Medical Coverage Policy

Effective Date.....7/15/2025
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Coverage Policy Number..... 0391

Diaphragmatic/Phrenic Nerve Stimulation

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Related Coverage Resources

Electrical Stimulation Therapy and Home Devices

INSTRUCTIONS FOR USE

The following Coverage Policy applies to health benefit plans administered by Cigna Companies. Certain Cigna Companies and/or lines of business only provide utilization review services to clients and do not make coverage determinations. References to standard benefit plan language and coverage determinations do not apply to those clients. Coverage Policies are intended to provide guidance in interpreting certain standard benefit plans administered by Cigna Companies. Please note, the terms of a customer's particular benefit plan document [Group Service Agreement, Evidence of Coverage, Certificate of Coverage, Summary Plan Description (SPD) or similar plan document] may differ significantly from the standard benefit plans upon which these Coverage Policies are based. For example, a customer's benefit plan document may contain a specific exclusion related to a topic addressed in a Coverage Policy. In the event of a conflict, a customer's benefit plan document always supersedes the information in the Coverage Policies. In the absence of a controlling federal or state coverage mandate, benefits are ultimately determined by the terms of the applicable benefit plan document. Coverage determinations in each specific instance require consideration of 1) the terms of the applicable benefit plan document in effect on the date of service; 2) any applicable laws/regulations; 3) any relevant collateral source materials including Coverage Policies and; 4) the specific facts of the particular situation. Each coverage request should be reviewed on its own merits. Medical directors are expected to exercise clinical judgment where appropriate and have discretion in making individual coverage determinations. Where coverage for care or services does not depend on specific circumstances, reimbursement will only be provided if a requested service(s) is submitted in accordance with the relevant criteria outlined in the applicable Coverage Policy, including covered diagnosis and/or procedure code(s). Reimbursement is not allowed for services when billed for conditions or diagnoses that are not covered under this Coverage Policy (see "Coding Information" below). When billing, providers must use the most appropriate codes as of the effective date of the submission. Claims submitted for services that are not accompanied by covered code(s) under the applicable Coverage Policy will be denied as not covered. Coverage Policies relate exclusively to the administration of health

benefit plans. Coverage Policies are not recommendations for treatment and should never be used as treatment guidelines. In certain markets, delegated vendor guidelines may be used to support medical necessity and other coverage determinations.

Overview

This Coverage Policy addresses diaphragmatic/phrenic (D/P) nerve stimulation and diaphragm pacing systems. D/P pacing is the electrical stimulation of the diaphragm via the phrenic nerve, the major nerve supply to the diaphragm that controls breathing.

Coverage Policy

Diaphragmatic/phrenic (D/P) nerve stimulation with the Avery Diaphragm Pacing System (previously the Mark IV™ Breathing Pacemaker System) as an alternative to invasive mechanical ventilation is considered medically necessary for an individual with severe, chronic respiratory failure requiring mechanical ventilation for EITHER of the following:

- alveolar hypoventilation, either primary or secondary to a brainstem disorder
- interruption of neuronal conduction at the upper cervical level, at or above the C3 vertebral level

AND when ALL of the following criteria are met:

- There is integrity of the intrathoracic section of the phrenic nerve.
- Diaphragmatic function is sufficient to accommodate chronic stimulation.
- Baseline estimated pulmonary function test is known, or likely, to be adequate.
- Individual has normal chest anatomy, normal level of consciousness, and the ability to participate in and complete the training and rehabilitation associated with the use of the device.

The NeuRx DPS® RA/4 Respiratory Stimulation System is considered medically necessary when provided in accordance with the Humanitarian Device Exemption (HDE) specifications of the U.S. Food and Drug Administration (FDA) and the individual meets ALL of the following criteria:

- Age 18 years and older
- Has a stable, high spinal cord injury
- Has a stimulable diaphragm (but lacks control of the diaphragm)

Health Equity Considerations

Health equity is the highest level of health for all people; health inequity is the avoidable difference in health status or distribution of health resources due to the social conditions in which people are born, grow, live, work, and age.

Social determinants of health are the conditions in the environment that affect a wide range of health, functioning, and quality of life outcomes and risks. Examples include safe housing, transportation and neighborhoods; racism, discrimination and violence; education, job

opportunities and income; access to nutritious foods and physical activity opportunities; access to clean air and water; and language and literacy skills.

General Background

Diaphragmatic/Phrenic Nerve Stimulators for Ventilator-Dependent Conditions
Patients with high-level, C1-C3 spinal cord injuries typically experience respiratory muscle paralysis leading to chronic ventilatory insufficiency. The standard therapy for these patients is chronic mechanical ventilation via tracheostomy. Diaphragmatic/phrenic (D/P) nerve stimulation is an alternative to mechanical ventilation for a select subgroup of patients. D/P nerve stimulation is also referred to as diaphragmatic/phrenic (D/P) nerve pacing, phrenic pacing, phrenic nerve stimulation, diaphragm pacing, or electrophrenic respiration. "An implanted diaphragmatic/phrenic nerve stimulator is a device that provides electrical stimulation of a patient's phrenic nerve to contract the diaphragm rhythmically and produce breathing in patients who have hypoventilation (a state in which an abnormally low amount of air enters the lungs) caused by brain stem disease, high cervical spinal cord injury, or chronic lung disease. The stimulator consists of an implanted receiver with electrodes that are placed around the patient's phrenic nerve and an external transmitter for transmitting the stimulating pulses across the patient's skin to the implanted receiver" (U.S. Food and Drug Administration [FDA], 2025).

The two FDA approved D/P pacing systems are the Avery Diaphragm Pacing System previously known as the Mark IV™ Breathing Pacemaker System (Avery Biomedical Device, Inc., Commack, NY) and the NeuRx DPS® RA/4 Respiratory Stimulation System (Synapse Biomedical Inc., Oberlin, OH). Prior to implantation, patients may undergo diaphragm electromyography (EMG), pulmonary function studies and/or polysomnography (i.e., sleep study).

Avery Diaphragm Pacing System previously known as the Mark IV™ Breathing Pacemaker System
The Avery Diaphragm Pacing (Mark IV) system is connected to the phrenic nerve via surgically implanted receivers and electrodes in the neck or chest area (i.e., thoracotomy) which are connected to an external transmitter. Implantation is indicated in patients with alveolar hypoventilation due to primary or secondary brainstem disorders or interruption of neuronal conduction at or above the C3 vertebral level. Diagnoses of patients who may be candidates for Avery Diaphragm Pacing (Mark IV) pacing include: complete or incomplete quadriplegia, congenital central hypoventilation syndrome (i.e., Ondine's curse), diaphragmatic paralysis, central sleep apnea, brainstem stroke, brain tumor, brain injury or Arnold-Chiari malformation.

For Avery Diaphragm Pacemaker (Mark IV) pacing to be effective, candidates must have an intact phrenic nerve, a functional diaphragm, normal chest anatomy, and uncompromised lung function. The patient should be alert, mentally competent, motivated and able to complete the training and rehabilitation needed for a successful outcome.

U.S. Food and Drug Administration (FDA): The Avery Diaphragm Pacing (Mark IV ™ Breathing Pacemaker) System (Avery Biomedical Devices, Inc.) is approved by the FDA premarket approval (PMA) process as a Class III neurologic therapeutic device. The device is indicated "for persons who require chronic ventilatory support because of upper motor neuron respiratory muscle paralysis (RMP) or because of central alveolar hypoventilation (CAH) and whose remaining phrenic nerve, lung, and diaphragm function is sufficient to accommodate electrical stimulation" (FDA, 2000).

Literature Review: Nonrandomized comparative studies, prospective case series and retrospective reviews have reported that the Mark IV device is a safe and effective alternative to

invasive mechanical ventilation and is considered an established alternative therapy in appropriate candidates. Clinical trials with up to ten years follow-up reported success rates of 73%–94% and included adult and pediatric patients with spinal cord injuries, congenital central alveolar hypoventilation syndrome and other causes of respiratory failure (Hirschfeld, et al., 2008; Elefteriades, et al., 2002; Shaul, et al., 2002; Garrido-Garcia, et al., 1998).

NeuRx DPS® RA/4 Respiratory Stimulation System

The NeuRx system is laparoscopically connected at the phrenic nerve motor point region in the diaphragm (i.e., intramuscular diaphragm pacing, direct pacing, or laparoscopic D/P pacing). This approach avoids the need for cervical or thoracic access to the phrenic nerve and the potential risk of phrenic nerve damage. The repetitive electrical stimulus by the pacer produces a rhythmic contraction of the diaphragm and a normal breathing pattern (i.e., inhalation upon electrical stimulation and exhalation on cessation of stimulation). The system includes four electrodes implanted in the diaphragm, a fifth electrode that completes the electrical circuit, a cable and an external pulse generator. Diaphragm stimulation devices are intended to lessen dependence on mechanical ventilators, increase mobility and independence, improve speech and sense of taste and smell, and reduce secretions and risks of infection. The NeuRx system has been proposed in patients with stable, high spinal cord injuries with a stimulatable diaphragm.

Spinal Cord Injury

U.S. Food and Drug Administration (FDA): In June 2008, the NeuRx DPS® RA/4 Respiratory Stimulation System (Synapse Biomedical) received FDA approval under the Humanitarian Device Exemption (HDE) process (H070003) for patients' age 18 years and older. The device is "intended for use in patients with stable, high spinal cord injuries with stimulatable diaphragms, but lack control of their diaphragms. The device is indicated to allow the patients to breathe without the assistance of a mechanical ventilator for at least four continuous hours a day" (FDA, 2008).

Literature Review Spinal Cord Injury: As the FDA approval for the NeuRx DPS® RA/4 Respiratory Stimulation System is an HDE, it is unlikely that there will be a sufficient body of evidence to conclusively demonstrate the safety and efficacy of this device. The available studies in the peer-reviewed published scientific literature are primarily in the form of case series and retrospective reviews. The studies (n=10-50) reported that a majority of the ventilatory dependant patients with spinal cord injuries were successfully transitioned to and paced with the NeuRx device from at least four hours and some patients up to 24 hours of the day. The available studies are limited by lack of a control or comparator group, small sample size, quality of life outcomes and long-term follow-up (Posluszny, et al., 2014, Onders, et al., 2009; Alshekhlee, et al., 2008; Onders, et al., 2007).

FDA HDE approval of the NeuRx device was based on a prospective, non-randomized, multicenter clinical trial (FDA Summary of Safety and Probable Benefit [SBSS], 2008; Onders, et al., 2009). A total of 50 patients were enrolled in this study at five investigational sites beginning in the year 2000. Patients in this study group have all suffered from high spinal cord injury and were full-time dependent on positive pressure mechanical ventilation prior to enrollment. The age of enrolled patients was from 18-74 years of age. The primary endpoint was to assess the ability of the NeuRx device to provide clinically acceptable tidal volume for at least four continuous hours of pacing. The safety endpoint was to qualitatively assess the adverse event reports and compare these to a similar patient population. Secondary endpoints include reduction of dependence on mechanical ventilation and surgical implementation site independence.

Inclusion criteria:

- age 18 years or older;
- cervical spinal cord injury with dependence on mechanical ventilation;
- clinically stable following acute spinal cord injury;

- bilateral phrenic nerve function clinically acceptable as demonstrated with EMG recordings and nerve conduction times;
- diaphragm movement with stimulation visible under fluoroscopy;
- clinically acceptable oxygenation on room air (greater than 90% 02 saturation);
- hemodynamically stable;
- no medical co-morbidities that would interfere with the proper placement or function of the device;
- committed primary caregiver;
- negative pregnancy test in females of child-bearing potential;
- informed consent from the device user or designated representative.

Exclusion criteria:

- co-morbid medical conditions that preclude surgery;
- active lung disease (obstructive, restrictive or membrane diseases);
- active cardiovascular disease or active brain disease;
- hemodynamic instability or low oxygen levels on room air;
- hospitalization for or a treated active infection, within the last 3 months;
- significant scoliosis or chest deformity;
- marked obesity;
- anticipated poor compliance with protocol by either the device user or primary caregiver;
- currently breastfeeding.

The authors reported average follow-up of 2.0±1.5 years (median 1.6 years, range 0.5–8.0 years). Overall, a total of 48 out of 50 patients enrolled were able to pace for longer than four consecutive hours while achieving tidal volumes greater than their basal metabolic requirements. At the end of the study period, a total of 44 patients were actively using the device for an unspecified period of time. About 50% of the patients had used the device for more than 24 continuous hours. Five deaths, which do not appear to be device-related, were reported during the study. Two deaths occurred during mechanical ventilation, and two deaths occurred during intramuscular diaphragm stimulation. One patient lost consciousness while the stimulator was functioning, and a second patient on the stimulator died of septic shock due to urosepsis. One patient was not able to be paced. There were eleven incidents of aspiration and three incidents of upper airway obstruction that occurred in three patients. Use of the device for periods greater than four continuous hours a day occurred after a period of diaphragmatic conditioning that ranged from one week to several months.

The most frequent reported adverse event attributable to this device was capnothorax. A total of 42% of the patients enrolled in the clinical study experienced this complication in association with implantation of the electrodes in the diaphragm. While no patients experienced compromised pulmonary gas exchange or hemodynamic instability as a result of the capnothorax, affected patients required treatment with a chest tube, for up to two days in one patient, and an extended hospital stay of five days, in one patient. The manufacturer addressed this risk in the labeling and training procedure provided with this device. This study did not report quality of life outcomes such as mobility, speech, comfort levels, and sense of taste and smell. This study lacked a control or comparator group.

Pediatric Population

Literature Review: Diaphragmatic/ phrenic nerve stimulation has been proposed in the pediatric population (i.e., individuals < 18 years of age) for a variety of conditions including tetraplegia, congenital central alveolar hypoventilation syndrome (CCAHS), cervical spinal cord injury, acute flaccid myelitis, and central neurological cause. The available studies in the peer-reviewed published scientific literature are primarily in the form of case series, case reports, and

retrospective studies. The studies are limited by the small patient populations (n=6–28) and lack of a control or comparator group. The clinical effectiveness and long-term safety of diaphragmatic pacing in the pediatric population needs to be further assessed (Onders, et al., 2011; Ali, et al., 2008; Onders, et al., 2007; Shaul, et al., 2002; Garrido-Garcia, et al., 1998).

Professional Societies/Organizations:
American Thoracic Society (ATS): In their discussion of the diagnosis and management of children with congenital central hypoventilation syndrome (CCHS) (Weese-Mayer, et al., 2010) the ATS states that in a subset of children, diaphragm pacing can be used during wakefulness to allow for age-appropriate activities while receiving assisted ventilation.

Medicare Coverage Determinations

	Contractor	Determination Name/Number	Revision Effective Date
NCD	National	Phrenic Nerve Stimulator/160.19	The effective date of this version has not been posted.
LCD		No Determination found	

Note: Please review the current Medicare Policy for the most up-to-date information.
(NCD = National Coverage Determination; LCD = Local Coverage Determination)

Coding Information

Notes:
1. This list of codes may not be all-inclusive.
2. Deleted codes and codes which are not effective at the time the service is rendered may not be eligible for reimbursement.

Considered Medically Necessary when criteria in the applicable policy statements listed above are met:

CPT®* Codes	Description
64575	Open implantation of neurostimulator electrode array; peripheral nerve (excludes sacral nerve)
64580	Open implantation of neurostimulator electrode array; neuromuscular
64590	Insertion or replacement of peripheral, sacral, or gastric neurostimulator pulse generator or receiver, requiring pocket creation and connection between electrode array and pulse generator or receiver

HCPCS Codes	Description
C1767	Generator, neurostimulator (implantable), nonrechargeable
C1778	Lead, neurostimulator (implantable)
C1816	Receiver and/or transmitter, neurostimulator (implantable)
C1820	Generator, neurostimulator (implantable), with rechargeable battery and charging system
C1883	Adapter/Extension, pacing lead or neurostimulator lead (implantable)
C1897	Lead, neurostimulator test kit (implantable)
L8680	Implantable neurostimulator electrode, each

HCPCS Codes	Description
L8683	Radiofrequency transmitter (external) for use with implantable neurostimulator radiofrequency receiver
L8685	Implantable neurostimulator pulse generator, single array, rechargeable, includes extension
L8686	Implantable neurostimulator pulse generator, single array, non-rechargeable, includes extension
L8687	Implantable neurostimulator pulse generator, dual array, rechargeable, includes extension
L8688	Implantable neurostimulator pulse generator, dual array, non-rechargeable, includes extension
L8696	Antenna (external) for use with implantable diaphragmatic/phrenic nerve stimulation device, replacement, each

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Revision Details

Type of Revision	Summary of Changes	Date
Annual review	• Removed noncoverage statement for diaphragmatic/phrenic (D/P) nerve stimulation for any other indication.	7/15/2025
Annual review	• No changes to coverage statement	7/15/2024
Annual review	• Updated to new template and formatting standards. • Added not covered: temporary respiratory insufficiency and in difficult to wean patients.	9/15/2023