Topics in
Electrical Stimulation Technology
## Table of Contents

<table>
<thead>
<tr>
<th>Page</th>
<th>Title</th>
<th>Author(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>589</td>
<td>Neurotechnology: Introducing a New Frontier for Neurological Conditions</td>
<td>Jennifer French</td>
</tr>
<tr>
<td>601</td>
<td>Diaphragm Pacing: Helping Patients Breathe</td>
<td>Mary Jo Elmo BSN, MSN, CNP</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cynthia Kaplan BSN, MSN,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Raymond P. Onders MD, FACS</td>
</tr>
<tr>
<td>613</td>
<td>Vagus Nerve Stimulation Therapy for Seizure Control</td>
<td>Shelly Kinney, RN, MSN, CCM, CNLCP</td>
</tr>
<tr>
<td>618</td>
<td>Receiving and Maintaining a Cochlear Implant: What Nurse Life Care Planners Need to Know</td>
<td>Michelle L. Hughes, PhD, CCC-A</td>
</tr>
<tr>
<td>631</td>
<td>Cochlear implants: Interview with Two Families</td>
<td>Victoria Powell, RN, CCM, LNCC,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CNLCP, CLCP, MSCC, CEASII</td>
</tr>
<tr>
<td>636</td>
<td>Deep Brain Stimulation: A Minimally Invasive Surgical Option for Movement Disorders</td>
<td>Lin Zhang MD PhD</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Laura Sperry MSN RN ANP-C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Kiarash Shahlaie MD PhD</td>
</tr>
<tr>
<td>644</td>
<td>Sacral Modulation for Bowel and Bladder Control</td>
<td>Ann Endy RN PHN LNCP-C</td>
</tr>
</tbody>
</table>

### Departments

<table>
<thead>
<tr>
<th>Page</th>
<th>Title</th>
<th>Author(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>584</td>
<td>Editor’s Note</td>
<td>Wendie A. Howland RN-BC MN CRRN CCM CNLCP LNCC</td>
</tr>
<tr>
<td>585</td>
<td>Information for Authors</td>
<td></td>
</tr>
<tr>
<td>586</td>
<td>Contributors to this Issue</td>
<td></td>
</tr>
<tr>
<td>588</td>
<td>Letters to the Editor</td>
<td></td>
</tr>
<tr>
<td>598</td>
<td>Technology Corner</td>
<td></td>
</tr>
</tbody>
</table>

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In order to make safe and effective judgments using NANDA-I nursing diagnoses it is essential that nurses refer to the definitions and defining characteristics of the diagnoses listed in this issue.
Editor’s Note

Sumer is icumen in.
http://tinyurl.com/d5z3lde

Summer is icumen in, finally, and the summer and fall conference seasons are before us. So many opportunities for learning, professional growth, networking, and a little sight-seeing along the way! If you haven’t been to an AANLCP conference lately, you have missed out not only on the fun that comes with sitting down with colleagues from all over the country, but some vitally important information that will make your plans much better and your professional life more successful. New members and those considering making the move to nurse life care planning will find a warm welcome, and will find sessions tailored to the needs of a new business in the field.

Plan for your own development. Come to Albuquerque in October, and bring a friend! You don’t have to be a member to attend and enjoy! If you act before July 15 you get the benefit of early-bird registration. The registration form and conference agenda are on pages 650 - 651.

But wait, there’s more! Those of you who have contacts in the vendor or financial/legal world can get $25 off the registration fee for each exhibitor you sign up, and $50 off for every sponsor you sign up, up to the full cost of the conference! That was enough to get me scurrying to my contacts list!

As I write this note, the product of all the hard work put in by a group of volunteers to craft a Scope and Standards of Practice for nurses doing Life Care Planning is still before the American Nurses Association. When nurse life care planning is approved as a nursing specialty, it’s one more giant step along the way on the path to having our certification recognized by an independent certifying body.

Will this affect you personally? The answer is, “It depends.” If you are ever asked about your certifications in interrogatory, deposition, or trial, you are on strong ground when you can say with confidence that the organization that sets independent standards for nursing and nursing certification has passed yours. Considerable hard work has gone into giving you, and your clients, that confidence.

Drop a line to the Journal and share your opinion. I expect we’ll be discussing it in October--at your professional meeting.

Cordially,

Wendie Howland
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The American Association of Nurse Life Care Planners promotes the unique qualities the Registered Nurse delivers to the Life Care Planning process. We support education, research, and standards related to the practice of Nurse Life Care Planning.

Photography in this issue by Linda Husted
Information for Authors

AANLCP® invites interested nurses and allied professionals to submit article queries or manuscripts that educate and inform the Nurse Life Care Planner about current clinical practice methods, professional development, and the promotion of Nurse Life Care Planning within the medical-legal community. Submitted material must be original. Manuscripts and queries may be addressed to the Editorial Committee. Authors should use the following guidelines for articles to be considered for publication. Please note capitalization of Nurse Life Care Plan, Planning, etc.

Text

Manuscript length: 1500 – 3000 words
- Use Word© format only (.doc)
- Submit only original manuscript not under consideration by other publications
- Put the title and page number in a header on each page (using the Header feature in Word)
- Set 1-inch margins
- Use Times, Times New Roman, or Arial font, 12 point
- Use double-spacing, using the Word formatting feature
- Place author name, contact information, and article title on a separate title page, so author name can be blinded for editorial review
- Use APA style (Publication Manual of the American Psychological Association)

Art, Figures, Links

All photos, figures, and artwork should be in JPG or PDF format (JPG preferred for photos). Line art should have a minimum resolution of 1000 dpi, halftone art (photos) a minimum of 300 dpi, and combination art (line/tone) a minimum of 500 dpi.

Each table, figure, photo, or art should be on a separate page, labeled to match its reference in text, with credits if needed (e.g., Table 1, Common nursing diagnoses in SCI; Figure 3, Time to endpoints by intervention, American Cancer Society, 2003)

Live links are encouraged. Please include the full URL for each.

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All accepted manuscripts are subject to editing, which may involve only minor changes of grammar, punctuation, paragraphing, etc. However, some editing may involve condensing or restructuring the narrative. Authors will be notified of extensive editing. Authors will approve the final revision for submission.

The author, not the Journal, is responsible for the views and conclusions of a published manuscript.

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All manuscripts published become the property of the Journal. Manuscripts not published will be returned to the author.

Queries may be addressed to the care of the Editor at: whowland@howlandhealthconsulting.com

Manuscript Review Process

Submitted articles are peer reviewed by Nurse Life Care Planners with diverse backgrounds in Life Care Planning, case management, rehabilitation, and the nursing profession. Acceptance is based on manuscript content, originality, suitability for the intended audience, relevance to Nurse Life Care Planning, and quality of the submitted material. If you would like to review articles for this journal, please contact the Editor.

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Contributing To this Issue

Mary Jo Elmo (”Diaphragm Pacing: Helping Patients Breathe”) is the Project Manager for Diaphragm Pacing at University Hospitals Case Medical Center. She received her MSN from Case Western Reserve University in 2003 and has since practiced as a CNP. Mary Jo is known for her work with ventilators for over 20 years and diaphragm pacing for nearly 10 years. She manages the world’s largest group of DP patients with various diagnoses including spinal cord injury and ALS. She holds certifications from the American Nurses Credentialing Center and is a member of the American Academy of Nurse Practitioners, and lectures and publishes in the US and internationally.

Cynthia Kaplan (”Diaphragm Pacing: Helping Patients Breathe”) is an advanced research/clinical nurse who has worked directly with diaphragm pacing for nearly five years. Her prior experience was in the operative setting, where she assisted in the implantation of diaphragm pacing in over 150 patients. She holds a national certification in perioperative nursing. Cynthia has co-authored multiple abstracts and has presented at national meetings.

Jennifer French (”Neurotechnology: Introducing a new frontier for neurological conditions”) is co-founder and Executive Director of a non-profit organization, Neurotech Network. She currently serves on the Advisory Boards for the FES for Cerebral Palsy project at Stanford University, the Brown University Institute for Brain Science, and the Advanced Platform Technology Center in Cleveland. Jennifer became a quadriplegic as a result of a snowboarding accident in 1998. She is an active user of Functional Electrical Stimulation (FES) systems. In November 1999, she received the Implantable Stand & Transfer System provided by the Cleveland FES Center, MetroHealth Medical Center, and Veterans Affair, and was the first woman to receive such a system.

Ann Endy (”Sacral Neuromodulation”) provides medical case management services, medical cost projections, workers’ compensation file reviews and lifetime nurse care plans. Ann has been a nurse for 25 years and has enjoyed a career in a variety of health care settings including, pediatrics, acute care, outpatient rehabilitation, research, pharmaceuticals, and public school districts. She has been a member of AANLCP since 2010. Currently, she is a member of the AANLCP 12th Annual Educational Conference vendor committee for the October 12-15th meetings in Albuquerque, New Mexico.

Shelly Kinney (”Vagus Nerve Stimulation for Seizure Control”) has over 20 years of experience in critical care and rehabilitation nursing, case management, and Life Care Planning. Through her independent consulting company, Kinney Consulting, Inc., she provides Life Care Planning services across the country and case management services in Nebraska and surrounding states. She is the chairperson of the Editorial Committee for the American Association of Nurse Life Care Planners and frequently speaks at conferences for Life Care Planners, case managers, and vocational specialists on Life Care Planning and long term needs of individuals who have experienced traumatic illness or injury.

Michelle L. Hughes (”Processes In Receiving and Maintaining A Cochlear Implant: What Life Care Planners Need To Know”) is the coordinator for the Cochlear Implant Program and Director of the Cochlear Implant Research Laboratory at Boys Town National Research Hospital, Omaha NE. She also serves as adjunct associate professor at the University of Nebraska-Lincoln, Department of Special Education and Communication Disorders.

Cynthia Kaplan (”Diaphragm Pacing: Helping Patients Breathe”) is an advanced research/clinical nurse who has worked directly with diaphragm pacing for nearly five years. Her prior experience was in the operative setting, where she assisted in the implantation of diaphragm pacing in over 150 patients. She holds a national certification in perioperative nursing. Cynthia has co-authored multiple abstracts and has presented at national meetings.

continued next page
Keith Sofka (‘‘Using Assistive Technology in a LCP: A Primer”) is a principal of Caragonne and Associates, Ajijic, Jalisco, MX. He has practiced the provision of assistive technology services for the past 30 years, consulting to hundreds of companies, schools, Government Agencies and individuals. A major focus of Mr. Sofka’s work has been to provide recommendations for and implementation of school and workplace reasonable accommodation for individuals and organizations, including housing and commercial building access, transportation, mobility and completion of daily living needs, and individual worksite modifications. He has also taken training and practiced in other areas of assistive technology including custom seating and positioning for individuals with severe orthopedic involvement. His work has always been focused on ways to use technology to increase the independence of the individual.

Raymond P. Onders (‘‘Diaphragm Pacing: Helping Patients Breathe”) is Professor of Surgery, holding the Margaret and Walter Remen Chair of Surgical Innovation at University Hospitals Case Medical Center. Over the last 12 years in Cleveland, Dr. Onders has focused his research on ways to help people breathe naturally using their own diaphragms. He has over one hundred papers, book chapters and published abstracts. His numerous honors include: The Maurice Saltzman Award, Northern Ohio Live Award of Achievement in Science and Technology, and Crain’s Cleveland Business 2008 Health Care Heroes for Advancement in Health. Dr. Onders is a co-founder of Synapse Biomedical, bringing this technology to patients.

Lin Zhang (“Deep Brain Stimulation”) is the co-Director of the Center for Neuromodulation at the University of California, Davis Medical Center in Sacramento, CA. Dr. Zhang’s clinical and research interests focus primarily on Parkinson’s disease, including its epidemiology and the association between past nutritional deficiency and current prevalence of the disease. He is testing new drugs with neuroprotective properties that may slow down the progression of Parkinson’s. He also is investigating the clinical manifestation of the disease in patients with atypical Parkinson’s disease, and those with a family history of pre-mutation for Fragile X Syndrome, a genetic disorder that typically affects children.

Victoria Powell (“First Person: Interview with Cochlear Implant Recipients”) provides legal nurse consulting, Life Care Planning, medical case management, Medicare set-aside (MSA) allocations, and medical cost projections. She has a special interest in amputation and other catastrophic injuries. She is an active member of the American Association of Legal Nurse Consultants, the American Association of Nurse Life Care Planners, the Case Management Society of America, International Academy of Rehab Professionals, and is a lifetime hall of fame recipient for her contributions to the National Nurses in Business Association. Ms. Powell provides expert witness testimony on Life Care Planning and medical cost projections. Her published works include articles in several journals, numerous chapter contributions, and she served as editor for the text Nursing Malpractice. Ms. Powell is a nationally recognized speaker and regularly presents on a variety of nursing and technology related subjects.

Kiarash Shahlaie (“Deep Brain Stimulation”) is an Assistant Professor in the Department of Neurological Surgery and the co-Director of the Center for Neuromodulation at the University of California, Davis Medical Center in Sacramento, CA. Dr. Shahlaie’s philosophy of care is to minimize the risks of surgery and facilitate rapid recovery by utilizing minimally invasive surgical techniques including endoscopy and ‘keyhole’ access surgery; to provide innovative surgical treatment options for patients with Parkinson’s disease, essential tremor, dystonia, and other movement disorders, as well as patients with certain psychiatric and pain conditions; and to closely involve the families and caretakers of patients with severe traumatic brain injury during the acute and chronic stages of recovery.

Laura Sperry (“Deep Brain Stimulation”) recently joined the Center for Neuromodulation at the University of California, Davis Medical Center in Sacramento, CA and helps to manage the Deep Brain Stimulation patients within the program. She previously worked as a nurse practitioner with the Center for Women’s Health and Continence and Pelvic Floor Center at the University of California, Davis Medical Center.
Kudos

Kudos to all who helped with the latest journal....great articles!

Judy Metekingi MS RN CRRN CDMS CCM LNCC CLCP
Draper UT

I just read the latest JNLCP (vol. XII, no. 2) in its entirety. I want to express my appreciation for this excellent, well-written journal. I thoroughly enjoyed it! The articles from coding to one handed assistive technology were pertinent and well-written. Also, the various authors and subjects were a wonderful mix. Thank you for sharing this wonderful resource! I will be sharing this with my students!

Cameron Parker, RN BSN CLCP
Cincinnati OH
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I reviewed the last 2 journals. They are quite impressive with valuable information.

Terry Schramm, RNC-OB AD CCM CLCP MSCC
East Hampton CT
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Thanks for sharing your resource. The Journal and its content are impressive and I will sit quietly and read it carefully.

Kathy Ferrell BSN RN LNCC

Letters on any topic are welcome and may be sent to the Editor at whowland@howlandhealthconsulting.com. Letters may be edited for brevity.

Errata, XII.2

The code given for baclofen is incorrect in the article on Coding and Costing, page 555. The correct code is J0475.

Mary L. Morollo’s name was misspelled in the list of new CNLCPs, page 547.
Medical technology has made rapid advancements in recent years; components have shrunk, electronics improved, and we, as a society, have become more accepting of using technology with our bodies. The implanted pacemaker has been around since the late 1950s. According to the American Heart Association, there are approximately 3 million people worldwide who have a cardiac pacemaker. (Wood & Ellenbogen, 2012) Within the medical technology arena, there is an emerging field of neurotechnology. Many therapies and devices are available commercially for use in pain management, spasticity control, breathing assistance, environmental control, and rehabilitation techniques. There are also many new technologies under investigation in research centers across the globe, tools to be used, for instance, to combat secondary conditions, provide further independence or to aid in the rehabilitation process. This article will provide an overview of neurotechnology, introduce a few applications, and provide resources to learn more.

Neurotechnology is a broad term used to refer to medical electronics that interact with the human nervous system. It is based on the electrical signals the body uses to send messages. (Cavuoto, 2011)

Technology can be designed to monitor electrical signals, block those signals or use the electrical signals for functional gain. For instance, electrical stimulation may be used on a paralyzed muscle. Even though a muscle is paralyzed due to loss of neurological control, it does not mean that the muscle cannot be stimulated. For those with mobility impairments without peripheral nerve damage, electrical stimulation may be used in ways to enhance exercise, aid in

Jennifer French is co-founder and Executive Director of a non-profit organization, Neurotech Network. She currently serves on the Advisory Boards for the FES for Cerebral Palsy project at Stanford University, the Brown University Institute for Brain Science, and the Advanced Platform Technology Center in Cleveland. Jennifer became a quadriplegic as a result of a snowboarding accident in 1998. A person living with quadriplegia, she is an active user of Functional Electrical Stimulation (FES) systems. She may be contacted at jfrench@neurotechnetwork.org
rehabilitation or provide functional daily living. In the 1950s, the first attempt was made to apply electrical stimulation to the phrenic nerve, allowing a person to breathe without a ventilator. (See page 601, Ed.) Also during this decade, the first auditory implant was performed, the precursor to the cochlear implant for those who are deaf or hard of hearing. (pages 618 and 631) These projects began the new field of science called Functional Electrical Stimulation (FES). FES encompasses a variety of therapeutic techniques and treatments used to activate muscles that may not be functioning properly due to injury, disease or a physical abnormality. Over the decades, this field combined medicine, biomedical engineering, and technology, evolving to what is now termed as neurotechnology. (Chase, 2006)

Areas of Neurotechnology
Neurotechnology is divided into four distinct areas: Neuromodulation, Neural Prosthesis, Neural Rehabilitation, and NeuroSensing and Diagnostics. (Cavuoto, 2011) Some devices may be applicable to more than one area.

Some systems are external, applied entirely outside the body or on the surface of the skin. Others may be surgically implanted, with the entire system operating inside the human body. One method is not better than another; the key is how the device is used.

Neuromodulation
This category refers to therapies using electrical stimulation to improve control of an existing part of the nervous system. Modulation can also be defined as regulation. Using undamaged components in the nervous system, a neuromodulation system regulates a targeted area for a desired effect, such as pain reduction, tremor control, or seizure management (page 613). Some examples of applications include deep brain stimulation used to control tremors associated with Parkinson’s disease or essential tremor (page 636), transcranial magnetic stimulation to manage severe depression, or sacral nerve stimulation application to help control incontinence (page 644).

Pain management accounts for a large segment of neuromodulation applications. There are many new types of neurotechnology, such as deep brain stimulation and transcranial magnetic stimulation, in research for pain treatment, although these are not yet clinically available.

Three areas of treatment currently available will be familiar to most Life Care Planners: transcutaneous electrical nerve stimulation (TENS), implanted drug delivery systems (IDDS), and spinal cord stimulators (SCS).

**TENS** works by delivering low level electrical stimulation through electrodes placed directly on the skin of the affected area. The contraction of muscles through electrical stimulation may help alleviate pain by blocking pain messages being sent to the brain.
TENS or NMES (neuromuscular electrical stimulation) applied to a spastic muscle or its nerve supply may reduce spasticity and improve function. Using TENS for spasticity requires a home program designed and monitored by a trained therapist.

Typically, results will not be realized until the treatment has been administered for 1-2 hours per day for 1-3 months. TENS requires a physician prescription but this therapy can provide a convenient means of treating some forms of pain. TENS is non-invasive and can be an economical solution.

Implanted Drug Delivery Systems (IDDS), also known as Intrathecal or Epidural Analgesia Therapy, deliver pain-relieving or spasticity-relieving medication via pump directly to the intrathecal or epidural space. The IDDS includes a drug reservoir for the pump that delivers the medication through a catheter directly into the spinal canal (intrathecal). The reservoir needs to be refilled, usually once every month or few months, by placing a needle through the skin. This is typically an outpatient procedure, often done during a regular physician visit. Generally, a person first undergoes a trial of the medication by an intrathecal injection or continuous infusion of the medication through an implanted catheter. If the trial is successful, the pump system is implanted permanently through a surgical procedure. IDDS reduces the need for oral medications and can be more effective than oral or parenteral medications. IDDS is now a mainstay of therapy for intractable pain, including neuropathic pain, and spasticity.

Spinal Cord Stimulation (SCS) is an implanted system comprised of implanted electrodes in the spine, under the skin, or both, and an external control unit. It uses electrical stimulation to block pain pathways that travel through the spinal cord to the brain. SCS has also been known to decrease spasticity. As with IDDS, an initial trial is needed to see if effective results can be achieved. If the trial is successful, a permanent system may be implanted. The user can keep the system on permanently or use it as needed.

Since the human nervous system is complex, not all devices and therapies apply to every neurological condition.

Neural Prosthesis or Neuroprosthesis

Similar to the familiar prosthesis for amputation, a neural prosthesis uses the human nervous system to replace or improve function of an impaired limb or organ. The stimulation harnesses the motor nerves,
which remain anatomically intact but are not functioning properly. Electrical stimulation devices use pulses of electricity to contract or excite the muscle, exploiting signal parameter such as pulse width, current, or voltage. This can potentially minimize loss of muscle bulk, improve muscle size and performance, and enhance physical fitness. For instance, an FES system may restore gross hand function for persons with quadriplegia; alternative electrical stimulation systems may restore swallowing for eating or drinking.

**Drop Foot Stimulation**

One fast-growing technology has been stimulation for drop foot syndrome. These systems are changing paradigms for treating individuals with neurological conditions such as traumatic brain injury, multiple sclerosis, stroke, spinal cord injury, and related disorders. Common among stroke survivors and people with multiple sclerosis and spinal injury, foot drop makes walking more difficult due to the inability to lift the foot and control knee flexion or extension while walking.

In the past, this condition has been treated by using an ankle-foot orthosis (AFO) and using the hip muscles to lift the foot. Drop foot stimulation systems uses a sensor attached to the bottom of the foot, surface electrodes placed on the calf muscles, and, if needed, the thigh muscles, and a microprocessor to coordinate the movement. *(Figure 1)* As the user takes a step, the sensor feeds information to the microprocessor, which activates the electrodes; the electrodes send stimulation to contract the muscles to lift the foot and control the knee. Proper fitting will allow the user to walk more naturally. *(Stein, et al. 2010 Feb; Laufer, Ring, Sprecher & Hausdorff 2009 Jun)*

**Diaphragm Pacing System**

A neurotechnology alternative to mechanical ventilation uses electrical stimulation of the diaphragm muscle. Unlike ventilators that use mechanical pressure to force air into the lungs, the stimulation system approximates normal respiratory mechanics, pulling air into the lungs by stimulating the diaphragm muscle to contract. Electrodes are implanted into the diaphragm. The system also consists of a connector holder, cable and external battery powered pulse generator. *(Figure 2)*

*Photo courtesy of Bioness Inc. Used with permission. [http://www.bioness.com](http://www.bioness.com)*
The pulse generator regulates movement of the diaphragm muscle. As the diaphragm contracts, the chest cavity expands and air is pulled into the lungs. As the diaphragm relaxes, the chest cavity naturally retracts and air pushes out of the lungs. The use of a breathing stimulation system is only possible if the diaphragm and lungs are intact and the person is responsive to stimulation, thus allowing the system to work using these body parts. (Glenn, et al. Nov 1988, Glenn, Haak, Sasaki & Kirchner, Jun 1980)

**Neural Rehabilitation**

These are therapies applied for rehabilitation or exercise, facilitating healing or encouraging the natural restoration of an impaired body function. The goals are to improve muscles and maintain overall health.

Robotics are used for repetitive motion therapy. Suspension treadmill training systems may improve function of voluntary movement in the legs. Adoption of new technology in the rehabilitation environment has been mainly for devices that deliver stimulation to the skin surface. (Posteraro, 2009 Nov)

**Functional Electrical Stimulation (FES) Cycling**

Exercise can be achieved using electrical stimulation which relies on the peripheral nervous system. FES cycling devices (Figure 3) cause muscle contraction by sending pulses of electricity through skin electrodes. For persons with some voluntary movement, exercising a muscle using FES can slowly build muscle mass, with the potential to gain functional movement.

For those with paralysis but intact peripheral nerves, electrical stimulation can maintain the muscle condition. Using FES cycling regularly under the supervision of a trained clinician can help minimize loss of muscle bulk, improve muscle size and performance, and boost physical fitness.

These devices have been used by physical therapists for decades to rehabilitate atrophied muscles, relax muscle spasms, and increase range of motion. FES cycling may reduce the incidence of medical complications of immobility and lead to an improved, healthier lifestyle. Before starting an FES exercise regimen, one should consult a physician or professional therapist. (Ambrosini, Ferrante, Pedrocchi, Ferrigno & Mol...
Re-Education Systems
For those with stroke, spinal cord injury, traumatic brain injury, multiple sclerosis or a variety of palsies who retain some voluntary movement, muscles can be reconditioned through rehabilitation. Movement enhancement systems assist with exercise or the work of limb muscles. It is believed that the repetitive pattern helps the brain and spinal cord work together to re-route signals interrupted by injury.

Re-education systems (Figure 4) use a combination of EMG sensing and electrical stimulation to record voluntary muscle contractions and contract the muscle. This combination capitalizes on visual and sensory feedback for re-learning in movement therapy. These tools go beyond traditional therapy to push the body toward more potential movement and improved exercise. (Page & Levine, 2006 Jan)

Neural Sensing and Neural Diagnostics
These are tools to diagnose or monitor activity in the nervous system. Peripheral nerve sensing may be used to diagnose peripheral nerve conduction due to diabetes or carpal tunnel syndrome, for example. Brain-computer interfaces monitor activity in the brain. Pressure-monitoring devices help prevent pressure sores. These sensing tools can be used in a variety of applications.

EMG Communication Systems
Neurotechnology devices for communication impairments have few options for brainstem lesions (locked-in syndrome) or neurodegenerative conditions. In these cases, muscles involved in speech production are paralyzed, so the solution is to allow the person to communicate indirectly, through a computer interface. Since hands are also paralyzed, the interface must feature hands-free operation.

If there is some muscle preservation around the eye or forehead area, electromyography (EMG) signals can interface with a computer. This can allow the user to write email, surf the internet, and communicate via text-to-speech software, for example.

The latest research for severe communication impairment are exploring the development of brain-computer interface (BCI) that processes electroencephalographic signals (EEG) and translates them into words. Future BCIs are in development which would translate more specific signals for intentions, such as motor intentions read from the cerebral cortex, into words and phrases, allowing for a faster and more natural rate of communication. (Wolpaw, Birbaumer, McFarland, continued next page)

**EEG for Diagnostics**

The neurotechnology field is developing additional tools for neuro-imaging and brain activity monitoring. Most recent developments have been in the application of EEG in the emergency department or in the battlefield to help triage patients for further brain activity-imaging technology.

EEG signals are processed by algorithms which convert them to a readable format, commonly by use of scalp electrodes. Recent improvements in EEG technology include the development of multi-sensor nets or headsets worn over the scalp, connected via wire or wirelessly to a computer for further analysis. **(Figure 5)** Advantages of the headgear and nets over traditional EEG methods include reduced use of conductive gels and more accurate extrapolation of electric signals despite individual differences in anatomy.

**Summary**

These four segments make up the innovative field of neurotechnology. Within these segments there are a variety of applications. These applications may be for a specific condition or symptom, such as depression, epilepsy, sleep apnea, urinary incontinence due to paralysis, or parkinsonian tremors.

Since the human nervous system is complex, not all devices and therapies apply to every neurological condition. Consider disability type, frequency of use, and individual needs before choosing any neurotechnology therapy, treatment or device. **(See Tech Corner, page 598)**

Cost is very important. The total cost of a technology depends on many different elements. Looking at cost over the time it will be used and the effect it may have on the person using it will be critical in any analysis of cost effectiveness. Explore reimbursement options and out-of-pocket expenses while planning long term care. Consult a trained and knowledgable medical professional before making any decisions.

Resources to learn more about neurotechnology, as well as the specific technologies mentioned in this article, are available free from Neurotech Network. Visit www.NeurotechNetwork.org for educational fact sheets, to meet other people who use the tech-

*continued next page*
technology, and search the only comprehensive neurotechnology database.

References:


Nursing Diagnoses to Consider

- **Readiness for Enhanced Self-Health Management** (Domain 1, Health Promotion; Class 2, Health Management)
- **Impaired Physical Mobility** (Domain 4, Activity/Rest; Class 2: Activity/Exercise)
- **Impaired Transfer Mobility** (Domain 4, Activity/Rest; Class 2: Activity/Exercise)
- **Impaired Walking**: (Domain 4, Activity/Rest; Class 2: Activity/Exercise)
- **Impaired Verbal Communication**: (Domain 5, Perception/Cognition; Class 4: Communication)
- **Risk for Falls**: (Domain 11: Safety/Protection, Class 2: Physical Injury)
- **Risk for Injury**: (Domain 11: Safety/Protection, Class 2: Physical Injury)
- **Impaired Comfort**: (Domain 12: Comfort, Class 1: Physical comfort; Class 2, Environmental comfort; Class 3, Social comfort)


Wood M, Ellenbogen K (2012). Cardiac Pacemakers Form the Patient’s Perspective, American Heart Association, referenced from www.heart.org
For the past five issues of the Journal of Nurse Life Care Planning I have been writing about a variety of topics related to Assistive Technology and Life Care Planning. I have been thinking about the historical and professional context of Assistive Technology (AT) and I think that this might be a good time to step back and offer some information about the general field of AT and how to best incorporate AT into a Life Care Plan.

Reviewing a Life Care Plan That Includes Assistive Technology

If AT is included in the plan, check to see that the source of the recommendations is an Assistive Technology Practitioner (ATP). As with any certification, this will not prove that the resources are properly identified, only that the person has some familiarity with assistive technology. The ATP must also have a specialization related to the needs of the individual for whom the Life Care Plan is being developed. Presenting AT recommendations without having training and certification is a bit like making medical recommendations without proper training, background, and certification.

These are some guidelines to consider when observing assistive technology resource recommendations in a Life Care Plan. If any of these items are missing or are incomplete, the reader would have reason to initiate a more thorough vetting of the Life Care Plan. At minimum, all resources should provide the following information:

- Purpose of the resource
- Explicit description of the resource
- Period during which the resource will be used
- Replacement cycle
- Cost for ongoing maintenance and repairs
- Description of the cost and type of training required (if needed)
- Individual making the recommendation and qualifications
- Cost of the resource
- Contact information for the vendor or vendors used to obtain cost information.

Review any separate assistive technology report appended to the Life Care Plan for thoroughness.

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The following items should be observed as indicators of a quality assessment. If there is no separate assistive technology report for review, look for the above information. Answers to the following information should be apparent within the existing Life Care Plan and cost charts.

**What is the consumer’s background?** This information includes reported disability and current situation related to the presenting obstacles, medical stability and the potential for changing functional capacities.

**Is there a thorough description of obstacle(s)?**

**What is/are the proposed solution(s)?** Often multiple solutions are feasible, it is best to present the choices and determine which solution through contact with the consumer and other interested parties.

**What is the estimated cost?** This cost should be fairly accurate and should have detailed supportive information. A simple number at the end of a list of recommendations is not detailed and probably not accurate, either.

**Are there recommendations for suppliers of**

the equipment, parts or materials included?

**How long will it take to implement**

the modification(s), including fabrication if needed, shipping assembly, and training?

**What are the recommendations for training?**

Consider training costs, where training is available, and training time-frames.

**What is the expected outcome** if the solution(s) are implemented? The report should include a description of what the true benefits would be if this individual obtained these accommodations.

**What new obstacles may be introduced** as a result of implementing this solution? This critical consideration is often overlooked in technology solutions. It is practically impossible to implement a solution without causing some other set of problems to arise. The goal is that new problems will be less serious than the original ones. These new problems may include the need for psychological adjustment to new independence.

In addition to the above information, the following questions should be asked and answered clearly.

Does this person

- Have experience with any adaptive equipment in the past?
- Have some degree of comfort with assistive technology?
- Have cognitive skills required for performing the task, but lacks physical access to the some parts of the task?
- Have the ability to perform the problem task if another person helps with some parts of the process?
- Have a strong desire or need to accomplish this task?

*continued next page*
• Exhibit a general interest in being as independent as possible? How strongly is basic sense of self-worth related to desire to be independent?

• Feel frustrated because interests and aptitudes conflict with physical capacities?

The summary checklist below will be helpful for reviewing an assistive technology plan.

### Sixteen Critical Criteria for Assistive Technology: A LCP Checklist

1. Is the ATP credentialed and qualified to identify AT resources?
2. Is an explicit description of the resource provided?
3. Is a description of the cost and type of training required (if needed) provided?
4. Is the period during which the resource will be used included?
5. Is the replacement cycle of the resource included?
6. Is the cost for ongoing maintenance and repairs provided?
7. Is the purpose of the resource described?
8. Is the cost of the resource and the vendor or vendors used to obtain cost information included?
9. Is the background information of the consumer included?
10. Is the expected outcome described?
11. Is the timeframe for implementation described?
12. Is information regarding potential new obstacles included?
13. Is the person’s history with AT described?
14. Are the AT recommendations internally consistent?
15. Are the AT recommendations complete?
16. Are the AT recommendations specific to this individual?
Diaphragm Pacing: Helping Patients Breathe

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Raymond P. Onders MD. FACS

Abstract
Diaphragm pacing is new technology that can be an alternative or adjunctive therapy to positive pressure ventilation. An electrical stimulus is delivered to surgically implanted electrodes that cause diaphragm contraction. Currently, diaphragm pacing is used in patients who have spinal cord injury or amyotrophic lateral sclerosis. Pacing has both physical and social advantages in both patient populations. Unique to the spinal cord patients, pacing provides a sense of freedom and independence. In the amyotrophic lateral sclerosis population pacing is one of the few therapies shown to prolong survival. The implantation procedure has been shown to be safe. Care and use of the device is easily learned.

Diaphragm pacing (DP), electrical stimulation of the diaphragm muscle, is a new technology aimed at either replacing or delaying the need for mechanical ventilation or maintaining and improving normal breathing. In DP, an electrical stimulus is delivered to electrodes implanted into the diaphragm muscle resulting in diaphragm contraction. There are currently two FDA approved indications for DP, spinal cord injury (SCI) and amyotrophic lateral sclerosis (ALS), commonly referred to as Lou Gerhig’s disease. To understand the benefits of DP, one must first understand problems with current ventilation modalities in these two populations.

Mechanical Ventilation in Spinal Cord Injury
SCI is often described as a life altering and devastating event that affects the entire family. Tracheostomy mechanical ventilation (TMV) is life saving in high cervical spinal cord injuries especially above the C5 level. In TMV, a mechanical ventilator forces air (positive pressure) through an artificial airway in the trachea and into the lungs. Vittaca et al. (2007) and Van Pelt et al. (2007) described how the addition of TMV increases stress, anxiety and complexity of care for both the patient and their caregivers. Positive-pressure ventilation is associated with a series of negative attributes, including barotrauma. It contributes to hemodynamic instability by decreasing venous return, thereby decreasing cardiac output and blood pressure (Chitila and Criner, 2002). Pneumonia, another common complication of mechanical ventilation, is the leading cause of death in the mechanically-ventilated SCI population.

There are multiple psychosocial issues associated with mechanical ventilation. Ventilators are noisy and attract unwanted attention. The tracheostomy and tub-
ing increase difficulty with transfers (Figures 1 and 2). The ventilator adds bulk and weight to wheelchairs, which decreases mobility (Onders, Elmo and Ignagni, 2007). Speech patterns on mechanical ventilation are altered becoming short, choppy and low in volume (Hoit, Banzett, Lohmeier, Hixon & Brown, 2003). Most importantly, the need for mechanical ventilation substantially decreases life expectancy. (http://www.spinalcord.uab.edu)

**Mechanical Ventilation in Amyotrophic Lateral Sclerosis**

ALS is a progressive degenerative motor neuron disease that affects both upper and lower motor neurons. The ensuing muscle weakness has devastating effects on the respiratory muscles; respiratory failure is the primary cause of death. There also appears to be a decrease in the central respiratory drive, resulting in sleep-disordered breathing. (Atalia et al., 2007)

ALS is a fatal disease. Unless a patient chooses TMV, death occurs within an average 3-5 years from symptom onset. Noninvasive ventilation (NIV) has been shown to improve survival in ALS patients and is standard therapy. NIV, like TMV, provides positive pressure respiratory support. However, NIV uses a noninvasive facial or nasal mask as a delivery method (Figure 3).

NIV is significantly underused, with reports of patient use ranging from 2.6% to 21%. While this is an underprescribed therapy, patient barriers to use are significant. Obstacles to use include feeling claustrophobic or pain and discomfort with the mask. There is also intolerance due to bulbar muscle weakness and secretions (Ritsma et al., 2010; Miller et al., 2009).

**Diaphragm Pacing**

DP can be an alternative or adjunctive therapy to positive pressure ventilation. There are three components to DP: the electrodes, the stimulator box and the cable, which connect the electrodes to the box (Figure 4). DP provides physiological negative pressure breathing. Unlike positive-pressure ventilation, DP ventilation aerates and opens the posterior lower lobes. DP improves lung

continued next page
compliance and decreases peak airway pressures. DP has both physical and social advantages, described later.

The DP system and surgical implantation procedure are the same for SCI and ALS. How the patients are educated on DP usage and benefits differ. In SCI, the goal is to replace TMV. In ALS, the goal is to delay TMV.

**Surgical Implantation**

DP requires surgical implantation of electrodes or wires into the diaphragm muscle. This is done using a standard four port laparoscopic approach. The diaphragm is “mapped,” meaning twitch stimuli are delivered in a grid-like pattern on each hemidiaphragm. This process identifies the motor point of the phrenic nerve. The diaphragm contraction is analyzed both qualitatively, by watching the diaphragm muscle contract, and quantitatively, by measuring changes in abdominal pressure. Two electrodes are implanted on each hemidiaphragm. The electrodes function synergistically and also provide redundancy (Onders et al., 2005).

The four electrodes are routed to a percutaneous exit site through the chest or under the rib cage. In addition, an indifferent (grounding) electrode is routed to the exit site (Figure 5). All electrodes are then re-tested and tidal volumes are measured. EKG strips are obtained to evaluate for any cardiac electrical interference.

The surgery is approximately two hours long. General anesthesia with no muscle paralytics is used. After surgery, patients are admitted for a 23-hour observation stay. Typically, patients are able to resume a regular diet and activity within a few hours after surgery (Onders et al., 2008).

**Benefits of pacing in SCI**

Data from the SCI clinical trial showed a 96% success rate with patients being able to achieve 4 continuous hours of DP and tidal volumes that met or exceeded their basal metabolic needs. There were no internal electrode failures, no pneumonia deaths, no patient stopped pacing and there were no device related deaths. The average age at implantation was 36 years old with a range of 18 to 74 years. Time from injury (time on a mechanical ventilator) to implanta-

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tion ranged from 3 months to 27 years with the average being 5.6 years. Younger patients and those with newer injuries conditioned their diaphragms more quickly than older patients or those with older injuries. The majority of injuries (40%) were due to motor vehicle accidents with (20%) due to sports related injuries. Seventy-four percent were males. Nine patients had injuries below the C2 level. Ten patients who had cardiac pacemakers were implanted with no device-to-device interference noted. In long term follow up with 28 responders, 68% reported fewer secretions, 68% of caregivers reported less work involved in caring for the patient and 95% reported an increased sense of freedom and independence. All patients would recommend DP to others (Onders et al., 2007, 2009).

Since this clinical trial, we have implanted a series of SCI children ranging from 3 years old to 17 years old. Regardless of age, the most commonly reported benefit from patients was how silent the DP system is. Unlike the noise of the ventilator, paced breathing is quiet breathing. This is extremely beneficial in social situations such as school and church. One patient told us, “It was so nice to go to class and be just a kid in a wheelchair and not be the kid in the chair with all the hoses.” Another patient told us, “I can’t wait to go back to school with the pacing system. I had this instructor last year who taught in one of those large halls with 200 some students who asked me if I could please turn off the machine until class was over. He said it was quite loud and disruptive. I was humiliated.”

Pacing eliminates the ventilator and all of its tubing which simplifies transfers and traveling. One mother of an implanted child commented on how incredible she felt the first time she was able to pick up her child and carry him up to bed without someone climbing the stairs behind carrying the ventilator. IW, a 10 year old C2 injured SCI patient, is able to join his family and friends in the pool now that he has a diaphragm pacing system housed in his flotation device. (Figure 6)

The DP system runs on a 3.6 volt inorganic lithium battery which lasts approximately 500 hours. Four implanted patients lived through natural disasters including hurricanes and an ice storm when power
failures left them without electricity for two days to two weeks. The power outages were not life-threatening because they used DP for breathing.

The ultimate benefit of DP in SCI is the potential for neuroplasticity, where the patient regains the ability to breathe without any assistive devices. The benefits of electrical stimulation to regain muscle strength and/or re-establish neuronal pathways are well-documented in the SCI and stroke literature. Patients can and have been implanted immediately post-injury. Others have been implanted several months to years post-injury. In the group of SCI patients implanted at University Hospitals Case Medical Center (UHCMC), only four were implanted within five months of injury. Three regained neural control of their diaphragms and were subsequently able to wean off DP and have the electrodes removed (Onders et al., 2010).

**Benefits of Pacing in ALS**

The goal for DP in ALS is to delay the need for TMV. In the United States only 5% of ALS patients choose TMV over death. The ALS multicenter clinical trial results showed patients who used DP had an improved survival compared to patients who did not. Patients who used DP plus NIV survived without TMV an average of 16 months longer compared to similar patients in another study who used NIV alone. Current ALS literature shows ALS patients undergoing feeding tube placement have a 30-day mortality rate of up to 25%. There was a zero 30-day mortality rate in the ALS patients who had DP placed at the same time as the feeding tube. (http://www.fda.gov/MedicalDevices/ProductsandMedica lProcedures/DeviceApprovalsandClearances/Recently-ApprovedDevices/ucm278684.htm). Patients who used DP for 4 months tended to have better sleep than before.

Among the ALS patients implanted at UHCMC, there is a subset of patients who have had improvement of hypercapnia and respiratory instability. Hypercapnia in ALS is due to both weakness in respiratory muscles resulting in decreased tidal volume, and a loss of central drive to breathe, resulting in decreased respiratory rate (Atalia et al., 2007).

TC is a 43-year-old female with onset of symptoms three years prior to implantation. She had significant sleep dysfunction. Her arterial blood gas (ABG) showed a compensated hypercapnia with pH 7.40, CO$_2$ 46, PO$_2$ 93, HCO$_3$ 28.5. TC was short of breath with most activity including talking. She was using NIV approximately 4 hours a night. TC had significant difficulty adjusting to the NIV mask and air flow pressure. She would begin the night wearing her mask but would remove it after only a few hours. At the time of surgery we found that with stimulation we had the ability to move a significant amount of diaphragm. She was instructed to use DP at night to aid with her sleep dysfunction.

On examination one month post implantation, TC’s blood gas improved with results being pH7.43, CO$_2$...
39.6, PO₂ 95, HCO₃ 25.8. She had more energy and no shortness of breath. She also ceased her nightly battle with NIV and used the pacer only.

**Evaluation for DP in SCI**

Regardless of the diagnosis, DP will only work on a diaphragm that responds to electrical stimulation (stimulatable). Two tests can predict diaphragm stimulatability. The first is fluoroscopic evaluation of the diaphragm. Diaphragms that move volitionally must have an intact phrenic nerve.

The other is a phrenic nerve conduction test (PNCT). Our institution uses the Bolton method to evaluate the phrenic nerve. An electrical stimulus is delivered to the posterior of the sternocleidomastoid muscle and the latency and amplitudes of the right and left phrenic nerve are recorded. A stimulatable diaphragm will have positive phrenic nerve responses.

In SCI, the goal for DP is to replace tracheostomy mechanical ventilation. DP should be considered for any SCI patient who has a stimulatable diaphragm. During the clinical trial, phrenic nerve studies were performed under fluoroscopy on all patients. These tests are no longer routine: most SCI patients are taken directly to surgery for diagnostic laparoscopy.

Initially, two incisions are made in the abdomen, one at the umbilicus, the second a few centimeters to the right of the umbilicus in the right upper quadrant of the abdomen. Stimuli are delivered to both hemidiaphragms. If the diaphragm is denervated and we are unable to elicit diaphragm contraction, the procedure is aborted. This process of direct visualization to determine stimulatability takes less than ten minutes.

Patients are exposed to minimal anesthesia and the SCI population is already on tracheotomy ventilation.

The preoperative evaluation includes a physical exam, a thorough patient history, and chest x-ray. Additional testing such as blood work or EKG is obtained if there is a clinical indication. Patients are informed of the risks and benefits. Included in this discussion is the possibility of finding a denervated diaphragm once in surgery. Physiologically, the phrenic nerve, which comes off the spinal column at C3-C5, should be intact in patients who have injuries above C3 with no involvement below. In those who have injuries at the C3-C5 level, there is an increased likelihood of phrenic nerve damage.

**Evaluation for DP in ALS**

Evaluation for DP in ALS is more extensive. Along with a history and physical, we obtain pulmonary

continued next page
testing and ABG. The pulmonary test is basic spirometry, specifically the forced vital capacity (FVC), lung volumes and respiratory muscle forces, both inspiratory and expiratory. The ALS patients will have fluoroscopy of the diaphragm, PNCT, and chest x-ray.

Patients are screened to predict stimulatability of the diaphragm. We also look closely at the risk-benefit profile. The test results are interpreted in combination and not independent of each other. For example, the ALS patient who has no response on PNCT, poor movement of the diaphragm on fluoroscopy and low FVC would not be a candidate for DP. The patient who has good movement on fluoroscopy and a negative PNCT may be offered DP. In this scenario, the PNCT may be a false negative.

Other factors such as FVC, ABG and comorbid conditions would influence the potential benefit versus potential risk. Another example is the patient who has little to no movement of the diaphragm on fluoroscopy but has positive phrenic nerve responses. ALS patients who have upper motor neuron involvement of the diaphragm muscle may have these test results. They are similar to patient TC’s results and pacing will often be beneficial.

DP Programming and Usage in SCI
The DP surgery, previously described, is a low-risk, minimally-invasive laparoscopic procedure. Prior to discharge, the pacers are programmed and the patient and caregivers are instructed on care and use of the system.

The pacers are programmed to the unique needs of the patient. Each individual electrode can be programmed with different amplitude and pulse width settings. Other parameters programmed include breaths per minute rate, inspiratory time, hertz (Hz, electrical cycles per second), and pulse modulation. The maximum settings are amplitudes of 25, pulse width of 200 and 20 Hz.

Typically, a stronger stimulus translates into a larger diaphragm contraction. In SCI, where the patient has less sensation, the pacers are usually programmed with amplitudes of 25, pulse width of 150 and 20 Hz. The breath per minute rate and the inspiratory time are often matched to ventilator settings. All patients are programmed with pulse modulation of 10, which allows smoother breathing.

After programming the pacer, a patient-specific conditioning guideline is developed. The pacer is turned on and the patient is removed from the ventilator. The patient is monitored for shortness of breath, distress, or decreases in pulse oximetry, as with any patient doing a ventilator wean trial. Initial time breathing with the pacer may be as short as sixty seconds or as long as sixty minutes. The length of time needed to condition or strengthen their diaphragm muscle so that it can sustain ventilation depends on the length of time an SCI patient spent on mechani-

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cal ventilation and patient age (Onders et al. 2009). Positive-pressure mechanical ventilation causes disuse atrophy of the diaphragm muscle. Slow-twitch type 1 muscle fibers convert to fast-fatiguable type 2b fibers when on a ventilator. The length of time the patient is able to initially breathe with the pacer is the goal time for subsequent pacing sessions. The more pacing sessions done in a day, the more quickly the patient will progress.

There should be a 60-minute rest time on the ventilator between pacing sessions. For patients who begin pacing short periods of time, less than ten to fifteen minutes, we recommend ten to twelve sessions daily. Every three to five days, the patient should attempt increasing the length of the pacing session. As the length of the sessions increase, the number of sessions decrease.

Initially, patients should avoid eating or drinking while pacing, or they should wear a speaking valve over their tracheostomy. When patients are able to breathe comfortably all day for approximately one week, then they can pace overnight. Speaking valves should be worn at night too.

Over time, the patient can convert to a capped tracheostomy. Capping the tracheostomy forces air movement into the lungs from the mouth and nose. Obstructive sleep apnea must be ruled out before using a cap instead of the speaking valve at night.

The conditioning process may take several weeks, and up to a year for patients who have been on long-term TMC. Patients who were implanted early post-injury will transition more rapidly. Two of the patients implanted within weeks of injury went directly onto full-time pacing immediately after surgery.

Pacing in ALS

The ALS patient will use DP differently than the SCI patient, and perhaps differently from other ALS patients. The initial pacer power settings in ALS are much lower than in the SCI population with amplitudes beginning at 8, pulse widths at 80 and 12 Hz. The initial settings are lower because ALS patients do not have alterations in sensation. The ALS patient is given the same instructions on the care of the device and electrodes as the SCI patient. Usage is tailored to the needs of the patient based on clinical presentation. The ALS patient who is not showing signs of significant respiratory compromise, not utilizing NIV, and has no sleep dysfunction will begin utilizing the device several times daily for 30 minute sessions to maintain their current diaphragm strength. ALS patients who utilize NIV

continued next page
are instructed to utilize the device simultaneously with their NIV. The patient who may not be using NIV but is having evidence of sleep dysfunction would be instructed to use the device at night while sleeping. Finally, the patient who has evidence of hypercapnia, shortness of breath, use of accessory muscles, or respiratory instability, would be instructed to use the device full time. As the disease progresses, pacer usage or power settings may increase.

The pacer is connected to the patient’s electrodes by a cable (Figure 7). When not in use, the pacer box may simply be turned off or the cable detached. The cable and pacer must be secured at all times while in use. The electrodes and surrounding skin require cleaning with alcohol three times a week or if the dressing gets wet or soiled. It is recommended the patient maintain a dressing covering the electrodes at all times to protect the electrodes from getting snagged or pulled. All patients receive a detailed user manual provided by the manufacturer that reviews care of the pacing system.

Cost
DP is covered by private insurance and Medicare and Medicaid when implanted for approved FDA indications. Patients’ out-of-pocket expenses for the evaluation and implantation are dependent on their policy. Charges for testing for those without insurance will vary depending on region and type of facility e.g., teaching hospital, community hospital, or standing clinic. The evaluation for a SCI patient can range from $500 to $2,000 depending on diagnostics needed. The ALS evaluation can range from $2,000 to $5,000. Hospital charges for the implantation procedure including 23-hour hospital stay can range from $55,000 to $70,000 for SCI and $45,000 - $60,000 for ALS, although the hospital costs are usually much less. Specific CPT codes are listed in Table 1.

Most insurance companies including Medicare have a negotiated reimbursement rate that is much lower than the charges. Out-of-pocket expenses for pacing supplies, such as batteries and cables, could be up to $100 monthly.

Costs for DP compare very favorably to those for home ventilation. Moss reported home mechanical ventilation can average $180,000 per year. Other studies show home mechanical ventilation with an

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estimated mean monthly cost of $12,771 with a range of $2,500 to $35,000. By contrast, first year expenses of diaphragm pacing would have an upper limit of $71,000 with following years averaging $1,200.


Diaphragm pacing is offered at several centers throughout the United States. The most up-to-date information on approved centers and the contact information can be found at the Synapse Biomedical website www.synapsebiomedical.com. Often, travel to a center may be required and the cost of travel with hotel accommodations is variable.

Summary/Discussions

Diaphragm pacing is a more physiologic and preferred method of breathing in SCI. In ALS, DP has been shown to prolong survival and improve sleep. It can be safely implanted in both patient populations. Other positive attributes are unlimited power source, compactness, silence, and unobtrusiveness (Figure 8). Patients with newer injuries transition from full time mechanical ventilation to full time pacing relatively quickly. Early implantation could eliminate the need for mechanical ventilation before the patient develops any type of psychological dependence on the machine and untoward physiologic effects of mechanical ventilation. DP is a therapy in ALS that should be considered in the early to mid stages of the disease. Often times, patients in the final stage of their disease are not good candidates. Pacing can maintain diaphragm muscle strength. A more viable diaphragm at implantation could mean more diaphragm muscle to preserve. DP has improved quality of life in both SCI and ALS patients and is a therapy option that should be considered.

Figure 8. Quadriplegic diaphragm pacing patient no longer with a ventilator or tracheostomy in his college dormitory room.

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Table 1. CPT Codes for diagnostic exams related to diaphragm pacing

<table>
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<th>Diagnostic testing</th>
<th>Physical Exam</th>
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<td>Arterial blood gas</td>
<td>Comprehensive, moderate</td>
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<tr>
<td>Fluoroscopic evaluation of the diaphragm</td>
<td>99204</td>
</tr>
<tr>
<td>Phrenic nerve conduction study</td>
<td>Comprehensive, high</td>
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<tr>
<td></td>
<td>99205</td>
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<tr>
<td><strong>Pulmonary function testing</strong></td>
<td><strong>Surgical Implantation</strong></td>
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<td>Basic spirometry</td>
<td>Unlisted laparoscopy</td>
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<td>Respiratory muscle forces</td>
<td>Incision for implantation of neuromuscular electrodes</td>
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<td>64580</td>
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</tbody>
</table>

Nursing Diagnoses to Consider

- **Readiness for Enhanced Self-Care**: (Domain 4, Activity/Rest; Class 5, Self-Care)
- **Dysfunctional Ventilatory Weaning Response**: (Domain 4, Activity/Rest; Class 4: Cardiovascular/Pulmonary Responses)
- **Impaired Verbal Communication**: (Domain 5, Perception/Cognition; Class 4: Communication)
- **Risk for Compromised Human Dignity**: (Domain 6, Self-Perception; Class 1: Self-Concept)
- **Powerlessness**: (Domain 6, Self-Perception; Class 1: Self-Concept)
- **Situational Low Self-Esteem**: Development of a negative perception of self-worth in response to a current situation (specify) (Domain 6, Self-Perception; Class 2: Self-Esteem)
- **Caregiver Role Strain**: (Domain 7, Role Relationships; Class 1: Caregiving Roles)

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childhood or adolescence. Journal of Spinal Cord Medicine, 30(S1), S25-S29.


Eucalyptus by the sea
Aptos CA
Nicki is a 7-year-old little girl who began experiencing frequent seizures at six months of age. Her seizures were of multiple types; she needed multiple oral medications. Nevertheless, she continued to have up to 15 seizures each day, at least one of the grand mal type. I came to know Nicki and her family last year as the result of a request to do a Life Care Plan. I was aware Nicki had VNS therapy, but I had no idea what that meant. As I learned more, I was intrigued but skeptical, until I read the documentation in the medical record showing how effective it had been for her.

This article describes the physiological rationale for vagus nerve stimulation (VNS) therapy, the device itself, and implantation procedure. It also includes live links to video stories from real VNS patients, illustrating the effect of the therapy from a psychological and functional perspective. Finally, it provides resources for costs and additional information for the Life Care Planner.

According to an article published in the New England Journal of Medicine, “Forty-seven percent of epilepsy patients will obtain seizure freedom with the first antiepileptic medication in monotherapy. Fourteen percent will obtain seizure freedom with the second drug in monotherapy and then there will be diminishing returns.” (Kwan and Brodie, 2000). Despite the relatively high success rate for medications, one-third of individuals who have seizures do not get adequate control with medication. Literature from Cyberonics, the only approved manufacturer of the VNS electrode, states, “Approximately 900,000 Americans have tried two, three, or more medications but are still not seizure-free.”

Shelley Kinney has over 20 years of experience in critical care and rehabilitation nursing, case management, and Life Care Planning. Kinney Consulting, Inc. provides Life Care Planning services across the country and case management services in Nebraska and surrounding states. Ms. Kinney is the chairperson of the Editorial Committee for the American Association of Nurse Life Care Planners and frequently speaks at conferences for Life Care Planners, case managers, and vocational specialists. She can be contacted at 402-657-0143, or srkinney@cox.net.
These patients are the candidates for VNS therapy, currently approved in the U.S. for use in adults and children over the age of twelve.

**The Vagus Nerve Stimulator Device**

VNS is not brain surgery, and brain surgery is not required to implant it. VNS therapy produces an electrical current used to stimulate the vagus nerve. The generator is similar to a pacemaker in size and weight, and is implanted under general anesthesia in the left chest. A thin, flexible lead runs under the skin and wraps around the left vagus nerve in the neck. (Figure 1) The electrical device automatically sends mild electrical stimulations to the vagus nerve and the nerve acts as an electrode to further transmit the electrical signals to the brain. Various areas of the brain are stimulated, helping to prevent electrical irregularities that can cause seizures.

The device is programmed to cycle on and off continuously at an individually-determined rate. Once implanted, it is programmed with an external computer in the physician’s office. Over time, the cycles are tailored to the needs of each patient. The goals of treatment are reduced seizures, a reduction in the dosage or numbers of anti-seizure medications, shortened recovery period after seizure, and improved mood and alertness. Seizure freedom and freedom from anti-seizure medications are not the expected outcome, but do sometimes occur.

VNS is currently used as an adjunctive therapy; because each patient has an individualized response to the treatment, there is no way to predict what medication may be tapered or discontinued. A long-term outcome study of 436 VNS patients revealed “more than 60% of patients with (treatment-resistant epilepsy) experienced at least a 50% reduction in seizure burden.” (Elliott and Morsi, 2011)

Adult users of VNS Therapy report additional benefits of control over the seizure, and a feeling of empowerment. A magnet allows users (or parents/guardians) to activate the device when they are having a seizure, or feel they will have a seizure. In some people, this can prevent a seizure or reduce its severity. The device can be de-activated for a period of time if there are bothersome side effects that will impact an activity, for example, if a tremulous voice would hamper speaking in public. Extra magnets can be obtained so they are available where ever the individual spends time. The magnets are provided at

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*Figure 1. VNS in place*

Reprinted from VNS patient teaching materials with permission from Cyberonics.

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no cost by the manufacturer, and can be replaced at no cost as well.

As with any invasive procedure, there are risks including infection (1% of cases), nerve damage (1% of cases) and anesthesia risks. Cyberonics, the manufacturer of the device, addresses this information in their patient materials. With VNS, most side effects are present only when the device cycles into active mode. Those most bothersome side effects are hoarse voice, tingling in the throat, cough, and dyspnea. These normally subside over time. There can also be occasional gastrointestinal side effects if the stimulation runs down the nerve to the stomach, rather than upwards to the brain. Every attempt is made to help the current travel appropriately.

**Follow up care**

To achieve the best seizure control with the fewest side effects, plan on frequent follow-up office visits with a neurologist skilled in the use of VNS and associated programming. The local company representative is a resource for patients and families, and works closely with the physician at the time of implantation and initial programming, as well as in follow up. The company website provides a list of physicians for this at:


The neurologist will use a computer to check the stimulator and adjust its frequency, intensity, and cycle. Once an optimum program is achieved, office visits are no more frequent than for someone without the device.

VNS offers a high rate of patient satisfaction. Four out of five patients using VNS experience some reduction in seizures. (Alexopoulos and Kotagal, 2006) Seventy percent choose to continue VNS long term, and have the device replaced when the battery runs down. Device life is currently between five and ten years, depending on usage needed to achieve positive effects.

When doing a Life Care Plan which includes VNS, ask the neurologist how long the battery is expected to last before replacement. A new smaller but more powerful device was recently approved, with expected battery life of ten to sixteen years. However, long-term data are not yet available.

**First-person Accounts of VNS**

The first two videos, from the Epilepsy Foundation and a local newscast, show personal stories and ad-

continued next page
dress outcomes of the treatment, how the magnet is used to activate or turn off the device on demand, and what happens at an office visit.

http://www.youtube.com/watch?v=PdlqfdlSoT4&feature=g-vrec&context=G2ee5958RVAAAAAAAw

http://www.youtube.com/watch?v=kBHYTPoHlbE&feature=related

The next video was created by the manufacturer, and provides patient stories as well as information regarding the device.

http://www.youtube.com/watch?v=Ry426N0o1kM

The Life Care Plan
Life Care Planners often work with persons who have seizure disorders, e.g., related to birth trauma, brain injury, or epilepsy. Since this technology is available now, consider asking the treating physician whether VNS could be a treatment option for seizures that affect level of function.

• What other medications or treatments are you considering for seizure control, now and for the future?
• Have you considered VNS as an option to enhance seizure control?

• Are you considering referral to an epileptologist for evaluation for other options?
• If the neurologist presently manages VNS therapy, ask who performs device implantation and generator replacements, neurologist or surgeon.

If the person is already receiving VNS therapy, additional questions for the physician should include:

• When was the device placed?
• When and how often do you anticipate replacement of the generator?
• Where is this done? As an inpatient or an outpatient procedure?
• Who is the representative from the manufacturer in this area? Do you have contact information?
• Do you have plans to decrease or discontinue medications used to prevent seizures?
• How often do you anticipate office visits? Do you recommend visits with the primary care physician as well to monitor lab studies, etc.?
• Do you replace the device, or do you work with a surgeon who does this?
• Who in your office can give me your professional fees for implantation and monitoring of the device?

The costs for the device, initial surgery, battery replacement, and office visits should all be included in

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Nursing Diagnoses to Consider NANDA-I Nursing Diagnosis, 2012-2014

› **Readiness for Enhanced Self-Health Management** *(Domain 1, Health Promotion; Class 2, Health Management)*
› **Readiness for Enhanced Decision-Making** *(Domain 10, Life Principles; Class 3, Value/Belief/Action congruence)*
› **Risk for Falls**: *(Domain 11: Safety/Protection, Class 2: Physical Injury)*
› **Risk for Injury**: *(Domain 11: Safety/Protection, Class 2: Physical Injury)*
a life care plan and will vary greatly across the country and between different care providers. Be sure to address both routine office visits and those for VNS programming. The best resource for these costs is the office staff of the care provider, usually a neurologist.

While VNS therapy for children under 12 is not yet FDA-approved, the medical literature supports earlier initiation of treatment to obtain the best outcome (Rossignol, Lortie et al., 2009) and it is prescribed off-label.

Nicki started VNS therapy when she was four years old. The frequency and severity of her seizures significantly decreased. Grand mal seizures, once a daily occurrence, decreased to less than once weekly. Her physician was able to taper medications characterized as “strong enough to sedate an elephant,” allowing Nicki to participate in school and play activities. Her parents and teachers keep magnets on their wrists; if she begins to have a seizure, the magnet either stops it or shortens her recovery time to the point she no longer needs to leave school.

Resources
The local VNS representatives (presently all from Cyberonics) are very helpful. With the patient’s consent and based on the program in use, they can help estimate the life of the generator. They are not only responsible for sales support, but are also involved with device programming immediately after implantation and during follow-up visits. Cyberonics maintains a case manager help line at (888) 867-7846 for general questions, and can send you an information packet providing a general product overview. The website is very helpful as well; on the page for healthcare professionals, you can find coding information, education material written for medical professionals, and the physician education information.

http://us.cyberonics.com/en/vns-therapy-for-epilepsy/healthcare-professionals

For information regarding epilepsy, the Epilepsy Foundation is a great place to start to locate resources on nearly any topic related to the condition.

http://epilepsyfoundation.org/.

Ms. Kinney attached materials from Cyberonics which included full information on ICD-9 and CPT coding for VNS therapy, which we cannot reproduce here due to size. These can be obtained from Cyberonics’ reimbursement hotline at 888-867-7846.

References


Epilepsy Foundation. Epilepsy treatment – beyond medication. 2011 [Brochure]


Cochlear implants (CIs) have been commercially available in the United States for almost three decades. Over 200,000 people worldwide have received CIs, with more than 70,000 of those being in the U.S. (National Institute on Deafness and Other Communication Disorders, 2012). Cochlear implantation has become the standard of care for those seeking treatment for severe to profound hearing loss who derive limited benefit from amplification. As a result, it is becoming more common for professionals outside of hearing healthcare to encounter CI recipients in their respective practices. The purpose of this article is to provide an overview of relevant information about CIs for nursing professionals who may provide services or life-care planning for individuals with CIs. The following sections address (1) how a CI works, (2) what types of devices/equipment are currently in use, (3) who is a candidate to receive an implant, (4) what costs are associated with receiving and maintaining the implant, and (5) what appointments and related services/support are necessary for a comprehensive pre- and post-implant process. The final two sections list potential problems that may require patients to be referred back to the implant center, and a brief list of additional resources about CIs that are available online.

**How a Cochlear Implant Works**

In the normal-hearing ear, sound waves are transmitted to the cochlea via vibrations of the tympanic membrane and middle-ear ossicles. Because the cochlea is filled with fluid, the vibrations from sound waves set the

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cochlear fluid in motion (the “traveling wave”). This wave-like motion causes the cochlear hair cells to release neurotransmitters that initiate firing of auditory nerve fibers. With sensorineural hearing loss, the cochlea loses its ability to convert the mechanical motion of sound waves to neural impulses. Electrical stimulation from the CI serves as a way to bypass damaged cochlear structures or hair cell—nerve synapses that cause sensorineural hearing loss. The implant directly stimulates the auditory nerve with electrical current, which relays that information to the brain where it is interpreted as sound.

CIs consist of two primary components: a surgically-implanted portion (internal device) (Figure 1, top) and an external sound processor (Figure 1, bottom). The internal portion of the implant consists of two main parts: (1) a receiver/stimulator, which contains the electronics package, magnet, and antenna/receiver coil (placed under the skin behind the ear); and (2) an intracochlear electrode array, which is the only portion that is inserted into the cochlea. The external portion consists of four main parts: (1) a microphone, (2) a speech processor, (3) a transmitting coil, and (4) a battery. Figure 2 illustrates how the internal and external portions work together to provide sound. The microphone picks up sound and converts it to an electrical signal, which is sent to the speech processor. The speech processor filters the sound into separate frequency bands; the output of each band corresponds to a different electrode in the intracochlear array. The ordering of the frequency bands is designed to match up with the natural frequency-based organization of the cochlea. The digitized signal from the speech processor is sent via a cable to the transmitting coil, which is held to the head by a pair of magnets (one external and one internal). The external coil within the headpiece transmits the digitized, processed information across the skin via radio frequency.
frequency (RF) pulses to the internal receiver coil. The internal electronics package decodes the signal and sends current pulses for each frequency band to the corresponding electrodes implanted within the cochlea. The batteries in the external processor not only power the processor, but also provide power to the internal device via the RF link. Thus, the internal device does not require its own power supply.

Some individuals have only one CI (unilateral), others use a CI on one side and a hearing aid on the opposite side (bimodal), and others have CIs on both sides (bilateral). Bilateral CIs may be placed during the same surgery (simultaneously), or during separate surgeries (sequentially) that are anywhere from weeks to years apart. In the case of sequential bilateral implantation with a long time interval between surgeries, it is possible that recipients may have two different generations of CIs or even CIs from two different manufacturers. Figure 3 shows two children with bilateral cochlear implants in place.

Figure 3. Photo of two children with bilateral cochlear implants. Photo courtesy of Boys Town National Research Hospital.

Cochlear Implant Devices and Related Equipment
Currently, there are three different CI manufacturers with FDA-approved devices on the market in the US. The first manufacturer to receive FDA approval was Cochlear Ltd., for the Nucleus 22 device, in 1985. Cochlear is based in Australia and has a US office in Colorado. Cochlear has manufactured several generations of Nucleus devices, including the Nucleus 22, Nucleus 24M, Nucleus 24R, Nucleus 24RE (“Freedom”), and CI512. The second manufacturer to receive FDA approval was Advanced Bionics, for the Clarion 1.2 in 1996. Advanced Bionics is based in California, and their parent company, Sonova, is based in Switzerland. Advanced Bionics has also manufactured several generations of devices, including the Clarion 1.0 (first device; never FDA approved), CII, and HiRes 90K. The most recent manufacturer to receive FDA approval was MED-EL, for the COMBI 40+ in 2001. MED-EL is based in Austria and has a US office in North Carolina.

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MED-EL has also manufactured several generations of devices, including the COMBI 40+, PULSAR, SONATA, and CONCERT. Links to each of the manufacturers’ websites are included below in the section titled “Other Resources.”

Because the internal portion of the CI contains a magnet, recipients are limited in whether or not they can undergo an MRI, and/or what MRI strengths can be used. Newer-generation implants either have removable magnets in the internal device (Advanced Bionics, 2003; Cochlear Ltd., 2009) or are approved for MRI field strengths of up to 0.2 Tesla with the magnet in place (MED-EL, 2007). In the case of a removable magnet (i.e., newer Cochlear and Advanced Bionics devices), the magnet can either be removed before initial implantation if multiple MRIs are anticipated postoperatively, or the magnet can be removed at a later date (but before MRI) via an additional surgical procedure. Recipients should always check with the implant center regarding device-specific MRI limitations before receiving an MRI with a cochlear implant in place.

External speech processors are designed to interface with various other electronic devices. All current CI speech processors have a port for direct audio input (DAI). This port allows for devices such as MP3 players and cell phones to be directly coupled to the processor. Advantages of using the DAI include improved signal-to-noise ratio (i.e., how loud the signal of interest is relative to the background noise), and elimination of problems with coupling (i.e., earphones) to the speech-processor microphone. Most CI speech processors typically come with special cables that connect external equipment to the DAI input. Figure 4 shows an example of an MP3 player connected to the DAI port of a MED-EL behind-the-ear speech processor.

Listening with a CI can be challenging in the presence of background noise, especially for people with only one implant. With only a single CI, the brain does not receive input from two ears that is normally needed for sound localization and focusing on the talker in background noise. To improve speech understanding in noise, a frequency-modulation (FM) system can be coupled to the CI speech processor (e.g., Schafer & Thibodeau, 2003; Thibodeau, 2010). Although most anyone with a hearing aid or CI can use an FM system, they are more commonly used by children in the school setting (Figure 3). FM systems come in a variety of configurations; three options are shown in Figure 5. An FM system consists of a microphone and transmitter, which is worn by the talker. The listener (CI recipient) wears an FM receiver coupled to the speech processor, either via

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an induction neck-loop (Fig. 5, top), a wireless receiver (Figure 5, middle and Figure 3), or directly coupled via the DAI (Figure 5, bottom). These configurations essentially bring the talker’s voice straight to the listener’s ear, making it substantially louder than the background noise. FM systems cost around $2000 and are typically not covered by most insurance plans. However, most school systems do provide FM systems for children with hearing loss while in the classroom.

Candidacy
CI candidacy has changed significantly since implants were first FDA approved in 1985. When cochlear implants were first made available, only adults with profound hearing loss who had already developed spoken language (postlingually deafened) were candidates for the device. Those individuals had to demonstrate no benefit with appropriately-fit hearing aids. Since then, candidacy criteria have expanded to include individuals with more residual hearing (e.g., severe hearing loss instead of profound), congenitally (prelingually) deafened children, individuals with multiple disabilities, and deaf children at least 12 months of age. Present candidacy criteria vary slightly across manufacturers’ devices, but generally, candidates must be at least 12 months of age, have a severe to profound bilateral sensorineural hearing loss, obtain limited benefit from appropriately-fit hearing aids, have no contraindications for placement of the implant (i.e., must have an auditory nerve and patent cochlea), be medically able to un-

Figure 5. Example of an FM system setup. Three receiver options are shown: an induction neck loop with receiver, which requires the speech processor to have a telecoil (top); a small wireless receiver, which is plugged into the processor (middle); and a receiver plugged into the direct-audio-input port of the speech processor (bottom). Image courtesy of MED-EL. (http://www.medel.com/us/show/index/id/573/title/Examples-of-ALDs?PHPSESSID=6lphas4s8tt6kg8u5foop331).
dergo surgery, and have realistic expectations for outcomes with the device.

Benefits and Limitations of a Cochlear Implant
For postlingually deafened adults or children, the memory of familiar sounds can help provide meaning to unfamiliar sounds received through the implant. For this population, benefits can range from sound awareness or enhanced lip-reading cues to being able to use the telephone with an unfamiliar talker. Improved communication abilities can positively influence communication-related stress, self esteem, social isolation, job opportunities, and/or educational placement (e.g., Cohen et al., 2004; Faber & Grøntved, 2000). For prelingually deafened children, intensive therapy is needed to learn how to listen and speak using the signal from the implant. In the best case, children who are implanted at a young age (i.e., with shorter duration of deafness), receive regular and appropriate therapy and processor programming, and have no additional disabilities can develop speech, language, and auditory skills that are similar to that of normal-hearing children of the same age. Conversely, limited benefit may be that the implant only provides awareness to sounds in the environment.

There are a number of factors that can affect outcomes with a CI. These include duration of deafness, etiology, length of hearing aid use, (re)habilitation, and communication mode (Hammes et al., 2002). Numerous studies have shown that speech production, spoken language, and auditory skills develop at a faster rate and reach overall higher levels of performance if children are implanted at younger ages (i.e., under the age of about two years; Connor et al., 2006; Fryauf-Bertschy et al., 1997; Kirk et al., 2002; Lesinski-Schiedat et al., 2004; Nicholas & Geers, 2007; Waltzman and Roland, 2005). Some centers do implant children younger than 12 months, at the discretion of the caregivers and surgeon (Colletti et al., 2012). Implantation of children who are younger than 12 months tends to be more common in cases of deafness following meningitis. In these cases, it is critical to place the implant as quickly as possible if signs of cochlear ossification are present; otherwise, extensive ossification can prevent successful insertion of the electrode array.

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Regarding limitations, it is important to understand that CIs do not restore normal hearing. Rather, they provide a representation of sound that enhances communication through the auditory modality. There are no guarantees that post-implant speech understanding will be better than that pre-implant. Recipients should also understand that there is the potential to lose all residual acoustic hearing due to insertion of the electrode array, which can damage fragile cochlear structures that are necessary for acoustic hearing (Kiefer et al., 2005).

Finally, because CIs do not restore normal hearing, sound quality may be perceived as unnatural. Many postlingually deafened CI recipients report that music does not sound as good through a CI compared with what they remember (Gfeller et al., 2008).

**Costs and Warranties**
Cochlear implants, surgery, and follow-up appointments tend to be covered, at least in part, by most health insurance plans. The implant center typically submits a list of CPT codes to insurance carriers that require preauthorization. Significant costs to the recipients remain: copays, deductibles, processor upgrades, and other non-covered expenses (e.g., disposable batteries). These costs will vary widely across health plans and service providers. According to the American Academy of Otolaryngology–Head and Neck Surgery (2012), the total cost of cochlear implantation (evaluations, surgery, device, rehabilitation) is approximately $100,000. However, that source did not specify the total time interval covered, or whether the total cost was for a postlingually deafened adult or a prelingually deafened child.

Currently, the manufacturers’ list price for a single internal device and two speech processors (one is typically used as a backup) ranges from approximately $30,000 to $35,000. This does not include surgery, hospitalization, or other service delivery. As more people receive bilateral CIs, these costs may nearly double.

For all three manufacturers, the internal device currently carries a 10-year warranty. Warranties for speech processors are typically about three years. If a manufacturer introduces a newer-generation speech processor, recipients can often upgrade by purchasing a new processor (typical cost around $7500 to $8500), and manufacturers may offer a trade-in value for the old processor. Insurance usually does not pay for processor upgrades unless the old processor has been rendered obsolete by the manufacturer (i.e., they will no longer provide repair service for that processor) or is no longer functioning. Medicare, however, will cover a replacement processor once every five years.

**Pre- and Post-Implant Evaluations**
The first step of the CI process is the pre-implant evaluation to determine whether the patient is a candidate. It is important to ensure that potential recipients and their families/caregivers are well-informed.
regarding all aspects of the CI process. The evaluation typically involves comprehensive testing and consultation with several professional disciplines; therefore, it is important to consider only CI programs comprised of a multidisciplinary team. Expect the following appointments to be included in this process:

**Audiological Evaluation:** Hearing levels and speech understanding are measured with and without hearing aids. Hearing aids are assessed to ensure they are fit appropriately. Based on the test results, the audiologist may recommend a trial with a different set of hearing aids (e.g., high-power hearing aids or frequency compression aids).

**Vestibular Evaluation:** The health of the balance system is assessed with a battery of tests, typically performed by an audiologist. Because of the proximity of the hearing and balance organs within the inner ear, some etiologies that result in hearing loss can also cause balance disorders. Additionally, cochlear implantation may cause disruptions in the balance system.

**Speech/Language Evaluation:** For pediatric candidates, a speech-language pathologist evaluates the child’s overall communication abilities (including receptive and expressive language, functional auditory skills, and speech production) as well as the child’s potential for growth in these areas. The results are used to determine the child’s areas of strength, identify ways to help the child further develop communication skills, and serve as baseline from which to compare subsequent performance. For adults, especially those with pre- or peri-lingual onset of hearing loss, a functional auditory skills assessment may be appropriate.

**Cochlear Implant Orientation:** The purpose of this appointment is to provide information about how a CI works, specific information about each manufacturer’s device, what is involved in the surgical and post-implant process, expectations for outcomes with the device, and the need for ongoing special services following implantation. It is important to ensure the patient (and/or caregiver) has a good understanding of the benefits and limitations of a CI.

**CT and/or MRI:** CT is used to determine whether the cochlea and internal auditory nerve canal have normal morphology. If ossification is present, it can potentially compromise insertion of the cochlear

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As more people receive bilateral CIs, costs may nearly double.
implant electrode array. MRI is useful for evaluating the presence of an auditory nerve, particularly in cases where the CT shows a narrowing of the internal auditory canal and/or no behavioral responses to sound can be obtained.

**Medical Evaluation:** The otologist will obtain the medical and hearing health history, conduct an otoscopic examination, assess general health status, and discuss issues regarding the medical and surgical aspects of cochlear implantation. Imaging and other test results will be reviewed to determine whether the patient can safely undergo surgery, whether there are any anatomical issues that could prevent successful insertion or use of a CI, and determine which ear to implant if not bilateral.

**Other Evaluations:** Additional evaluations may be recommended on a case-by-case basis. These may include appointments with a neurologist, psychologist, counselor, geneticist, ophthalmologist, occupational therapist, physical therapist, or social worker, for example.

Once these evaluations are completed, the CI team provides a recommendation regarding candidacy. If the patient is deemed a candidate and elects to move forward, surgery is scheduled. The surgery typically takes between 1-3 hours and is usually performed on an outpatient basis.

Approximately 1-4 weeks after surgery, the initial stimulation occurs. This is when the audiologist fits the external speech processor by creating an individualized program (often called *mapping*) based on subjective responses from the recipient. In this process, the audiologist uses special software to stimulate each electrode, and the recipient reports the softest sound they can hear as well as what level is most comfortable. These measurements define the electrical dynamic range for the individual. The goal is to ensure that the incoming acoustic signal is represented using the right amount of current so that soft sounds are soft and loud sounds are loud but not uncomfortable.

For very young children, or those otherwise unable to provide reliable subjective feedback, objective electrophysiological tests are often performed to assist in the mapping process. These include measures of the auditory nerve (Hughes et al., 2000), auditory brainstem (Brown et al., 1994), middle ear muscle reflex (Hodges et al., 1997), or a combination of these (Gordon et al., 2004). Speech-processor maps are highly individualized; thus, recipients should never swap or try on another recipient’s processor. Newer CIs have technology built into the internal device so that it will only connect with the external processor that has been assigned to that implant. This safeguard prevents unintentional overstimula-

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Table 1. Approximate timeline and appointments to expect as part of the pre- and post-implant process. Adapted from Boys Town National Research Hospital [http://www.boystownhospital.org/hearingLoss/cochlearImplant/PediatricCochlearImplantProgram/Pages/FollowUpVisits.aspx](http://www.boystownhospital.org/hearingLoss/cochlearImplant/PediatricCochlearImplantProgram/Pages/FollowUpVisits.aspx)

*For children implanted before the age of 5 years.

<table>
<thead>
<tr>
<th>Visit</th>
<th>Appointments</th>
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| Pre-implant | · Audiological evaluation  
| | · Hearing aid trial (if not already completed)  
| | · Vestibular evaluation  
| | · Speech and language evaluation  
| | · Orientation/expectations discussion  
| | · CT scan and/or MRI  
| | · ENT office visit  
| | · Other specialists, as needed |
| Surgery (outpatient): 1-3 hours | |
| Initial Stimulation (IS)  
Day 1 | · ENT office visit  
| | · Baseline X-ray  
| | · Cochlear implant programming  
| Initial Stimulation (IS)  
Day 2 | · Cochlear implant programming  
| | · Auditory learning session  
| 1-2 weeks post-IS* | · Cochlear implant programming |
| 1 month post-IS | · Cochlear implant programming & speech perception testing  
| | · Auditory learning session  
| 3 months post-IS | · Cochlear implant programming & speech perception testing  
| | · Baseline electrophysiological testing  
| | · Auditory learning session  
| 6 months post-IS | · Cochlear implant programming & speech perception testing  
| | · Speech/language evaluation (for children under age 3)  
| | · Auditory learning session  
| | · ENT follow-up as needed  
| 9 months post-IS | · Cochlear implant programming & speech perception testing  
| | · Auditory learning session |
| 1 year post-IS | · Cochlear implant programming & speech perception testing  
| | · Speech/language evaluation  
| | · Auditory learning session  
| | · ENT follow-up as needed  
| Semi-annual visits  
(6-month intervals)* | · Cochlear implant programming & speech perception testing  
| | · Speech/language evaluation (for children under age 3)  
| | · Auditory learning session  
| | · ENT follow-up as needed |
tion from using a map that was not created for that recipient.

The entire cochlear implant process can be somewhat lengthy, and does not end once the initial processor fitting is over. Table 1 outlines the timeline and approximate number of visits to be expected as part of the candidacy and post-implant follow-up process. For all recipients, multiple visits are necessary within the first year to program the speech processor and periodically assess progress with the device.

For adults and older children who are post-lingually deafened, rehabilitation is helpful to learn how to “re-train” the brain to understand processed speech through a CI. For this group, periodic rehabilitation sessions may be needed for the first 6-12 months of device use.

For children who are born deaf or become deaf prior to learning spoken language, extensive therapy is needed to help them learn to use and understand sounds via the CI. Frequency and intensity of these habilitation sessions will vary widely according to the specific needs and resources available for each child. For a typically-developing child implanted early (i.e., around 12 months of age), weekly sessions will likely be needed for at least the first 2-3 years, assuming strong parental/caregiver involvement. For children with additional disabilities or late identification of hearing loss, more frequent and intensive therapy sessions over a longer time period will likely be necessary. Ongoing therapy and periodic formal assessments of speech, language, and auditory skills are therefore highly necessary for pediatric recipients.

When are Referrals or Follow-Up Needed?

The following scenarios describe when it may be necessary to refer a CI recipient back to the implanting center. Referrals should be made if any of the following are noticed or reported:

- Redness or swelling around the incision or implant site. This could be a sign of infection; recipients should be referred back to the implanting surgeon.

- Scabbing or redness of the skin under the magnet. This may be a sign that the magnet is too tight. Excessive pressure at the magnet site may cause tissue breakdown and may require subsequent surgical correction. Recipients should be referred back to the implanting surgeon.

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Infection in the implanted ear. Ear infections pose a greater risk of meningitis for CI recipients, and should be treated aggressively.

Decrease in performance with the device. These cases should be referred back to the CI audiologist. The cause could be related to a problem with the internal device, external equipment, or processor program.

Non-auditory percepts. Examples include complaints of pain near the implant site, pressure, eye or other facial twitches, or dizziness with the implant on. These should also be referred back to the CI audiologist, as they may indicate a problem with the internal device.

Refusal to wear the device. This may indicate a problem with the internal device, excessive loudness of the processor program, or physical discomfort with the magnet, coil, earhook, etc. These cases should be referred back to the CI audiologist.

Other Resources
The following list of websites provides additional information about cochlear implants. This list is by no means exhaustive.

- Advanced Bionics: http://www.advancedbionics.com/
- American Academy of Audiology: www.audiology.org
- American Academy of Otolaryngology—Head and Neck Surgery: http://www.entnet.org/HealthInformation/cochlearImplants.cfm
- Boys Town National Research Hospital: http://www.boystownhospital.org/hearingLoss/cochlearImplant/Pages/default.aspx
- Cochlear Americas: http://www.cochlearamericas.com/
- Healthy Hearing (FM systems with cochlear implants): http://www.healthyhearing.com/content/faqs/Technology/Cochlear-implants/31104-Fm-systems-with-cochlear

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MED-EL Corporation: http://www.medel.com/us/index/index/id/1/title/HOME


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MED-EL Corp. (2007). Instructions for use for the SONATI100 Cochlear Implant, rev. 1.0. Durham, NC, USA.


Recently I visited two families with experience with cochlear implant technology. They offer different perspectives. Cochlear implants are used in sensorineural hearing loss. They do not restore or cure hearing loss, but rather allow for the brain to perceive the sensation of sound. The benefits of a cochlear implant can depend on the age of the individual receiving the implant, whether he or she had developed any language skills, and the motivation of the patient and family members.

Trish Carlton (L) is 32 years of age. She is currently attending college with plans of becoming a social worker. She was born deaf and is one of the very first recipients of a cochlear implant, from the pioneer of cochlear implants in the US, Dr. William House. Trish’s mother Jean Carlton (R) also participated in our interview.

Britton Risor (L) is 22 years of age and is also attending college. She was born hearing and became a cochlear implant wearer much later than Trish. Britton received her implant at Trinity Lutheran Hospital from the founder of the Ear Institute in 1980, Dr. Charles Luette. Britton’s mother, Kelly Giles (R), became a deaf interpreter because of Britton’s hearing loss and now works with the Deaf community.

Q. When did the hearing loss begin and for what reason?
Jean Carlton: Trish was born deaf for unknown reasons.

Kelly Giles: We believe Britton was born hearing. I noticed around 10 months that her babble had diminished and she wasn't responding to sound consistently. Doctors are unsure of the actual cause of her hearing loss, but think it could be due to high fever and roseola (measles) at 9 months. She had usable aided hearing on the left and severe to profound loss on the right. She had hearing aids at 15 months and progressed with speech and language comprehension quite rapidly. Then at a routine audiology check up at age 3, we discovered she had lost the hearing in her left ear as well. Doctors believe that whatever caused the initial loss was most likely the reason for the secondary loss. "Her body is attacking itself," is one statement I recall them saying. The doctors explained that the hair cells in the right ear were dead, but the brain would “remember” the recent hearing she had in her left ear and recommended an implant to be placed right away.
so she would not lose the speech and language skills she had acquired.

Britton received the implant in her left ear, but has no hearing and no implant on the right side. Britton would like to have an implant in her right ear, but we have been told that she would likely only receive environmental sounds. She does so well without it that we have never pursued this.

Q. What was it like when the doctors first turned on the unit?

Jean Carlton: Since she never had hearing it was a real surprise. To have seen her expression was priceless.

Trish Carlton: I had my first cochlear implant when I was baby. When I was teenager, I wanted to get a second one. After the second one was placed I was thrilled! This is my third.

When I got my implant turned on, I was very nervous because I was not sure if it would be successful since I hadn’t been wearing my old one. When I first heard a tone from the computer, I was thrilled it worked.

Kelly Giles: The implant was turned on and programmed soon after Britton’s fourth birthday. I can vividly remember the first time it was turned on; after only having 5 channels programmed. I was standing behind her and I said, "Britton, can you hear momma?” She looked over her left shoulder at me with those big brown eyes and shook her head to affirm she indeed had heard me. Understandably, I had to excuse myself and have a good cry.

Q. Was there any noticeable increase in speech after the implant?

Jean Carlton: Yes. Her speech was not understandable before the implant.

Trish Carlton: I had people telling me that my speech improved and they are able to understand me better now. I noticed that I use my voice more now too.

Kelly Giles: Soon after programming we began intensive speech therapy and auditory training. I noticed a dramatic change in both her receptive and expressive language soon after surgery.

Britton Risor: People think I talk with an accent as if I am from a different part of the country. They don’t know I am deaf. I still struggle with the letter “R.”

Q. What did/does the care of the implant require?

Jean Carlton: It was not hard. She had one of the very first units ever implanted so it had wires going from her ears to a unit that was very much like a cell phone. I made pouches for it because being a young and active child I had to have a way of keeping it in place. It used batteries so they had to be tested and changed often.

Trish Carlton: Taking care of my current implant is easy. All I have to do is to put it in a dehumidifier box to clear any moisture. I have everything that I can use for cleaning or repairing if needed.

Kelly Giles: Britton’s biggest problem is she is hard on her implants. Once she dropped her implant in the Buf-
falo River and we had to get a canoe and go dive for it. Once she was at an amusement park and her implant got flung off during a ride. We had to practically shut the park down to find it!

**Britton Risor:** I hate replacing the batteries every two or three days. Now that I am on my own, I have had a hard time paying for them. I recently had to go a week without them due to lack of funds. A box that lasts less than one month costs $45. Luckily I read lips very well, but I hate not being able to hear.

**Q.** Did Trish attend public school as a mainstreamed student or at the deaf school?

**Trish Carlton:** I switched to the Deaf school when I was in middle of my seventh grade year and went there through my freshman year in my high school. I went back to public school my sophomore year.

**Kelly Giles:** Britton attended ASD (Arkansas School for the Deaf) from first through third grade. We then made the decision for her to attend school in Benton in the fourth grade....for numerous reasons.

**Britton Risor:** Changing to public school made me who I am today.

**Q.** If mainstreamed, was this successful and how so? Were tutors or interpreters required?

**Jean Carlton:** I think it was fairly successful. Trish started school being mainstreamed with help from interpreters. However, mainstreaming was new and I think in some cases education was watered down for Deaf children.

**Trish Carlton:** I absolutely loved when I was mainstreamed with other students because it challenged me to do better in school. I was able to learn new things just as all the other students. I had interpreters for all of my classes, allowing me to ask questions if I became curious about anything. I had always loved school; I still do. Being in college is my biggest challenge of all. Even while attending college, I still have interpreters for my classes.

**Kelly Giles:** Although Britton can function without an interpreter, I felt it necessary to be sure nothing was missed. She still has an interpreter for lectures in college.

**Q.** Was there any pressure from family or peers to have the implant replaced after it failed?

**Jean Carlton:** The pressure came when Trish was in the deaf school. The other kids made fun of her because of the wires. She just stopped wearing it until recently. She was reimplanted on the left side last year and in a few weeks will be obtaining a new implant on the right side.

**Trish Carlton:** The reason I chose to stop wearing it is because there was huge pressure from Deaf peers while I was in Deaf school, negativity about my implant. I was even bullied by some of the educators. I wanted to be a part of the Deaf community and was convinced that I was missing out somehow. I also honestly thought the bullying would stop when I gave up wearing it. I cracked under the pressure and gave it up.

When my family found out what I did, it caused a huge strain between us. After that, I did not wear my cochlear implant for a long time.

I did miss wearing it once in a while, but I did not go back wearing it again until last year. I was given a loan implant, but was so afraid I would break it.

When I learned there was a chance for me to obtain a replacement, I grabbed the chance and started the process.

Last January, I finally got approved for surgery. Throughout this process, it has been my decision to get this done.

I felt no pressure from my family at all and they have **continued next page**
been very supportive. I still have to deal with some strong negative reactions from others in the Deaf community, including some interpreters, but it is better now because there is a better understanding of how cochlear implants work.

I have learned to stand my ground. I refuse to give in to peer pressure. I am hoping it will resolve when we educate the Deaf community about the cochlear implant and have a better understanding why it has so many great benefits for the people who have them.

Q. Why was the decision made to replace the implant?

Jean Carlton: Trish made the decision to replace her implants herself. I think she finally realized what she was missing.

Trish Carlton: I knew I needed to wear my cochlear implant again because my speech had gotten worse over the years of not wearing one. I also knew that if I wanted to work alongside hearing people in the future, I needed to use it. I missed so much by not wearing it. I do regret the time I went without.

Kelly Giles: In fifth grade, Britton fell against a grate with an electrical outlet and was shocked. We didn’t know it had malfunctioned until we took her to the doctor. All we knew is that her behavior had really gone down; it was caused by her lack of hearing. I made the decision for her first implant, but now she was older and could tell me what she wanted.

Britton Risor: There was no question of my decision. I wanted the replacement. I wanted to hear!

Q. How much speech therapy is required after a cochlear implantation?

Jean Carlton: After the first ones were placed Trish had a lot of speech therapy. I worked with her every day and she was using the implant really well until she just gave it up and stopped using it.

Trish Carlton: I strongly recommend speech therapy. I knew when I stopped wearing the cochlear implant my speech got worse. I also knew I needed help to further improve my speech. I am not in speech therapy while I’m in college, but I recognize the benefits of getting speech therapy.

Kelly Giles: Britton received years of therapy in preschool programs as well as regular school settings.

Britton Risor: I wanted to learn how to talk, but it drove me insane when my parents had me to repeat words over and over. They labeled everything in our house, covered their mouths, and would require me to say the words constantly. It was frustrating at times, but it is also the reason I speak so well now.

Q. At what age was the implant first placed? How many replacements and at what age?

Jean Carlton: Trish actually made history because at the time she got her first implant it was still an experimental surgery. She was the youngest child born Deaf to get one. She was two years old at the time, but now they are implanting babies.

Trish Carlton: The first cochlear implant was placed when I was a baby. When I was around 12 years old, I got...
a second cochlear implant. My third surgery was to replace the nonworking cochlear implant on my left side. I am now scheduled for my fourth one (for the right side) because one of the cochlear implant wires is stuck to my ear drum.

**Britton Risor:** I have the original implant and the one replacement while I was in fifth grade. I still have the same processor, but it is out of date and no longer serviceable.

**Q. What is the recovery from surgery?**

**Jean Carlton:** When she received the first set the recovery was easy, maybe 6 weeks. However, it is much easier on children. Today they don’t make the incision as big, but Trish’s first implants were very large. The second is longer and a little harder because they have to remove the old implant first which requires some digging in the scalp. The recovery time is actually how long it takes the scar to heal. Her left ear that she got done last year took about eight weeks.

**Trish Carlton:** My recovery period from last year’s surgery went surprisingly well. I did have to deal with dizziness spells for a couple of weeks. I went back to college after only one week of recovery time.

**Kelly Giles:** The recovery process, after both surgeries, was uncomplicated. The staff indicated she would be down for a few days, but she was out playing ball the next day.

**Q. Do you have any idea of the cost for the implant and related services?**

**Jean Carlton:** The first time around insurance wasn't paying for it and for one implant it cost around $50,000. And we had travel expenses also.

**Kelly Giles:** The costs have never been an issue for us, until now. Unfortunately, Arkansas Medicaid will not provide any upgrades, batteries, payments for audiologist visits, and so forth after age 21. We did not learn this until she was 22. Now we are faced with the problem of buying batteries as well as an upgrade. If her current processor needs repair, Cochlear Corporation will not provide the services because her processor is beyond outdated. Therefore, we are currently searching for help to get an upgrade that costs over $8,000.

**Britton Risor:** I know that some people don’t get the same results I have had, but I would still recommend it. The one thing to remember is that this is brain surgery. This thing stays in your head forever and it can’t be taken out. It is a serious decision to make, but I would recommend it because of how happy I am with my cochlear implant. I have never regretted it.

Cochlear implant centers are now located all over the country. Teams of professionals such as audiologist, otologist, surgeon, psychologist, counselor and speech-language pathologists come together to work with patients throughout the process. With any device, it is important to know what the device will and will not do.

Researchers are now evaluating how cochlear implants might be used for other types of hearing loss and to improve upon the benefits provided by the implants. Other studies are exploring ways to make a cochlear implant convey the sounds of speech more clearly. For more information on these developments visit the National Institute on Deafness and Other Communication Disorders.
Deep brain stimulation (DBS) has been an established and effective treatment option for patients with a variety of movement disorders since the 1990s (Weaver et al., 2009). Currently, Parkinson’s disease (PD) and essential tremor (ET) are the only FDA approved indications for DBS, with dystonia being approved under a humanitarian device exemption (HDE). However, many more neurological and psychiatric disorders, typically treated symptomatically with medications, are currently being studied (Marks, 2001; Medtronic, 2012). In the past, patients who failed medical treatment often underwent invasive, ablative surgical procedures, such as thalamotomy and pallidotomy. While these procedures offer immediate symptom improvement, they are irreversible and associated with potentially serious complications, including hemiparesis, spasticity, ataxia, dysphagia, and dysarthria. Thus, the less-invasive, adjustable, and potentially reversible DBS is now the surgical procedure of choice for these disorders.

DBS is a neurosurgical procedure that implants a brain pacemaker device to deliver constant electrical stimulation to specific targets in the brain. Leads are placed in different areas of the brain according to the symptoms involved. DBS of the subthalamic nucleus

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(STN) or of the internal segment of globus pallidus (GPi) has been shown to significantly reduce rigidity, tremor, bradykinesia and, occasionally, gait disturbances, and subsequently improve motor complications in patients with moderate to severe PD (Rodriguez-Oroz et al., 2005). DBS of the ventral intermediate (Vim) thalamic nucleus has been shown to reduce tremors in PD and non-Parkinsonian ET (Benabid et al., 1991). (Table 1)

Even though DBS suppresses symptoms, it does not alter disease progression. (Marks, 2011)

**Patient Selection**

Proper patient selection is critical in order to maximize the post-operative benefits and minimize the surgical risks for the patient. Over 30% of DBS surgical failures are attributed to inappropriate patient selection (Bronstein et al., 2011). To justify the potential surgical risks of DBS, patients must be experiencing significant disability from their disorders, although what defines “significant disability” is subjective and must be individualized to each patient.

The goal of DBS is to maintain motor function and quality of life before disability becomes debilitating (Marks, 2011).

In general, DBS is recommended when pharmacotherapy no longer provides adequate symptom relief. Before qualifying for DBS, patients must have medication regimens optimized. In PD, a patient’s responsiveness to dopaminergic medication (i.e., levodopa) often is predictive of a positive outcome to DBS. Signs and symptoms unresponsive to levodopa are often resistant to DBS (Marks, 2011; Bronstein et al., 2011). continued next page

Table 1. Deep brain stimulation summary (Benabid et al., 1991; Hariz, 2002; Rodriquez-Oroz et al., 2005)

<table>
<thead>
<tr>
<th>Subthalamic nucleus: STN</th>
<th>Target Site Selection</th>
<th>Ventral intermediate thalamic nucleus: Vim</th>
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| Disease Intended to Treat | Internal globus pallidus: GPI | • ET  
• parkinsonian tremor |
| • PD  
• Dystonia (HDE) | • PD  
• Dystonia (HDE) | • Postural and action tremor |
| Symptoms Intended to Alleviate | | |
| • Tremor  
• Rigidity  
• Bradykinesia | • Dystonia and subsequent postural instability | |
| Stimulation-related side effects (26) | | • Confusion  
• Depression  
• Increase in akinesia  
• Induction of gait or speech disturbances |
| • Increased dyskinesias  
• Blepharospasm  
• Confusion/memory disturbances  
• Personality changes, mood changes, apathy  
• Cognitive changes  
• Dysphonia  
• Dysthria  
• Weight gain | • Paresthesias  
• Muscular cramp, dystonia  
• Dizziness  
• Dysarthria  
• Gait and balance disturbances, limb ataxia  
• Impaired proprioception  
• Decreased fine motor movement |
Ideal candidates have no medical contraindications, few comorbidities, good motor response to medications, and no significant cognitive impairment or behavioral disorders (Weaver et al. 2009). Patients with idiopathic PD receive the most benefit from DBS; other parkinsonian syndromes do not typically benefit from this procedure (Bronstein et al., 2011). PD symptoms such as micrographia, severe postural instability, freezing of gait, cognitive dysfunction, dysarthria, dysphagia, and dysautonomia are less responsive to DBS (Marks, 2011).

A detailed understanding of a patient’s cognitive status is essential. Patients with dementia may have the following challenges with DBS surgery:

- diminished motor response
- difficulty cooperating with the awake surgical procedure
- difficulty accurately describing symptoms, making adjusting the DBS settings and medications post-surgery more challenging
- worsening of cognitive status post-surgery (most concerning)

There is also concern that mood disorders (depression and anxiety) can worsen following surgery. Patients with severe, unresolved psychotic symptoms should be excluded from consideration for this procedure (Marks, 2011; Bronstein et al., 2011).

Patients are awake during the electrode lead placement, which can be quite stressful. Any neurologically-compromised patient may show exacerbation of symptoms under stress. For those with cognitive deficits, severe autonomic dysfunction or severe ataxia, DBS surgery may provide an unacceptable risk of significant complications. This becomes especially concerning in patients undergoing bilateral STN DBS (Hariz, 2002).

Untreated hypertension, coagulopathy or evidence of small vessel ischemia or extensive cerebral atrophy significantly increases the risk of hemorrhagic stroke (Hariz, 2002). Thus, patients typically undergo a preoperative MRI (magnetic resonance imaging) of the brain to rule out these risk factors. Longstanding diabetes and chronic immunosuppression are relative contraindications, as they significantly increase the risk of device-related infection (Marks, 2011).

Patients and family must thoroughly understand the expected outcomes for this procedure and have reasonable expectations (Hariz, 2002). Symptom improvement will take time as the patient and management team work to optimize stimulator settings and pharmacologic therapy. This will require continued next page
multiple clinic visits following the surgical procedure.

The Procedure
Patients undergo an extensive workup, on and off of medication therapies, prior to surgery including consultations with neurology, neurological surgery, neuropsychiatry, and nursing. The preoperative neurological examination is often videotaped to help assess treatment response postsurgery. A multidisciplinary case conference is held to review the patient’s medical history, motor testing scores, neuro-cognitive and psychiatric data, neuroimaging results and clinical assessment. This process provides a thorough determination of patient eligibility prior to scheduling DBS surgery.

To accurately implant a DBS lead into a deep brain structure, an operative plan is developed using a special high-resolution MRI scan. Targets are first identified using a 3-dimensional coordinate system, and further refined for each patient’s specific neuro-anatomical characteristics. A safe entry point and trajectory are determined, and the surgical plan is stored in a neuronavigation station (the planning station).

Under local anesthesia, a stereotactic headframe is secured to the patient’s skull and an additional imaging study (a specialized CT scan in our center) is obtained that allows the software program to guide the surgeon along the previously developed plan. This extra CT scan provides the final confirmation of the target localization as it is merged with the MRI on the planning station.

The patient is awake during microelectrode recording (MER) above and below the surgical target, which results in a physiological map that determines if the intended surgical target represents the dysfunctional area of the brain. As the probe advances along the predefined tract through the different areas in the brain, the patient is asked to perform tasks that are anatomically defined to best correlate with the MER. Such correlation provides ultimate confirmation of the target according to the expected sensorimotor responses clinically. Once the final DBS electrode is implanted, test stimulation is performed to confirm that the patient experiences therapeutic benefit without significant clinical side effects. Patients are typically discharged from the hospital 1-2 days after surgery.

The implanted pulse generator (IPG, “battery”, “neurostimulator”) is implanted under general anesthesia either on the same day as the electrode placement or at a later date (Weaver et al., 2009; Bronstein et al., 2011). If this portion of the surgery is done on a subsequent day, it is usually an outpatient procedure. The DBS leads are connected subcutaneously to the IPG near the clavicle using “lead extenders” (Medtronic Inc., 2012) (Figure 1)
Two to four weeks following IPG implantation, the patient returns to the clinic to have the stimulator turned on and programmed. Tremor and rigidity are typically the first signs targeted, although motor speed and gait are also assessed (Bronstein et al., 2011). The patient will then return for subsequent visits to adjust the stimulator and medications, as needed. Once therapy is optimized, often within 3-6 months, patients will return to the neurologist for ongoing management (Medtronic Inc., 2012; Bronstein et al., 2011). The IPG typically requires surgical replacement every three to five years, which is done on an outpatient basis under general or local anesthesia. (Medtronic Inc., 2012) DBS requires lifelong monitoring and follow-up. (Hariz, 2002)

**Surgical Outcomes**

In one of the most comprehensive, randomized, controlled trials comparing DBS to best medical therapy, DBS was found to be more effective in improving motor function and quality of life (Weaver et al., 2009). Weaver et al. found that DBS patients gained an average of 4.6 hours of “on” time per day (the amount of time when patients experience relief from Parkinson’s symptoms) with reductions in the amount of “on” time with dyskinesia and “off” time (the time when PD patients are not receiving relief from their symptoms). Self-reported improvements in motor functioning showed a 29% gain. In contrast, most patients undergoing best medical therapy showed no improvement in motor functioning after 6 months of treatment. Improved motor functioning scores were understandably associated with a significant improvement in quality of life measurements.

Weaver et al. found slight reductions in cognitive function test results in the DBS group compared to the best medical therapy group. This was consistent with previous findings suggesting an association with reduced verbal associative fluency, working memory and visuo-motor speed in patients who have undergone DBS.

Patients have reported symptom improvements for up to 5 years with DBS, particularly in motor fluctuations and tremor. Unfortunately, DBS does not appear to alter the disease progression of these neurodegenerative disorders (Bronstein et al., 2011).

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**Risks and Complications**

While DBS is intended to be minimally invasive and nonablative, it is associated with several concerning complications, some of which are irreversible. Rates of complications are quite variable from site to site (Bronstein et al., 2011). Patient selection, surgical methods and surgical team experience are critical components in minimizing these risks (Hariz, 2002). Accurate stereotactic radiological studies and intraoperative physio-logic corroboration of the target site(s) are critical to help limit the number of necessary exploratory tracks and limit surgical time, reducing hemorrhage and device-related infection risk. (Hariz, 2002) Symptomatic hemorrhage risk is 1.5-3% per lead implant. The risk of hemorrhage resulting in permanent morbidity is 0.5-1.0% per lead. (Marks, 2011) Serious infection related to the device insertion is approximately 10% per device. (Weaver et al. 2009)

**Frequent side effects** following DBS include falls, gait disturbances, depression, dystonia and surgical site pain and infection. Weaver et al. (2009) found that patients undergoing DBS experienced a serious adverse effect 3.8 times more than those patients undergoing best medical therapy; however, 99% of these events resolved within 6 months following the procedure. The majority of adverse events in the DBS patients occurred in the first 3 months post-surgery. Many of these events were anticipated outcomes in elderly surgical patients with comorbidities or temporary effects due to adjustments in stimulation and pharmacotherapy. Depression, anxiety and confusional state were the most common neurobehavioral adverse events.

**Fall risk** must be reviewed with patients. It is unclear if this increased risk is directly due to the DBS surgery or if it results secondary to the patients’ newly improved activity level. (Weaver et al. 2009)

**Device-related complications** including infection, skin erosion (1-2.5%), electrode migration (0-19%), electrode fracture (0-15%) and hardware failure may occur at any time following the device insertion (Hariz, 2002; Bronstein et al., 2011).

**Environmental-related complications** where the device is inadvertently turned off by an external magnetic device, resulting in an emergent hospital

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admission, can be avoided with the newer, magnetically-shielded IPGs (Hariz, 2002).

Previous ablative procedures were very effective at reducing tremor, but have a high incidence of balance problems and dysarthria. Thus, the postoperative flexibility to "program around" such side effects with DBS has been enthusiastically received by neurosurgeons as a substitute for thalamotomy (Benabid et al., 1991). Even a patient with a relatively uncomplicated diagnosis of ET is likely to encounter side effects of dysphagia, dysarthria, gait/balance problems and fine motor discoordination during a DBS programming session (Bronstein et al., 2011). The clinical challenge is to maximize the tremor control while minimizing such side effects.

**Future Roles of DBS**
While DBS is currently only FDA-approved for PD, ET and dystonia (under HDE), there are many exciting uses being investigated (*Figure 2*). The use of DBS in the treatment of the neurodegenerative disorder, Fragile X-associated Tremor Ataxia Syndrome (FXTAS), where patients initially present with intention tremor followed by gait ataxia, has recently been investigated (Hagerman et al., 2012). While the number of cases is very small, Vim DBS did show a dramatic effect on controlling tremor. In addition, it is likely, in the near future, that we will see DBS become an accepted treatment alternative for disease processes such as depression, epilepsy, eating disorder, cluster headaches, chronic and phantom limb pain, Tourette’s syndrome and posttraumatic coma (Pluta, Perazza, & Golub, 2011).

**Conclusions**
Over the past decade, DBS has become a well-established treatment for certain neurological disorders with PD, ET, and dystonia. The overall clinical results treating these conditions have been promising and gratifying. Like most neurosurgical procedures, DBS carries certain risks, some of which are procedure-related and some disease-specific. Careful and regimented protocols have been developed.

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oped and must be followed in selecting these patients to minimize the risks. Continued efforts are being made to improve and refine the technology and sustained benefits from DBS. New indications are being explored and systemically examined in various laboratories, and a variety of clinical trials are currently underway.

Editor’s note: The authors kindly supplied a reprint of Medtronic’s resource for DBS Therapy with all applicable ICD-9 and CPT codes and other information. Due to its size it is not reprinted here, and it is available from Medtronic reps or by contacting Medtronic.

**References**


As nurse life care planners we know bladder and bowel issues are generally non life-threatening, but our assessments indicate they can be life-altering for the clients we serve. Many of us are familiar with conservative, first-line treatments for bladder and bowel problems including, dietary modifications, biofeedback, bladder retraining, pelvic floor physical therapy and medications; but when these options fail, a client may choose to consider sacral neuromodulation therapy under advisement of their physician.

Persons with non-obstructive urinary retention often describe several trips to the toilet only to produce an unsatisfactory void with a weak dribbling stream. The individual is not able to empty the bladder or does so very inefficiently with minimal frequent voids. Bladder control issues can profoundly affect quality of life with everyday activities such as working, exercise, travel and socializing with family and friends. In addition, it is estimated as many as 18 million Americans suffer from fecal incontinence. Persons who suffer from fecal incontinence may feel embarrassed and ashamed, leaving them reluctant to seek medical attention. The loss of bowel control can be devastating as individuals attempt to hide the problem and withdraw from social relationships. (National Digestive Diseases Information Clearing House, 2012)

Sacral nerve stimulation (neuromodulation) therapy is a reversible and clinically-proven treatment for individuals with bladder and bowel control problems. Sacral neuromodulation therapy involves electrical stimulation of the nerves that control the bladder and bowel and is delivered via the InterStim therapy system by Medtronic, Inc.

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This device is FDA-approved to treat problems such as overactive bladder (urgency-frequency and urge incontinence), non-obstructive urinary retention, and chronic fecal incontinence and constipation.

Sacral neuromodulation therapy is contraindicated for persons with conditions such as, benign prostatic hyperplasia, cancer or urethral stricture, all of which may cause urinary symptoms due to an obstruction. (Medtronic for Health Care Professionals-Sacral Neuromodulation, 2012)

InterStim therapy uses an implantable system including a neurostimulator, a wire lead, and patient programmers to deliver mild electrical pulses to the sacral nerves. The neurostimulator is about the size of a stopwatch, and is surgically implanted under the skin in the upper buttock area. (Figure 1)

The implantable system uses a thin lead wire with four electrodes (Figure 2) to send mild electrical pulses to the sacral nerves that modulate pelvic floor neural activity of the lower urinary tract, urinary and anal sphincters, and colon.

**Mechanism of Action**

The precise mechanism of action is not fully understood but clinical studies have proven efficacy of sacral neuromodulation. It is thought the electrical pulses regulate the sacral nerves and assist in communication with the brain to affect bladder function. One review of the literature on the evolution of sacral neuromodulation therapy notes:

Symptoms of incontinence and voiding dysfunction may represent an alteration of the pelvic neuromuscular environment by changes in the inhibitory and excitatory signals on the voiding reflexes. Sacral neuromodulation is likely to exert its influence by alteration of sacral afferent inflow on storage and emptying reflexes. The findings that both urinary retention and overactive bladder are clinically affected by sacral neuromodulation may likely mean the treatment is modulating the central nervous system at the point where bladder storage and emptying occur. (Thompson, Sutherland & Siegel, 2010)

Sacral neuromodulation therapy may greatly improve urinary control symptoms in individuals diagnosed with non-obstructive urinary retention or overactive bladder. There are numerous reports of improved quality of life after being treated with InterStim therapy. (Aboseif, 2007)

Sacral neuromodulation is not a cure for bladder control problems but can reduce the number of voids

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or incontinence episodes by 50%. (Thompson, Sutherland, & Siegel, 2010)

**Trial Stimulation**
Sacral neuromodulation is unique because it is tested for potential success before surgically implanting the neurostimulator for long-term therapy. Test stimulation is an in-office or outpatient procedure using a local anesthetic. Two temporary test wires (leads) are placed percutaneously.

The client receives an external stimulator box connected to a cable (*Figure 3*); the cable is connected to the lead wires under the skin. The patient controls the amount of sacral nerve stimulation, up/down, on/off. The test stimulation should remain on, day and night, unless driving or bathing.

The health care providers teach the patient the stimulation may feel like a prominent pulsing, tingling, or vibrating sensation and should never be uncomfortable. The patient wears the external stimulator for six to seven days to determine if significant symptom reduction and improvement is achieved.

The patient is required to keep a bladder and/or bowel diary before and during the test stimulation process. This includes average 24-hour fluid intake, urine output volumes, frequency of trips to the toilet, leaking episodes, the degree of urgency, force of stream, and any pelvic and bladder pain.

**Implantation**
If the test stimulation is successful, as defined by the patient and treating physician, then a long-term neurostimulator is surgically implanted. This surgery is generally an outpatient procedure. The physician adjusts the initial stimulation settings. Following the implant the patient can control neurostimulation intensity with the external patient programmer, subject to individualized physician-set parameters.

As with any surgical procedure there are risks associated which may include swelling, bleeding, bruising, and infection. Sacral neuromodulation may cause pain at the implant site, lead wire migration or movement, device problems, interaction with other devices or diagnostic equipment such as MRI, unanticipated changes in urinary or bowel function and uncomfortable electrical pulse stimulation. The treatment is reversible after implantation and can be discontinued by removing the device or turning off the neurostimulator. (Medtronic for Healthcare Professionals- Sacral Neuromodulation, 2012)

**Clinical Experience**
The FDA originally approved the InterStim therapy system in 1997 for urge incontinence and in 1999 for urinary retention and significant urgency-frequency.

*continued next page*
symptoms. The FDA recently granted approval to use InterStim therapy for chronic bowel incontinence and constipation. Over 100,000 persons worldwide have received InterStim therapy. (Data from InterStim Sales Analysis, Medtronic, Inc. 2011)

Most private insurance companies cover InterStim therapy for urinary control. Medicare has a national policy providing coverage for all FDA-approved urinary control indications. Private insurance companies and local Medicare carriers are in the process of determining coverage for the use of InterStim therapy system for fecal incontinence and chronic constipation.

The following case studies provide a brief narrative and the cost estimate tables included in lifetime care plans for two clients with bladder problems, one of whom experienced intermittent bowel incontinence as well. The recommendations regarding MD followup and medical device replacement intervals listed in Tables 1 and 2 were obtained from treating physician consultation, medical records, urology office RNs, and clinical specialists at Medtronic, Inc. The cost figures and CPT codes were obtained from actual billing invoices, midwest hospital cost estimate patient services, and Medtronic, Inc. coding and reimbursement documents.

Case Study, Sacral Injury
Ms. Anderson is a 19-year-old female who sustained a severe burst fracture at the lumbar level and an incomplete spinal cord injury in a catastrophic fall. During the initial home visit she stated, “The past two and a half years since the injury have been very difficult due to frequent embarrassing bladder and bowel accidents.” She reported she rarely leaves her home due to the 14 daily trips to the toilet, and is no longer able to participate in the daily exercise instruction classes she enjoyed before the injury. The daily bladder incontinence and occasional bowel incontinence interfered with her enjoyment in life and her relationships with family and friends.

Her providing urologist obtained urodynamic studies including a complex uroflow and complex cystometrogram with void pressure and urethral pressure profile studies. She underwent cystoscopy and was catheterized for post-void residual urine. Ms. Anderson was diagnosed with incomplete bladder emptying, overactive bladder with urge incontinence, and recurrent urinary tract infections. She had physical therapy to improve pelvic muscle control, modified her dietary and fluid intake, and taken medication prescribed for overactive bladder, all of which treatments failed. She was not interested or willing to perform clean intermittent catheterization.

The urologist and Ms. Anderson discussed sacral neuromodulation and the use of the InterStim therapy system. She was willing to keep a baseline bladder diary. Bilateral peripheral nerve evaluation to determine if she would experience significant im-
Improve was performed in the physician’s office under local anesthesia. This is done using lateral fluoroscopy to identify the approximate sacral level and identify the corresponding skin entry point to position the peripheral nerve evaluation leads. The test stimulation period began.

Approximately one week later her bladder diary summary showed the following improvements: total leakage decreased, frequency decreased (from 14x/day to 7.5 to 8x/day), larger overall void volumes, and much less severe urge. She felt empty more often and her stream was stronger.

Ms. Anderson and her urologist were pleased with the significant symptom improvement. Three months after the initial visit with the nurse life care planner, Ms. Anderson had outpatient surgery under general anesthesia for implantation.

After implantation, Ms. Anderson had extensive postoperative follow up with treating urologist and urology RN. She was in weekly telephone contact with the nurse for education and stimulation adjustments.

Summary
In conclusion, sacral neuromodulation is a proven, effective treatment for bladder and bowel problems that have failed first line behavioral and medication treatments. It may be appropriate to ask your clients if they have discussed sacral neuromodulation therapy options with their physicians. Sacral neuromodulation is not a cure for bladder and bowel issues but clinical trials have reported significant

Nursing Diagnoses to Consider    NANDA-I Nursing Diagnosis, 2012-2014

- **Impaired Urinary Elimination**: (Domain 3, Elimination and Exchange; Class 1, Urinary Function)
- **Overflow Urinary Incontinence**: Involuntary loss of urine associated with overdistension of the bladder (Domain 3, Elimination and Exchange; Class 1, Urinary Function)
- **Reflex Urinary Incontinence**: Involuntary loss of urine at somewhat predictable intervals when a specific bladder volume is reached (Domain 3, Elimination and Exchange; Class 1, Urinary Function)
- **Stress Urinary Incontinence**: Sudden leakage of urine with activities that increase intra-abdominal pressure (Domain 3, Elimination and Exchange; Class 1, Urinary Function)
- **Urge Urinary Incontinence**: Involuntary passage of urine occurring soon after a strong sense of urgency to void (Domain 3, Elimination and Exchange; Class 1, Urinary Function)
- **Bowel Incontinence**: (Domain 3, Elimination and Exchange; Class 2, Gastrointestinal Function)
- **Constipation**: (Domain 3, Elimination and Exchange; Class 2, Gastrointestinal Function)
- **Situational Low Self-Esteem**: (Domain 6, Self-Perception; Class 2: Self-Esteem)
- **Social Isolation** (Domain 12, Comfort; Class 3, Social Comfort)
symptom improvement. Ms. Anderson reported significant quality of life improvements, including the emotional ability to return to work and a renewed interest in socializing with family and friends.

Bibliography


Data from InterStim Sales Analysis. Medtronic, Inc. August 2011.

http://digestive.niddk.nih.gov/ddiseases/pubs/fecalincontinence/
Accessed April 2012.

InterStim Therapy Clinical Summary 2011. Medtronic, Inc.

Medtronic- Sacral Neuromodulation for Health Care Professionals
http://professional.medtronic.com/pt/uro/snm/cdu/about/index.htm
Accessed April 2012.


Table 1. Codes and costs, case study. See text for explanation of sources.

<table>
<thead>
<tr>
<th>Item/Procedure</th>
<th>Replacement</th>
<th>Base Cost</th>
<th>Annual Cost</th>
<th>Resources</th>
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</thead>
<tbody>
<tr>
<td>Trial Percutaneous lead placement in urology office CPT 64561</td>
<td>One-time office test stimulation</td>
<td>$3,949.00</td>
<td>One time cost</td>
<td>MD billing office</td>
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<tr>
<td>Initial implantation or subsequent replacement of peripheral neurostimulator generator-battery CPT 64590</td>
<td>Every 3-5 years (average every 4 years)</td>
<td>$56,056.00</td>
<td>$14,014.00</td>
<td>• Actual hospital billing statement • MD business office • Anesthesia cost estimate</td>
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<td>Implantation/replacement of neurostimulator electrodes CPT 64581</td>
<td>1-2 replaced in lifetime if electrodes migrate or break.</td>
<td>$33,312 - $66,624</td>
<td>• Facility • Surgeon • Anesthesia</td>
<td>• Hospital cost estimate • MD business office • Anesthesia cost estimate</td>
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<tr>
<td>InterStim remote control programmer</td>
<td>2 replaced in lifetime</td>
<td>$1,200</td>
<td>--</td>
<td>Urology nurse</td>
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</table>

Table 2. Followup medical services, case study. See text for explanation of sources.

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<th>Service</th>
<th>Frequency</th>
<th>Base Cost</th>
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<th>Resource</th>
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<tbody>
<tr>
<td>Urology Visit</td>
<td>3 visits in 1st year after implant Then 1-2 visits/year</td>
<td>$185.00</td>
<td>$644.00 1st year, then $274.00</td>
<td>MD business office</td>
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<td>Office Visit with Nurse &amp; MD CPT 95972</td>
<td>4-6 visits 1st year, then 1-2 visits/year</td>
<td>$218.00/visit</td>
<td>$1,090.00 1st year, then $218.00</td>
<td>MD business office</td>
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Cancellation Policy
All Cancellations must be in writing and sent to AANLCP. You will receive a full refund, minus $100 processing fee to all cancellations postmarked on or before September 15, 2012. Cancellations postmarked or received September 15 to September 28, 2012 will receive a 50% refund minus the $100 processing fee. No refunds after September 29, 2012. Please keep a copy of your registration form for your records. AANLCP reserves the right to substitute faculty or to cancel due to low enrollment of other unforeseen circumstances. If AANLCP must cancel registrants will receive full credit or refunds of their paid registration fees. No refunds will be made for lodging or travel.

Rising to New Heights
Albuquerque, NM Sheraton Uptown

Please print clearly. Please submit a separate form for each individual.

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<tr>
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<td>Standard registration postmarked by 9/15/12 $625 (member) / $800 (non-member)</td>
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### CONFERENCE AGENDA

**Friday, October 12, 2012 - Pre-Conferences**

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<tr>
<td>8:00 am - 5:00 pm</td>
<td>MSA Update</td>
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<td>Launching and Maintaining a Successful Business -FREE (with paid registration)</td>
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**Saturday, October 13, 2012**

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<th>Time</th>
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<tr>
<td>7:00 am - 8:00 am</td>
<td>Continental Breakfast - Visit Vendors</td>
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<tr>
<td>8:00 am - 8:15 am</td>
<td>Welcome: Anne Sambucini, AANLCP President</td>
</tr>
<tr>
<td>8:15 am - 9:15 am</td>
<td>Keynote Address: Life Care Planning - A Nursing Specialty</td>
</tr>
<tr>
<td></td>
<td>Carol J. Bickford, PhD, RN-BC, CPHIMS</td>
</tr>
<tr>
<td></td>
<td>Senior Policy Fellow in the Department of Nursing Practice and Policy, American Nurses Association</td>
</tr>
<tr>
<td>9:15 am - 10:30 am</td>
<td>Presentation: Using AANLCP's 2012 Scope and Standards of Practice to Optimize Your Role as a Nurse Life Care Planner</td>
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<tr>
<td>10:30 am - 11:00 am</td>
<td>Break with Vendors</td>
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<tr>
<td>11:00 am - 12:00 pm</td>
<td>Presentation: Incorporating Evidence Based Practice into the Nursing Process</td>
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<tr>
<td></td>
<td>Judy Metekingi MS RN CRRN CDMS CCM LNCC CLCP</td>
</tr>
<tr>
<td>12:00 pm - 1:00 pm</td>
<td>Networking Lunch</td>
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<tr>
<td>1:00 pm - 2:15 pm</td>
<td>Presentation: Conditional and Secondary Payments: What you need to know even if you are not preparing MSAs</td>
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<tr>
<td>2:15 pm - 3:00 pm</td>
<td>Presentation: Advanced Processes and Techniques for Review/Critique of Life Care Plans and Daubert Challenges</td>
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<tr>
<td></td>
<td>Kelly Lance BSN, RN, CNLP, LNCNP-C; Founder, AANLCP</td>
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<tr>
<td>3:00 pm - 3:30 pm</td>
<td>Break with Vendors</td>
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<tr>
<td>3:30 pm - 4:45 pm</td>
<td>Presentation: Champagne Marketing on a Beer Budget</td>
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<td>Lucy Rosen, President, SmartMarketing Communications</td>
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<tr>
<td>5:00 pm - 9:30 pm</td>
<td>Diamond Club Dinner at Balloon Museum</td>
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**Sunday, October 14, 2012**

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<th>Time</th>
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<td>7:00 am - 8:00 am</td>
<td>Continental Breakfast - Visit Vendors</td>
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<tr>
<td>8:00 am - 9:30 am</td>
<td>Presentation: TBA</td>
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<tr>
<td>9:30 am - 10:00 am</td>
<td>Break with Vendors</td>
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<tr>
<td>10:00 am - 11:15 am</td>
<td>Presentation: More than Words: Speech-Language Pathology Supports and Amplifies the Life Care Plan</td>
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<td>Sally Asquith, MS, CC-SLP</td>
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<tr>
<td>11:30 am - 12:30 pm</td>
<td>Presentation: Spinal Cord Injury and Aging: Applying Evidenced Based Research</td>
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<td>Linda Nelson CCM, CLCP, MSCC</td>
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<td>12:30 pm - 1:30 pm</td>
<td>Lunch with Speaker TBA</td>
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<td>1:45 pm - 3:15 pm</td>
<td>Presentation: Advances in Integrated Specialty Bed Options</td>
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<td>Tricia Litzinger, RN, BSN, CCM, CDS, Hill Rom</td>
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<td>3:15 pm - 3:45 pm</td>
<td>Break with Vendors</td>
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<tr>
<td>3:45 pm - 4:45 pm</td>
<td>Presentation: TBA</td>
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<tr>
<td>5:00 pm - 6:00 pm</td>
<td>Presentation: TBA</td>
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<tr>
<td>6:30 pm - 9:00 pm</td>
<td>Dinner and Silent Auction</td>
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**Monday, October 15, 2012**

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<th>Time</th>
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<tr>
<td>7:00 am - 7:30 am</td>
<td>Continental Breakfast</td>
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<tr>
<td>7:30 am - 9:30 am</td>
<td>Membership Meeting - All AANLCP Members Welcome</td>
</tr>
<tr>
<td>9:30 am - 9:45 am</td>
<td>Break</td>
</tr>
<tr>
<td>9:45 am - 11:00 am</td>
<td>Presentation: Life Care Planning Within the Private Sector: Elder Care and Special Needs Trusts</td>
</tr>
<tr>
<td></td>
<td>Lori Lomahan, LCSW, Shay Jacobson, RN MA</td>
</tr>
<tr>
<td>11:15 am - 11:45 am</td>
<td>Presentation: Working with Estate and Special Needs Trusts, Conservators and Guardians</td>
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<tr>
<td>11:45 am - 12:45 pm</td>
<td>Presentation: Creating Life Care Plans for Persons with Significant Pre-Existing Disabilities</td>
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<tr>
<td></td>
<td>Lynn Trautwein MSN, RN, CCM, CMM, CMAC, CNLCP</td>
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<tr>
<td></td>
<td>Nancy J. Bond, M.Ed, CCM, CLCP</td>
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<tr>
<td>12:45pm - 1:15 pm</td>
<td>Closing Remarks and Evaluations</td>
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