IMPORTANT: Read the following dystonia-specific information on this envelope.

Give your patient the *Your Activa® Therapy for Dystonia* patient manual that is in this envelope. Do NOT give your patient the patient manual packaged with the neurostimulator.

The following information is taken from the *Activa Dystonia Therapy Technical Manual* contained in this envelope.

Indications for Use

Unilateral or bilateral stimulation of the internal globus pallidus (GPi) or the subthalamic nucleus (STN) by the Medtronic Activa System is indicated as an aid in the management of chronic, intractable (drug refractory) primary dystonia, including generalized and segmental dystonia, hemidystonia, and cervical dystonia (torticollis), for individuals 7 years of age and older.

Individualization of Treatment

Best results are achieved when the patient and caregiver are fully informed about the therapy risks and benefits, surgical procedures, follow-up requirements, and self-care responsibilities. Activa Dystonia Therapy is appropriate for patients who meet the following criteria:

- Patients with chronic, intractable (drug refractory) primary dystonia, including generalized and segmental dystonia, hemidystonia, and cervical dystonia (torticollis), for individuals 7 years of age and older.
- Patients should be suitable candidates for stereotactic neurosurgery.

Use extreme care with lead implantation in patients with a heightened risk of intracranial hemorrhage. Physicians should consider underlying factors, such as previous neurological injury or prescribed medications (anticoagulants), that may predispose a patient to the risk of bleeding.

Physicians should be aware that the risks associated with initial surgery may increase with clinical conditions such as:

- Stroke or neurological disorders other than idiopathic Parkinson's disease
- Cardiovascular disease
- Renal or hepatic failure
- Diabetes mellitus

To help ensure maximum benefits from the neurostimulation system, long-term, post-surgical management of patients is recommended. Stimulation parameters should be adjusted such that maximal symptom suppression is achieved with minimal side effects. High parameter values may indicate a system problem or less than optimal lead placement. Patients should be informed of the risks of higher stimulation parameters, which may result in possible excessive charge density, as noted in the "Programming the Neurostimulator" section of the *Model 3387/3389 DBS Lead Implant Manual*.

Special Considerations for Pediatric Patients

Dual System Implant — If two neurostimulators are implanted, they should be implanted at least 8 inches apart to minimize cross-programming interference. In smaller patients, consider placing one neurostimulator in the abdomen and one in the chest region. In this case, route both lead/extension assemblies and implant both neurostimulators on the same side of the body to minimize potential electromagnetic interference. A 95-cm extension is recommended to connect the lead to the abdominal neurostimulator. Verify final programmed parameters by reviewing both devices at the conclusion of any programming session.

Patient growth and lead/extension length — Evaluate the patient's implanted lead/extension assembly for sufficient strain relief (eg, consider patient comfort, range of motion, x-ray visualization of the extension) at regular post-implant follow-up sessions. This monitoring is especially important for patients whose growth is not complete at implant. Consideration should be given to replacement of the extension with one of greater length during other elective surgery procedures, such as during the regular changeout of neurostimulators that must occur because of battery depletion.

Patient brain growth and lead migration — Medtronic recommends the use of Activa Therapy for individuals in whom brain growth is approximately 90% complete. In cases where growth of the brain and/or skull is not complete at time of implant, the distance from the lead anchor point (burr hole) to the target site increases with time and growth of the individual. As a result, lead migration relative to the target site may occur.

If significant patient growth and potential resultant lead migration are anticipated, consider positioning lead electrodes as follows at the time of initial lead placement: Position the lead so that the center bipole electrodes (eg, electrodes 1 and 2) will be active. If lead migration occurs, effective stimulation may be regained through programming adjustments instead of surgical repositioning. The need for frequent programming or the inability to control dystonic symptoms may indicate lead migration. Consider assessing system performance and potential modifications to the therapeutic settings (neurostimulator settings and/or electrode configurations). These factors should be considered in the establishment of long-term care and follow-up schedules for individuals who receive an Activa System at an early age.

Important Patient Counseling Information

Refer to the "Patient Counseling Information" section in the *Soletra Neurostimulator Physician and Hospital Staff Manual* for general patient counseling information for deep brain stimulation therapies. Activa Dystonia Therapy is an active therapy that requires both physician and patient involvement to be successful. Ensure the patient understands this will be a long-term relationship between physician, medical staff, patient, and family. Show the patient and family the device before implant. This may be particularly useful when dealing with children. After the Activa System is implanted, advise the patient or caregiver to read the Activa Therapy patient manual for dystonia. The Activa Therapy patient manual for dystonia is included in the envelope in the kit package.

Symptom Suppression — Dystonia patients may not experience immediate symptom suppression from the therapy. The patient should be advised that frequent, non-invasive adjustments to the stimulation parameters may be required to achieve optimal symptom suppression. This adjustment period may take weeks or months.

Rebound Effect — Patients need to be aware that dystonia symptoms may return following accidental system turn-off, battery depletion, or system failure. It is important that the physician discuss the predicted time of battery replacement with the patient and that the battery condition be closely monitored. It is also important that the patient and caregiver know how to use the control magnet in case the neurostimulator is accidentally turned off. If symptoms return, the patient should contact his or her physician immediately so the status of the system can be assessed and the condition of the patient can be monitored.

Pediatric Considerations

The following issues should be included in physician discussions with the patient and the patient's family or caregiver(s):

- Children are often engaged in active play and sports activities that could damage components of the implanted system. While some degree of rough play may be unavoidable, children should be advised to avoid games, sports and other pastimes where a strain to the lead/connector assembly or a percussive injury to system components may be likely to occur (eg, soccer, football/rugby).
- Various medical or environmental (home, occupational, and other) devices may generate enough electromagnetic interference (EMI) to change the parameters of a neurostimulator, turn a neurostimulator off and on, or cause a neurostimulator to surge, shock, or jolt the patient. Ensure the patient and parents/caregivers are clear on why EMI is a potential concern, and where information on this issue can be found in their patient manuals. EMI is addressed in the "Precautions" section, the "General Warnings" section, and the "Electromagnetic Interference" section in the "Your Activa Therapy for Dystonia" patient manual. EMI also is addressed in the precautions section of the neurostimulator physician manual.

Medtronic

Activa® Dystonia Therapy Kit

3307
3309

For Deep Brain Stimulation

Humanitarian Device: Authorized by Federal Law as an aid in the management of chronic, intractable (drug refractory) primary dystonia, including generalized and segmental dystonia, hemidystonia, and cervical dystonia (torticollis), for individuals 7 years of age and older. The effectiveness of the devices in this kit for treating these conditions has not been demonstrated.

Technical manual

Rx Only

Activa® Dystonia Therapy Kit Technical Manual

Model 3307 Kit

Includes:

- Model 3387 DBS™ Lead
- Model 7426 Soletra™ Neurostimulator
- Model 7482 DBS™ Extension
- Model 7452 Control Magnet

Model 3309 Kit

Includes:

- Model 3389 DBS™ Lead
- Model 7426 Soletra™ Neurostimulator
- Model 7482 DBS™ Extension
- Model 7452 Control Magnet

Table of contents

Overview of Manual

This manual provides dystonia-specific information about the Activa System. The manual is to be used in conjunction with the technical manuals packaged with each component in this kit.

Kit Description

The Activa Dystonia Therapy Kit includes a Soletra Model 7426 Neurostimulator, a Model 7482 DBS Extension, a Model 7452 Control Magnet, and either a Model 3387 or Model 3389 DBS Lead.

The lead, extension, and neurostimulator are the implantable components of a programmable system called the Medtronic Activa System. Electrical signals are transmitted from the neurostimulator to targets in the brain via the extension and lead. The control magnet allows the patient to turn the neurostimulator on and off.

Associated Products

The following products are used in conjunction with the Activa Dystonia Therapy Kit but are not included in the kit.

The Model 3625 Test Stimulator is designed to provide output characteristics similar to Medtronic Neurological Stimulation Systems (amplitude, pulse width, and rate). The test stimulator enables the physician to evaluate the efficacy of neurostimulation for the patient, particularly in relation to lead position, during intraoperative testing.

The Model 8840 N'Vision Clinician Programmer and the Model 7432 Clinician Programmer are designed for use by a physician to noninvasively program Medtronic neurostimulators.

The Model 8870 Application Card is a plug-in card designed to control the specific functions of the Model 8840 Clinician Programmer. It contains the necessary software to program the Soletra Neurostimulator.

The Model 7460 MemoryMod Software Cartridge is a plug-in cartridge designed to control the specific functions of the Model 7432 Clinician Programmer. It contains the necessary software to program the Soletra Neurostimulator.

There are two lead frame kits designed to temporarily hold the lead in place during target localization and insertion cannula removal. Model 3353 Lead Frame Kit is intended for use with a Radionics stereotactic frame, while Model 3354 Lead Frame Kit is intended for use with a Leksell stereotactic frame.

The Access Review Model 7438 Therapy Controller is designed for use by a patient or caregiver. Using the therapy controller, the patient or caregiver can turn the therapy on or off, check whether the therapy is on or off, and check the condition of the neurostimulator's battery.

Indications

Unilateral or bilateral stimulation of the internal globus pallidus (GPi) or the subthalamic nucleus (STN) by the Medtronic Activa System is indicated as an aid in the management of chronic, intractable (drug refractory) primary dystonia, including generalized and segmental dystonia, hemidystonia, and cervical dystonia (torticollis), for individuals 7 years of age and older.

Contraindications

Implantation of an Activa Brain Stimulation System is contraindicated for:

- Patients exposed to diathermy. Do not use shortwave diathermy, microwave diathermy or therapeutic ultrasound diathermy (all now referred to as diathermy) on patients implanted with a neurostimulation system. Energy from diathermy can be transferred through the implanted system and can cause tissue damage at the location of the implanted electrodes, resulting in severe injury or death.

  Diathermy is further prohibited because it can also damage the neurostimulation system components resulting in loss of therapy, requiring additional surgery for system explantation and replacement. Injury or damage can occur during diathermy treatment whether the neurostimulation system is turned "on" or "off." Advise your patients to inform all their health care professionals that they should not be exposed to diathermy treatment.
- Patients who will be exposed to Magnetic Resonance Imaging (MRI) using a full body radio-frequency (RF) coil or a head transmit coil that extends over the chest area. Refer to "Appendix: MRI and Activa Therapy" in the *Soletra Neurostimulator Physician and Hospital Staff Manual* for comprehensive safety information.
- Patients who are unable to properly operate the brain stimulator.

Warnings

Refer to the "Warnings" sections in the component technical manuals packaged in this kit.

Precautions

Refer to the "Precautions" sections in the component technical manuals packaged in this kit.

Rebound Effect – Inform patients and their caregivers that abrupt cessation of stimulation for any reason may cause a return of disease symptoms. In some cases, symptoms may return with an intensity greater than was experienced prior to system implant (rebound effect).

Adverse Events

Reported Adverse Events

Thirty-four manuscripts on published studies to date were reviewed. The studies described consist of non-randomized, non-blinded trials involving a total of 201 patients. Literature described the following adverse events:

- Hemiplegia/hemiparesis
- Worsening of motor impairment
  - Dysphagia
- Speech/language
- Subcutaneous hemorrhage/seroma
- Cerebral spinal fluid abnormality
- General[a]
  - Infection
  - Erosion
  - Lead fractures
  - Hardware breakage
  - Neurostimulator failure
- Déjà vu corrected by surgically revised lead placement
- Irritating cough with stimulation ON

[a] Includes adverse events related to the system components.

Potential Adverse Effects

Additionally, one may reasonably expect the risks associated with the use of the Activa System for the approved indications of Parkinson's disease (PD) and Essential Tremor (ET) to be similar in treating dystonia. As described in the summary of safety and effectiveness data for a supplemental premarket approval application for bilateral stimulation of the internal globus pallidus (GPi) or the subthalamic nucleus (STN) using Medtronic Activa Parkinson's Control Therapy indicated for adjunctive therapy in reducing some of the symptoms of advanced, levodopa-responsive Parkinson's disease that are not adequately controlled with medication (P960009S007), a description of adverse events that may also be applicable for use with dystonia is provided from a prospective open label design study.

Over the entire study duration, 12/160 patients (7.5%) had intracranial hemorrhage; 17/160 patients (10.6%) had device-related infection; 16 patients (10.0%) had paresis/asthenia; and 13/160 patients (8.1%) had hemiplegia/hemiparesis. The rate of stimulation-related adverse events was 51.9% (83/160 patients) and the rate of ongoing stimulation-related events was 22.5% (36/160 patients). The rate of serious stimulation-related adverse events was 9.4% (15/160)

and the rate of ongoing serious stimulation-related adverse events was 3.1% (5/160) patients. Ongoing serious stimulation-related adverse events included: worsening of motor impairment/PD symptoms (dyskinesia); sensory impairment (pain); and speech/language (dysarthria, hypophonia, speech disorder). Other stimulation related adverse events included: worsening of motor impairment/PD symptoms (worse motor fluctuations, incoordination, abnormal gait, akinesia/bradykinesia, tremor, rigidity, myoclonus and dysphagia); sensory impairment (paresthesia, sensory disturbance, hypesthesia, hearing [tinnitus] and headache); speech/language (voice alteration); eye (visual disturbances [diplopia, abnormal vision and visual field defect] and eye disorders [twitching]); cognitive (thinking abnormal, confusion, alteration of mentation [dizziness]); general (respiratory [laryngismus], musculoskeletal [abnormal posture], gastrointestinal [vomiting], urogenital [urinaryincontinence], metabolic/nutritional [weight loss], skin and appendages [sweating] and systemic [accidental injury]; sleep [somnolence and insomnia]; neuropsychological (psychiatric disturbances [manic reaction and neurosis]); general paresis/asthenia; internal system events (shock/jolt, positioning difficulties); cardiovascular (cerebrovascular accident); hemiplegia/hemiparesis (asthenia) and depression.

The rate of device-related adverse events was 36.9% (59/160 patients) and the rate of ongoing device-related events was 10.0% (16/160 patients). The rate of serious device-related adverse events was 17.5% (28/160 patients) and the rate of ongoing serious device-related adverse events was 6.3% (10/160 patients). Ongoing, serious device-related adverse events included: internal DBS system events (intermittent continuity, electromagnetic interference, and lead breakage); infection, worsening of motor impairment/PD symptoms (worse motor fluctuations, and incoordination) due to loss of effect; and skin and appendages (erosion). Other device-related adverse events included: internal DBS system events (shock/jolt, dislodged, migration, normal battery failure, malfunction, current leak, wire breakage, kinked electrode, electrode problem, positioning difficulties, impedance low); external system events (difficult to program, printer problem); sensory impairment (pain, sensory disturbance, paresthesia and headache); speech/language (hypophonia); skin and appendages (skin disorder); subcutaneous hemorrhage/seroma (seroma); paresis/asthenia; metabolic/nutritional (edema); and cerebral spinal fluid abnormality pneumocaphalus). One patient experienced manic symptoms (manic reaction) and attention and cognitive deficits (thinking abnormal) concurrent with exposure to an electronic article surveillance (electromagnetic interference) device.

Table 1. *Summary of Adverse Events Reported in the Parkinson's Disease Clinical Trial*

Major Category	All Patients (n = 160)			
	# of Events (known serious)	Study Related	# (%) of Patients	95% CI**
Intracranial Hemorrhage*	13 (8)	13	12 (7.5%)	(3.4, 11.6)
Device-Related Infection*	32 (23)	31	17 (10.6%)	(5.9, 15.4)
Infection with Explant*	15 (15)	15	9 (5.6%)	(2.1, 9.2)
Infection without Explant*	17 (8)	16	12 (7.5%)	(3.4, 11.6)
Paresis/Asthenia*	16 (1)	6	16 (10%)	(5.4, 14.7)
Hemiplegia/Hemiparesis*	15 (8)	10	13 (8.1%)	(3.9, 12.4)
Worsening of Motor Impairment/ PD Symptom*	357 (48)	130	110 (68.8%)	(61.6, 75.9)
Dyskinesia*	131 (22)	64	60 (37.5%)	(30.0, 45.0)
Worse Motor Fluctuations*	85 (15)	23	56 (35%)	(27.6, 42.4)
Abnormal Gait*	38 (4)	10	30 (18.8%)	(12.7, 24.8)
Incoordination*	33 (3)	14	29 (18.1%)	(12.2, 24.1)
Tremor*	22 (0)	4	18 (11.3%)	(6.4, 16.2)
Akinesia/Bradykinesia*	20 (0)	9	19 (11.9%)	(6.9, 16.9)
Dysphagia*	13 (3)	2	12 (7.5%)	(3.4, 11.6)
Rigidity*	13 (1)	3	12 (7.5%)	(3.4, 11.6)
Myoclonus	1 (0)	1	1 (0.6%)	(0, 1.9)
Therapeutic Response, Decreased	1 (0)	0	1 (0.6%)	(0, 1.9)
Sensory Impairment*	148 (14)	59	79 (49.4%)	(41.6, 57.1)
Pain*	71 (5)	15	50 (31.3%)	(24.1, 38.4)
Paresthesia*	37 (1)	23	29 (18.1%)	(12.2, 24.1)
Sensory Disturbance*	18 (2)	11	16 (10%)	(5.4, 14.7)
Headache*	16 (4)	8	14 (8.8%)	(4.4, 13.1)
Neuralgia	3 (2)	0	3 (1.9%)	(0, 4.0)
Hearing*	2 (0)	1	2 (1.3%)	(0, 3.0)
Neuropathy	1 (0)	1	1 (0.6%)	(0, 1.9)
Cognitive*	142 (21)	61	72 (45%)	(37.3, 52.7)
Confusion*	56 (5)	27	44 (27.5%)	(20.6, 34.4)
Thinking Abnormal*	39 (3)	16	33 (20.6%)	(14.4, 26.9)
Hallucinations	15 (2)	1	11 (6.9%)	(3.0, 10.8)
Alteration of Mentation*	16 (5)	9	14 (8.8%)	(4.4, 13.1)
Amnesia*	9 (2)	6	8 (5.0%)	(1.6, 8.4)
Delusions*	5 (4)	0	4 (2.5%)	(0, 4.9)
Dementia	2 (0)	2	2 (1.3%)	(0, 3.0)

* At least one instance was associated with the system components.

** Note: Exact 95% confidence intervals were used when the # (%) of patients was 0 (0%) because the normal approximation to the binomial does not provide a confidence interval. In every other case, the normal approximation to the binomial was used to calculate confidence intervals.

Table 1. *Summary of Adverse Events Reported in the Parkinson's Disease Clinical Trial (continued)*

Major Category	All Patients (n = 160)			
	# of Events (known serious)	Study Related	# (%) of Patients	95% CI**
DBS System*	93 (33)	80	57 (35.6%)	(28.2, 43.1)
Internal*	86 (33)	74	55 (34.4%)	(27.0, 41.7)
External*	7 (0)	6	6 (3.8%)	(0.8, 6.7)
Speech/Language*	77 (15)	48	59 (36.9%)	(29.4, 44.4)
Dysarthria*	47 (6)	32	42 (26.3%)	(19.4, 33.1)
Speech/Language*	30 (9)	16	23 (14.4%)	(8.9, 19.8)
Neuropsychological*	55 (18)	6	31 (19.4%)	(13.3, 26.0)
Psychiatric Disturbances*	25 (8)	4	14 (8.8%)	(4.4, 13.1)
Personality Disorder	12 (4)	1	9 (5.6%)	(2.1, 9.2)
Hostility	6 (2)	0	5 (3.1%)	(0.4, 5.8)
Manic Reaction*	5 (2)	2	3 (1.9%)	(0, 4.0)
Neurosis*	1 (0)	1	1 (0.6%)	(0, 1.9)
Paranoid Reaction	1 (0)	0	1 (0.6%)	(0, 1.9)
Anxiety*	25 (7)	2	20 (12.5%)	(7.4, 17.6)
Apathy	4 (2)	0	4 (2.5%)	(0, 4.9)
Suicide Attempt	1 (1)	0	1 (0.6%)	(0, 1.9)
Depression*	41 (10)	4	35 (21.9%)	(15.5, 28.3)
Sleep*	45 (1)	8	37 (23.1%)	(16.6, 29.7)
Eye*	48 (6)	25	39 (24.4%)	(17.7, 31.0)
Visual Disturbance*	33 (6)	20	30 (18.8%)	(12.7, 24.8)
Eye Disorder*	10 (0)	5	9 (5.6%)	(2.1, 9.2)
Eye Infection*	5 (0)	0	4 (2.5%)	(0, 4.9)
Subcutaneous Hemorrhage/Seroma*	15 (6)	10	14 (8.8%)	(4.4, 13.1)
Convulsions	7 (6)	5	7 (4.4%)	(1.2, 7.5)
Death	3 (3)	0	3 (1.9%)	(0, 4.0)
Cerebral Spinal Fluid Abnormality	5 (1)	5	5 (3.1%)	(0.4, 5.8)

* At least one instance was associated with the system components.

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Table 1. Summary of Adverse Events Reported in the Parkinson's Disease Clinical Trial (continued)

Major Category	All Patients (n = 160)			
	# of Events (known serious)	Study Related Known/Unknown	# (%) of Patients	95% CI**
General*	312 (52)	40	110 (68.8%)	(61.6, 75.9)
Systemic*	75 (14)	7	49 (30.6%)	(23.5, 37.8)
Gastrointestinal*	55 (5)	9	41 (25.6%)	(18.9, 32.4)
Urogenital*	53 (7)	3	43 (26.9%)	(20.0, 33.7)
Respiratory	43 (10)	8	30 (18.8%)	(12.7, 24.8)
Metabolic/Nutritional*	36 (4)	6	29 (18.1%)	(12.2, 24.1)
Musculo-Skeletal*	21 (7)	2	19 (11.9%)	(6.9, 16.9)
Skin and Appendages*	25 (5)	5	22 (13.8%)	(8.4, 19.1)
Ecchymosis	1 (0)	0	1 (0.6)	(0, 1.9)
Erosion*	3 (3)	2	3 (1.9%)	(0, 4.0)
Infection, fungal	2 (0)	0	2 (1.3%)	(0, 3.0)
Lymphedema	1 (0)	0	1 (0.6%)	(0, 1.9)
Petechia	1 (0)	0	1 (0.6%)	(0, 1.9)
Psoriasis	1 (1)	0	1 (0.6%)	(0, 1.9)
Rash	7 (0)	0	7 (4.4%)	(1.2, 7.5)
Skin Disorder*	6 (1)	2	6 (3.8%)	(0.8, 6.7)
Sweating*	3 (0)	1	3 (1.9%)	(0, 4.0)
Ear	4 (0)	0	4 (2.5%)	(0, 4.9)
Cardiovascular*	64 (14)	24	32 (20%)	(13.8, 26.2)

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Individualization of Treatment

Best results are achieved when the patient and caregiver are fully informed about the therapy risks and benefits, surgical procedures, follow-up requirements, and self-care responsibilities. Activa Dystonia Therapy is appropriate for patients who meet the following criteria:

- Patients with chronic, intractable (drug refractory) primary dystonia, including generalized and segmental dystonia, hemidystonia, and cervical dystonia (torticollis), for individuals 7 years of age and older.
- Patients should be suitable candidates for stereotactic neurosurgery.

Use extreme care with lead implantation in patients with a heightened risk of intracranial hemorrhage. Physicians should consider underlying factors, such as previous neurological injury or prescribed medications (anticoagulants), that may predispose a patient to the risk of bleeding.

Physicians should be aware that the risks associated with initial surgery may increase with clinical conditions such as:

- Stroke or neurological disorders other than idiopathic Parkinson's disease
- Cardiovascular disease
- Renal or hepatic failure
- Diabetes mellitus

To help ensure maximum benefits from the neurostimulation system, long-term, post-surgical management of patients is recommended.

Stimulation parameters should be adjusted such that maximal symptom suppression is achieved with minimal side effects. High parameter values may indicate a system problem or less than optimal lead placement. Patients should be informed of the risks of higher stimulation parameters, which may result in possible excessive charge density, as noted in the "Programming the Neurostimulator" section of the *Model 3387/3389 DBS Lead Implant Manual.*

Special Considerations for Pediatric Patients

Dual System Implant – If two neurostimulators are implanted, they should be implanted at least 8 inches apart to minimize cross-programming interference. In smaller patients consider placing one neurostimulator in the abdomen and one in the chest region. In this case, route both lead/extension assemblies and implant both neurostimulators on the same side of the body to minimize potential electromagnetic interference. A 95-cm extension is recommended to connect the lead to the abdominal neurostimulator. Verify final programmed parameters by reviewing both devices at the conclusion of any programming session.

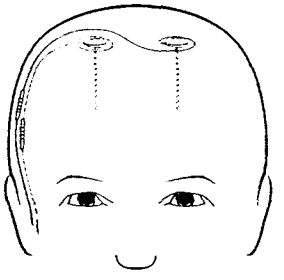

Figure 1. *Lead/extension assembly routing with a dual system implant.*

Patient growth and lead/extension length – Evaluate the patient's implanted lead/extension assembly for sufficient strain relief (eg, consider patient comfort, range of motion, x-ray visualization of the extension) at regular post-implant follow-up sessions. This monitoring is especially important for patients whose growth is not complete at implant. Consideration should be given to replacement of the extension with one of greater length during other elective surgery procedures, such as during the regular changeout of neurostimulators that must occur because of battery depletion.

Patient brain growth and lead migration – Medtronic recommends the use of Activa Therapy for individuals in whom brain growth is approximately 90% complete.[1] In cases where growth of the brain and/or skull is not complete at time of implant, the distance from the lead anchor point (burr hole) to the target site increases with time and growth of the individual. As a result, lead migration relative to the target site may occur.

If significant patient growth and potential resultant lead migration are anticipated, consider positioning lead electrodes as follows at the time of initial lead placement: Position the lead so that the center bipole electrodes (eg, electrodes 1 and 2) will be active. If lead migration occurs, effective stimulation may be regained through programming adjustments instead of surgical repositioning.

The need for frequent programming or the inability to control dystonic symptoms may indicate lead migration. Consider assessing system performance and potential modifications to the therapeutic settings (neurostimulator settings and/or electrode configurations). These factors should be considered in the establishment of long-term care and follow-up schedules for individuals who receive an Activa System at an early age.

Important Patient Counseling Information

Refer to the "Patient Counseling Information" section in the *Soletra Neurostimulator Physician and Hospital Staff Manual* for general patient counseling information for deep brain stimulation therapies.

Activa Dystonia Therapy is an active therapy that requires both physician and patient involvement to be successful. Ensure the patient understands this will be a long-term relationship between physician, medical staff, patient, and family.

Show the patient and family the device before implant. This may be particularly useful when dealing with children.

After the Activa System is implanted, advise the patient or caregiver to read the Activa Therapy patient manual **for dystonia.** The Activa Therapy patient manual for dystonia is included in the envelope in the kit package.

[1] At birth, the brain is 25% of adult size. By age 1 year, the brain has completed half its postnatal growth and is 75% of adult size. By age 3 years, it reaches 80% of adult size, and by age 7 years, it is 90% (*The Merck Manual of Diagnosis and Therapy.* 17th ed. Merck & Co., Inc.;1999: Section 19; Pediatrics).

Symptom Suppression

Dystonia patients may not experience immediate symptom suppression from the therapy. The patient should be advised that frequent, non-invasive adjustments to the stimulation parameters may be required to achieve optimal symptom suppression. This adjustment period may take weeks or months.

Rebound Effect

Patients need to be aware that dystonia symptoms may return following accidental system turn-off, battery depletion, or system failure. It is important that the physician discuss the predicted time of battery replacement with the patient and that the battery condition be closely monitored. It is also important that the patient and caregiver know how to use the control magnet in case the neurostimulator is accidentally turned off. If symptoms return, the patient should contact his or her physician immediately so the status of the system can be assessed and the condition of the patient can be monitored.

Pediatric Considerations

The following issues should be included in physician discussions with the patient and the patient's family or caregiver(s):

- Children are often engaged in active play and sports activities that could damage components of the implanted system. While some degree of rough play may be unavoidable, children should be advised to avoid games, sports and other pastimes where a strain to the lead/connector assembly or a percussive injury to system components may be likely to occur (eg, soccer, football/rugby).
- Various medical or environmental (home, occupational, and other) devices may generate enough electromagnetic interference (EMI) to change the parameters of a neurostimulator, turn a neurostimulator off and on, or cause a neurostimulator to surge, shock, or jolt the patient. Ensure the patient and parents/caregivers are clear on why EMI is a potential concern, and where information on this issue can be found in their patient manuals. EMI is addressed in the "Precautions" section, the "General Warnings" section, and the "Electromagnetic Interference" section in the "Your Activa Therapy for Dystonia" patient manual. EMI also is addressed in the precautions section of the neurostimulator physician manual.

Directions for Use

Refer to the "Directions for Use" sections in the component technical manuals packaged in this kit.

Dystonia Rating Scales

There are three rating scales that physicians use for evaluating dystonia symptoms:

Burke-Fahn-Marsden Rating Scale (BFMRS) – Kumar R, Dagher A, Hutchison WD, Lan AE, Lozano AM. Globus pallidus deep brain stimulation for generalized dystonia: clinical and PEt investigation. *Neurology* 1999; 53:871-874.

Unified Dystonia Rating Scale (UDRS) – Comella CL, Leurgans S, Chmura TA and Dystonia Study Group. The Unified Dystonia Rating Scale: initial concurrent validity testing with other dystonia scales. *Neurology* 1999; 52(Suppl 2):S46.002.

Toronto Western Spasmodic Torticollis Rating Scale (TWSTRS) – Krauss JK, Pohl T, Weber S, Ozdoba C, Burgunder JM. Bilateral stimulation of globus pallidus internus for the treatment of cervical dystonia. *Lancet* 1999; 354:837-838.

Clinical Studies

Summary

The effectiveness of the Activa System in treating dystonia has not been demonstrated in controlled clinical trials. Assessment of probable benefit from 3 publications describing more than 10 patients shows the following: Coubes et al (2002a) reported 19 patients with generalized dystonia positive for the DYT1 mutation, with a clinical score improvement of 71% and functional score improvement of 63% following one year of therapy; improvement is defined as the percent decrease between pre-implant and post-implant motor assessment scores (Burke-Fahn-Marsden Dystonia Rating Scale [BFM]). Vidailhet et al (2002) reported upon 14 primary generalized dystonia patients (with at least 6 months follow-up) treated with bilateral stimulation. Clinical scores were 56 ± 21 pre-operatively and 26 ± 16 post-operatively (BFM). Broggi et al (2002) reported upon 10 primary dystonia patients. Eight of the 10 patients observed clinical improvement evaluated by BFM, ranging between 27% and 88% (up to 6 months follow-up); improvement is defined as the percent decrease between pre-implant and post-implant motor assessment scores.

Deep Brain Stimulation Therapy in Children & Adolescents

Eight manuscripts discuss specific outcomes in pediatric populations. In the largest series, Coubes et al (2002a,b) treated dystonic children (≤12 years, N=20) and adolescents (13 to 17 years, N=14) with deep brain stimulation therapy. Clinical scores (BFM) in patients with generalized dystonia positive for the DYT1 mutation were 61 ± 23 pre-operatively and 21 ± 21 post-operatively (at 3 months), 11 ± 11 post-operatively (at 6 months), and 14 ± 17 post-operatively (at 12 months).

Additional Clinical Studies Data

The following information further describes the documented clinical studies and case reports on dystonia patients summarized above that were not sponsored by Medtronic.

A literature review was conducted on 40 total abstracts and manuscripts pertaining to the treatment of dystonia with Deep Brain Stimulation (DBS). There were 34 literature sources that discussed specific case studies and outcomes. These manuscripts are summarized in Tables 1, 2, 3, 4 and 5.

There were an additional 5 manuscripts that included general information related to DBS for dystonia. These manuscripts are summarized in Table 6. Although Vayssiere et al., 2002 does mention 35 patient uses of DBS for dystonia, it is unclear whether or not some of these patients are already discussed in individual case studies summarized in Tables 1, 2, 3, 4 and 5. Therefore, the 35 patients referenced in this manuscript were not included in the patient data summary (Tables 1, 2, 3, 4 and 5).

There were 201 patients represented in the 34 manuscripts discussing specific case studies and outcomes. Four patients experienced multiple surgeries. The age at the time of first surgery was the age used in this analysis. The mean age at time of first surgery was approximately 31.8 years (range: 6 to 78 years). There were ages available on 146 of the 201 patients as shown in Table 1.

Table 1. Age

N	Mean	Minimum	Maximum
146	31.8	6	78

The type of dystonia experienced in these patients was primarily generalized dystonia (65.2%) as shown in Table 2. There were 34 patients where the type of dystonia was unspecified.

Table 2. Type of Dystonia

Type of Dystonia	N	Percent (n=201)
Generalized	131	65.2%
Cervical	17	8.5%
Hemidystonia	5	2.5%
Multifocal	3	1.5%
Segmental	8	4.0%
Cervical (and truncal)	1	0.5%
Focal	1	0.5%
Dystonic Tremor	1	0.5%
Unspecified	34	16.9%

The follow-up experience in this literature totaled 2313.7 months (range: 0.7 to 132 months; average: 12.1 months). Follow-up experience data was available on 191 of the 205 patient uses as shown in Table 3.

Table 3. Follow-up Experience in Months

N	Total (sum)	Mean	Minimum	Maximum
191	2313.7	12.1	0.7	132

The stimulation target was primarily the globus pallidus internus (bilateral GPi 71.2%, unilateral GPi 6.8%) as shown in Table 4.

Table 4. *Stimulation Target*

Stimulation Target	N	Percent (n=205)
GPi, bilateral	146	71.2%
GPi, unilateral	14	6.8%
GPi, unspecified	8	3.9%
pallidal, bilateral	1	0.5%
pallidal, unspecified	5	2.4%
STN, bilateral	15	7.3%
VLp, bilateral posterior	7	3.4%
VLp, unilateral posterior	6	2.9%
Vim, unilateral	1	0.5%
internal capsule-thalamic interphases, bilateral	1	0.5%
VPL thalamic nucleus, unilateral	1	0.5%

Table 5 provides a summarization of the patient data from the literature review. The definitions and codes used in the table are as follows:

- C = Cervical Dystonia
- F = Focal Dystonia
- G = Generalized Dystonia
- H = Hemidystonia
- DT = Dystonic Tremor
- M = Multifocal
- S = Segmental
- T = Truncal
- U = Unknown
- P = Pediatric
- A = Adult
- AIMS = Abnormal Involuntary Movement Scale
- BFM = Burke Fahn Marsden Rating Scale
- BFMDRS = Burke Fahn Marsden Dystonia Rating Scale
- BMFDRS = Burke-Marsden-Fahn's Dystonia Rating Scale
- FM = (Fahn-Marsden) disability
- FM Dystonia = Fahn Marsden Dystonia Scale
- GMFCS = Gross Motor Functional Classification System for Cerebral Palsy
- GMFM = Gross Motor Function Measure
- GS = Global Severity
- TWSTRS = Toronto Western Spasmodic Torticollis Rating Scale
- UDRS = Unified Dystonia Rating Scale
- VAS = Visual Analog Scale
- VLp = ventrolateral thalamic nucleus
- VPL =ventro posterolateral nucleus of the thalamus

***Table 5.** Patient Data Summarization Table*
(listed alphabetically by stimulation target)

Reference	Type	N	Ped / Adult	Target Site	Outcome	Follow-Up
Andaluz et al., 2001	C&T	1	A	GPi, bilateral	Patient and family reported 80% - 90% subjective symptom improvement at 8 mos. TWSTRS: change from 32 to 16 Complete resolution of dystonic neck tremor and rare occurrence of upper limb dystonia reported.	8 mos
Angelini et al., 2000	G	1	P	GPi, bilateral	Patient able to talk (with mild dysarthria) and capable of autonomous walking and eating.	7 mos
Berezai et al., 2002	S(3) G(1) C(2)	6	A	GPi, bilateral	One day to 2 weeks after surgery, all except one patient (patient 3) experienced a major improvement in motor symptoms. Reduction in BFM movement score at 3 months ranged from 53.7% to 87.9% with a mean reduction of 72.5%. Reduction in the Tsur score for cervical dystonia at 3 months ranged from 0-92.3% with a mean reduction of 45%. Surgery-related adverse events included transient 4-day-long brachiofacial hemiparesis in two patients, presumably due to local edema impinging on the internal capsula and seroma with subsequent infection of the subclavicular pocket in one patient, requiring temporary removal of the generator. Two patients had persistent speech problems.	3 mos in 3 patients 12 mos in 3 patients

Table 5. Patient Data Summarization Table (Continued)
(listed alphabetically by stimulation target)

Reference	Type	N	Ped / Adult	Target Site	Outcome	Follow-Up
Broggi et al., 2002	G(6) S(3) H(1)	10	P & A	GPi, bilateral (9) unilateral (1)	BFMDRS: 8 patients showed an improvement that ranged between 27% and 88%. The improvement was progressive over a period of 3 to 6 months after surgery and persisted during the follow-up. One patient with hemidystonia did not show any clinical change. One patient had to have electrodes removed for a soft tissue infection one week after implantation. Periopertive complications were limited to the one infection. No remarkable side effects observed, even in childhood. Pharmacological treatment for dystonia was completely withdrawn in all cases.	Ranges from 2 to 33 mos

Table 5. *Patient Data Summarization Table (Continued)*
(listed alphabetically by stimulation target)

Reference	Type	N	Ped / Adult	Target Site	Outcome	Follow-Up
Coubes et al., 2002 (*Mov Disord* 2002a, *Arch Pediatr* 2002b)	G	65	P & A	GPi, bilateral	**Group 1:** 19 patients with the DYT1 mutation (mean age 19.5 yr). BMFDRS after one year: Clinical score improved by 71%, functional score by 63% and postural score by 81.1±31.8%. **Group 2:** 3 patients with the PKAN mutation (mean age 15.3 yr). BMFDRS after one year: Clinical score improved by 54% and functional score by 32%. **Group 3:** 26 patients with primary generalized dystonia of unknown etiology (mean age 21.6 yr). BMFDRS after one year: Clinical score improved by 74%, functional score by 49% and postural score by 91.5±19.6%. **Group 4:** 17 patients with secondary dystonia (mean age 31.4 yr). BMFDRS after one year: Clinical score improved by 44%. Stimulation efficiency did not decrease with time (maximal follow-up: 5 months). During the following years, the clinical improvement for several patients was completed. Delayed infection occurred in three cases and there were two lead fractures. No hemorrhages were reported. No specific complications were observed in the pediatric group (quality of life, cognitive, growth and puberty, tolerance if IPG).	Ranges from 6 mos to 5 yrs

Table 5. *Patient Data Summarization Table (Continued)*
(listed alphabetically by stimulation target)

Reference	Type	N	Ped / Adult	Target Site	Outcome	Follow-Up
Filipovic et al., 2002	G	2	P & A	GPi, bilateral	Both patients exhibited clinical improvement one month after surgery. Data demonstrate the beneficial effect of bilateral GPi DBS in re-establishing some aspects of the normal thalamic functions that are thought to be under basal ganglia control. Data also suggest that distinctive subtypes of generalized dystonia may react differently to DBS.	U
Gill et al., 2001	G	1	P	GPi, bilateral	Sustained improvement in movement disorder (dystonic quadriplegic cerebral palsy with hyperkinesias) with disappearance of hyperkinetic elements and modest improvement in dystonia. GMFM: lying and rolling - change from 21/51 to 20/51 sitting - change from 10/60 to 6/60 total score - change from 31/101 to 26/101 GMFCS: no change	U
Krauss et al., 2002 *(Mov Disord)*	G	2	A	GPi, bilateral	Both patients suffered from non DYT1 generalized dystonia Both patients improved 70% to 80% in both the UDRS and BFM scores. In both patients, medication for treatment of the dystonia was stopped postoperatively. There were no intraoperative or postoperative adverse events.	24 mos

Table 5. *Patient Data Summarization Table (Continued)*
(listed alphabetically by stimulation target)

Reference	Type	N	Ped / Adult	Target Site	Outcome	Follow-Up
Krauss et al., 2002 (*J Neurol Neurosurg Psychiatry*)	C	5	A	GPi, bilateral	All subscores of the TWSTRS assessment were improved substantially by 3 months after surgery. Total severity score improved by 38% at 3 months and 63% at 20 months. Total disability improved by 54% at 3 months and 69% at 20 months. Total pain score improved by 38% at 3 months and 50% at 20 months. One patient was completely pain free at the last follow-up but all other patients still complained of residual neck pain or tension. One patient required repositioning of one electrode. The article reports three electrode fractures, two generator replacements, and one infection that was treated with antibiotics. Two electrode fractures and a generator battery depletion in one patient led to exacerbations of chronic cervical dystonia. After replacement of non-functioning hardware, clinical improvement was noted to occur. Mild dysphagia and difficulty in speaking was reported and was eliminated by adjusting stimulation parameters.	20 mos (mean follow-up)

Table 5. Patient Data Summarization Table (Continued)
(listed alphabetically by stimulation target)

Reference	Type	N	Ped / Adult	Target Site	Outcome	Follow-Up
Kulisevsky et al., 2000	C	2	A	GPi, bilateral	Torticollis scale: Pt 1: change from 21 to 16 (3 and 24 mos) – 21% improvement Pt 2: change from 17 to 15 to 17 (3 and 17 mos) – 7% improvement Hamilton depression score: Pt 1: change from 36 to 12 Pt 2: no data reported VAS: Pt 1: change from 84 to 20 (3 and 24 mos) – 64% improvement Pt 2: change from 77 to 24 to 22 (3 and 17 mos) – 55% improvement	Pt 1: 24 mos Pt 2: 17 mos
Kumar et al., 1999	G	1	A	GPi, bilateral	BFM: 67% improvement Hardware breakage and contralateral scalp erosion necessitated removal of the DBS system.	18 mos
Marks et al., 2002	U	12	U	GPi, bilateral (9) unilateral (3)	Clinical outcomes ranged from normalization of motor function to no discernible benefit. DYT1 and tardive dystonia patients exhibited the greatest improvement, with a mean improvement of 80% on the BFMDRS. Those with secondary dystonias associated with structural brain abnormalities on MRI tended to benefit the least.	Ranges from 1-36 mos

Table 5. *Patient Data Summarization Table (Continued)*
(listed alphabetically by stimulation target)

Reference	Type	N	Ped / Adult	Target Site	Outcome	Follow-Up
Parkin et al., 2001	C	3	A	GPi, bilateral	Pt 1: natural posture improved by 67% (at 1 day) and 83% (at 2 mos) No longer in pain at 2 months Pt 2: natural posture improved by 71% (head turn) and 50% (head tilt) (at 6 mos) Pt 3: natural head posture, tremor and jerky movements were improving (at 1 wk)	Pt 1: 6 mos Pt 2: 6 mos Pt 3: 3 mos
Raoul et al., 2002	C	4	U	GPi, bilateral	Improvement was assessed by TWSTRS: Global improvement was 78.7%. Two patients were completely pain free. One year after surgery, patients with spasmodic torticollis had improved by 60.17% in the severity score, by 78.56% in the disability score and by 94.28% in the pain score.	12 mos

Table 5. Patient Data Summarization Table (Continued)
(listed alphabetically by stimulation target)

Reference	Type	N	Ped / Adult	Target Site	Outcome	Follow-Up
Tagliati et al., 2002	G	7	P & A	GPi, bilateral	Six primary generalized dystonia patients (4 females and 2 males, age range 13 to 63). All six showed improvement of BFMDRS scores (best average improvement 57.6%, range 15% to 91%). Improvement in primary dystonia patients was progressive over time [31.7% on average at 1 month, 36.1% at 3 months, 48.5% at 6 months and 60% (4 patients) at 1 year]. Muscle spasms and dyskinetic movements showed a more rapid improvement, while resolution of dystonic postures had a slower time course and was only partial in some cases. One patient with secondary generalized dystonia (female, 18 yrs old) showed a limited improvement of BFMDRS score at 6 months (26.4%), however she subjectively enjoyed better motor control of her limbs. No major complications were reported in any of the patients included in this study. One patient required removal of both DBS systems due to infection. Both systems were replaced following antibiotic treatment without incident. One patient required replacement of a fractured extension cable.	12 mos in 4 patients 6 mos in 3 patients

Table 5. *Patient Data Summarization Table (Continued)*
(listed alphabetically by stimulation target)

Reference	Type	N	Ped / Adult	Target Site	Outcome	Follow-Up
Tronnier and Fogel, 2000	G	3	A	GPi, bilateral	Burke & Fahn Movement Scale: Pt 1: decrease from 84 to 34.5 Pt 2: decrease from 70 to 60 Pt 3: decrease from 77 to 50.5 Burke & Fahn Movement Scale: improved by average of 36% at 6 mos. Patient 3 reported episodes of déjà vu. This was corrected by surgically revised lead placement.	Pt 1: 18 mos Pt 2: 6 mos Pt 3: 6 mos
Vidailhet et al., 2002	G	14	A	GPi, bilateral	14 patients, mean age 31 BFM scale: Dystonia score was 56±21 preoperatively and 26±16 postoperatively, with a mean percentage improvement of 50%±29. Disability score was 13±16 preoperatively and 8±5 postoperatively, with a mean percentage improvement of 34%±39. No permanent adverse effects were observed. Preliminary results of this ongoing controlled trial demonstrate sustained benefit of bilateral pallidal stimulation in adult generalized primary dystonia, both on disability and dystonia severity, without adverse effects.	6 mos
Wihl et al., 2001	G	1	A	GPi, bilateral	Marked perioperative result with marked reduction of hyperkinesias, however no benefit from either acute or prolonged high-frequency stimulation, increased side effects with stimulation after implantation.	20 days

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Table 5. *Patient Data Summarization Table (Continued)*
(listed alphabetically by stimulation target)

Reference	Type	N	Ped / Adult	Target Site	Outcome	Follow-Up
Wohrle et al., 2002	S	1	A	GPi, bilateral	DBS improved the segmental dystonia without operative or stimulation-induced side effects. Medication was reduced following DBS. Preoperative BFM scores: medication on (8 mg risperidone) = 54 medication off = 67 BFM scores 1 week following implant: medication on / stim on = 28 medication on / stim off = 52 medication off / stim on = 34 medication off / stim off = 63 After adjusting stimulation parameters and reducing medication to 2 mg, further results were obtained. BFM scores 8 months following implant: medication on / stim on = 11.5 medication on / stim off = 75 medication off / stim on = 15.5 medication off / stim off = 76 Prior to surgery, there was a 19% improvement due to medication alone, and at 8 months this effect was still present in the stim on condition (25%) with the smaller dose of 2 mg risperidone, but abolished in the stim off condition (1%).	8 mos

Table 5. *Patient Data Summarization Table (Continued)*
(listed alphabetically by stimulation target)

Reference	Type	N	Ped / Adult	Target Site	Outcome	Follow-Up
Brin et al., 1998	G	2	A	GPi, unilateral	BFM motor: Pt 1: increase from 11 to 14.5 Pt 2: decrease from 51 to 25 GS: Pt 1: decrease from 4.0 to 3.0 Pt 2: decrease from 3.5 to 2.0 VAS: Pt 1: increase from 10% to 30% Pt 2: increase from 35% to 65% Patient 1 had post-op cranial CSF leak which resolved with conservative treatment.	1 mo
Islekel et al., 1999	C	1	A	GPi, unilateral	Patient was symptom free during blind testing. In post-op period, slight head rotation reappeared 3 weeks later, which was abolished with adjustment of stimulation parameters. Patient reported irritating cough during stimulation.	U
Lavano et al., 2002	G	1	A	GPi, unilateral	One month after implantation, improvement of left-sided dystonic movement disorder was observed and pain had completely disappeared. No changes in the patient's condition observed after 6 months.	6 mos
Loher et al., 2000	H	1	A	GPi, unilateral	During early postoperative period, patient free of left-sided pain and mild improvement of left-sided hemidystonia; two months after implantation, marked improvement of left-sided hemidystonia and pain free; 4 years after implantation, mild increase in residual left-sided hemidystonia.	4 yrs

Table 5. Patient Data Summarization Table (Continued)
(listed alphabetically by stimulation target)

Reference	Type	N	Ped / Adult	Target Site	Outcome	Follow-Up
Morrison et al., 1998	U	2	A	GPi, unilateral	Pt 1 improved by 19% in executive domain Pt 2 improved by 21% in attention domain All other domains (language, visual-spatial, verbal learning, verbal recall, and verbal and visual recognition memory) were within 10% of baseline for both patients.	1 mo
Caputo et al., 1998	DT	1	A	GPi, unilateral (following ipsilateral VIM stim)	FM dystonia: 52% improvement at 3 mos and 79% improvement at 6 mos FM disability: 40% improvement at 6 mos tremor scale: mild improvement	6 mos
Vitek et al., 1999	G	1	U	GPi, unilateral (following pallidotomy on contralateral side)	BFMDRS-M: decrease from 40 to 7	Approx 12 mos
Kelm et al., 2002	G (7) S (1)	8	U	GPi (unspecified)	Postoperative improvement in two subscales of the BFM was observed in 5 of the 8 patients. Disability subscale improvement ranged from 33.3% to 57.1%. Motor subscale improvement ranged from 8.1% to 70.4%. Improvement was not observed in 3 patients.	3 mos

Table 5. Patient Data Summarization Table (Continued)
(listed alphabetically by stimulation target)

Reference	Type	N	Ped / Adult	Target Site	Outcome	Follow-Up
Kulisevsky, et al., 1998	G	1	A	Pallidal, bilateral	VAS: 75% improvement AIMS: decrease from 37 to 22 Hamilton depression scale: decrease from 36 to 13 Dystonic tremor markedly improved	3 mos
Kuehn, et al, 2002	U	5	U	Pallidal, (unspecified)	The objective of this study was to investigate the influence of DBS on motor cortex excitability.	U
Krack et al., 1998	U	15	A	STN, bilateral	Off-period dystonia improved in 100% of patients and was completely suppressed in 73%. Pain decreased from 3.2 ± 0.9 to 1.1 ± 1.1 ($p < 0.001$)	6 mos
Vercueil et al., 2001	G	2	A	VLp, unilateral posterior	Global functional outcome: Pt 1: 3 Pt 2: 2	Pt 1: 6 mos Pt 2: 36 mos

Table 5. *Patient Data Summarization Table (Continued)*
(listed alphabetically by stimulation target)

Reference	Type	N	Ped / Adult	Target Site	Outcome	Follow-Up
Vercueil et al., 2001	G	5	A	VLp, bilateral posterior	% improvement in BFM MS/DS Pt 1: n/a Pt 2: 28/28 Pt 3: n/a Pt 4: 26/no improvement Pt 5: no improvement/no improvement Global functional outcome: Pt 1: 0 Pt 2: 2 Pt 3: 2 Pt 4: 1 Pt 5: 0	Pt 1: 96 mos Pt 2: 72 mos Pt 3: 132 mos Pt 4: 120 mos Pt 5: 96 mos
Vercueil et al., 2001	G	1	A	VLp, bilateral posterior followed by GPi, bilateral	% improvement in BFM MS/DS: no improvement/no improvement Global functional outcome: 0 % improvement in BFM MS/DS: 28/41 Global functional outcome: 2	36 mos 18 mos

Table 5. *Patient Data Summarization Table (Continued)*
(listed alphabetically by stimulation target)

Reference	Type	N	Ped / Adult	Target Site	Outcome	Follow-Up
Vercueil et al., 2001	G	1	A	VLp, unilateral posterior	% improvement in BFM MS/DS: no improvement/no improvement Global functional outcome: 2 (related to dystonic tremor suppression)	6 mos
				Followed by GPi, bilateral	% improvement in BFM MS/DS: 67/81 Global functional outcome: 3 Patient presented with small subdural hematoma which delayed the implantation of the final electrode.	12 mos
Vercueil et al., 2001	G	5	P & A	GPi, bilateral	% improvement in BFM MS/DS: Pt 1: not stimulated due to infection Pt 2: not stimulated, failed test stimulation, IPG not implanted Pt 3: 86/86 Pt 4: 41/43 Pt 5: 70/50 Global functional outcome: Pt 1: not stimulated due to infection Pt 2: not stimulated, failed test stimulation, IPG not implanted Pt 3: 3 Pt 4: 2 Pt 5: 3 Patient 1 experienced extracranial electrode infection due to skin erosion, leading to withdrawal of the electrodes.	Pt 3: 12 mos Pt 4: 24 mos Pt 5: 6 mos

Table 5. *Patient Data Summarization Table (Continued)*
(listed alphabetically by stimulation target)

Reference	Type	N	Ped / Adult	Target Site	Outcome	Follow-Up
Vercueil et al., 2001	H	1	A	VLp, unilateral	% improvement in BFM MS/DS: 31/no improvement Global functional outcome: 1	36 mos
Vercueil et al., 2001	M	1	A	VLp, bilateral	Global functional outcome: 2	60 mos
Vercueil et al., 2001	M	1	A	GPi, bilateral	% improvement in BFM MS/DS: 66/66 Global functional outcome: 3	6 mos
Vercueil et al., 2001	M	1	A	VLp, unilateral	% improvement in BFM MS/DS: no improvement/no improvement Global functional outcome: 0	4 mos
				Followed by GPi, bilateral	% improvement in BFM MS/DS: 3/16 Global functional outcome: 1	18 mos
Vercueil et al., 2001	H	1	A	GPi, unilateral and VLp, unilateral	% improvement in BFM MS/DS: 72/60 Global functional outcome: 3 No change after switching off VLp DBS at 12 months	12 mos
Loher et al., 2001	F	1	A	Vim, unilateral	Dystonic arm spasms decreased from 10 times per day to 2-3 times per wk, with duration decreasing from between 0.5 and 5 hrs to less than 15 min on average. VAS decreased from 10 to maximum of 5	4 yrs

Table 5. *Patient Data Summarization Table (Continued)*
(listed alphabetically by stimulation target)

Reference	Type	N	Ped / Adult	Target Site	Outcome	Follow-Up
Rosenberg and Nelson, 1986	G	1	A	Internal capsule-thalamic interphases, bilateral	Marked reduction in dystonic posturing (neck extension, lumbar lordosis, plantarflexion), decrease in spasticity in left upper extremities (other 3 extremities continued to be spastic), able to sit in chair.	U
Sellal et al., 1993	H	1	P	VPL thalamic nucleus, unilateral	Dramatic improvement in dystonic postures and movement of the right upper limb and to a lesser degree the right lower limb. Scalp lesion required system removal 8 months after implant.	8 mos

Table 6 provides a summarization of additional literature involving information related to DBS for dystonia.

Table 6. *Additional Literature Summarization Table*

Reference	Title	Summary
Benabid et al., 2001	Deep brain stimulation of the corpus luysi (subthalamic nucleus) and other targets in Parkinson's disease. Extension to new indications such as dystonia and epilepsy.	Discusses stimulation of the GPi and STN for dystonia and compares it to stimulation used to treat Parkinson's disease. Mentions that improvement in symptoms following DBS may occur sooner in Parkinson's patients than in dystonia patients. Discusses types of dystonia that may respond well to DBS.
Kumar, 2002	Methods for programming and patient management with deep brain stimulation of the globus pallidus for the treatment of advanced Parkinson's disease and dystonia.	Addresses deep brain stimulation of the GPi for the treatment of dystonia and discusses methods for programming and patient management. Concerns related to battery longevity are also discussed.
Vayssiere et al., 2002	Comparison of atlas- and magnetic resonance imaging-based stereotactic targeting of the globus pallidus internus in the performance of deep brain stimulation for treatment of dystonia.	To assess the validity of relying on atlases during stereotactic neurosurgery, the authors compared target coordinates in the GPi obtained using magnetic resonance (MR) imaging with those determined using an atlas. The targets were used in DBS for the treatment of generalized dystonia. The 35 patients referenced in this article were not included in the clinical data summary (Table 5). It is unclear whether or not some of these patients are already discussed in individual case studies included in Table 5 (see Coubes et al., 2000).

Table 6. *Additional Literature Summarization Table (Continued)*

Reference	Title	Summary
Vercueil et al., 2002	Results of deep brain stimulation for dystonia: a critical reappraisal.	Discusses previous clinical experience with DBS for dystonia. Addresses multiple stimulation targets and various types of dystonia. Supportive of the relative safety of this procedure when performed by an experienced physician.
Volkmann and Benecke, 2002	Deep brain stimulation for dystonia: patient selection and evaluation.	Discusses the different factors influencing patient selection for surgical treatment (including DBS) and describes standardized methods and the caveats for the clinical documentation of treatment results in dystonia. The importance of discussing patient expectations and individual risks and benefits are also addressed.

Appendix: References

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