. CODING INFORMATION

**Note:** This list of codes may not be all-inclusive, and codes are subject to change at any time. The identification of a code in this section does not denote coverage as coverage is determined by the terms of member benefit information. In addition, not all covered services are eligible for separate reimbursement.

**Covered when medically necessary:**

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**HCPSC Codes**

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**ICD-10-CM Diagnosis Codes**

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<td>Neuroleptic induced parkinsonism</td>
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IX. REFERENCES


### MEDICAL POLICY

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### X. POLICY HISTORY

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### MEDICAL POLICY

**Policy Title**: Deep Brain Stimulation  
**Policy Number**: MP-1.042

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<td>Added neurologic disorders, Tourette syndrome, epilepsy and tardive dyskinesia as investigational. References updated.</td>
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<td>Added neurologic disorders, Tourette syndrome, epilepsy and tardive dyskinesia as investigational. References updated.</td>
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<td>CAC 7/26/11</td>
<td>Adopt BCBSA; For unilateral deep brain stimulation of the thalamus, removed the requirement of inadequate control by maximal dosage of levodopa for at least three months before implant for Parkinson's disease. An FEP variation was added.</td>
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<td>CAC 7/30/2013</td>
<td>Consensus review list</td>
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<tr>
<td>CAC 3/25/14</td>
<td>Consensus review. References updated. Anorexia nervosa, alcohol addiction, and chronic pain were added to the list of examples of psychiatric and neurological disorders considered investigational. Rationale added.</td>
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<td>Consensus review. No changes to the policy statements. References updated. Coding reviewed.</td>
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<td>Product variation section reformatted</td>
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<td>CAC 3/28/17</td>
<td>Consensus review. The word “upper” as added the medically necessary statement on DBS for medically unresponsive tremor due to essential tremor or Parkinson disease to provide clarification that the statement refers to both upper limbs. Rationale and references updated. Coding reviewed.</td>
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*Health care benefit programs issued or administered by Capital BlueCross and/or its subsidiaries, Capital Advantage Insurance Company®, Capital Advantage Assurance Company® and Keystone Health Plan® Central. Independent licensees of the BlueCross BlueShield Association. Communications issued by Capital BlueCross in its capacity as administrator of programs and provider relations for all companies.*